



Important Notice

We have pleasure in announcing to all our Readers and advertisers that we are bringing out our ANNUAL NUMBER by the end of December, 1957 which will contain interesting articles on all branches of railway engineering contributed by eminent engineers. From this issue, the size of our technical journal is increased to that of sister railway publications in deference to numerous requests from overseas advertisers and other high officials of the Indian Railways. The price of our technical journal as well as advertisement rates remain unchanged.

Advertisers are requested to expedite their space orders on or before 30th November, 1957 as there is very limited advertising space available for commercial and institutional advertisements.

(Inserted by the Advertising Department)

KUMARDHUBI ENGINEERING WORKS LTD.

have
IMMEDIATE CAPACITY
for
RAILWAY WAGON CASTINGS
and
MISCELLANEOUS CAST STEEL CASTINGS
Also
MACHINE SHOP FACILITIES

KUMARDHUBI ENGINEERING WORKS LTD.
Chartered Bank Buildings, Calcutta-1

Managing Agents :
BIRD & CO. (PRIVATE) LTD.

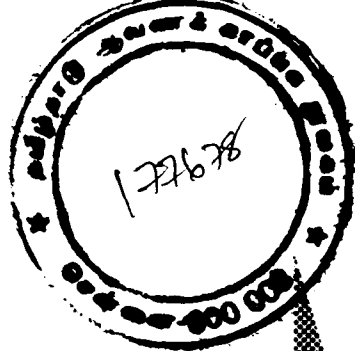
THE INDIAN RAILWAYS WORKSHOP MAGAZINE

INTEGRAL COACH FACTORY SUPPLEMENT

Vol. III No. 4 AUGUST 1957 Price As. 8/-

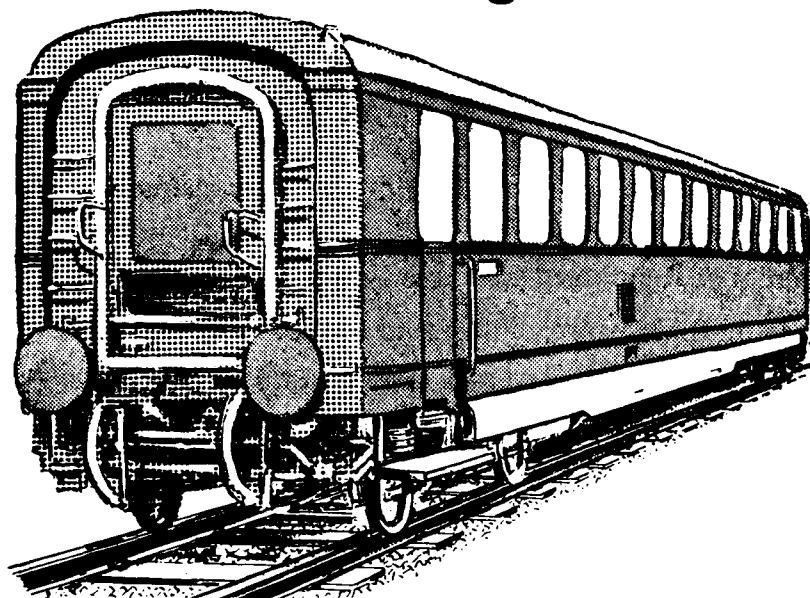
CONTENTS

	PAGE
A Peep into the Integral Coach Factory	3
The ' Schlieren ' Bogie for the new Integral Coaches for the Indian Railways, manufactured by the Integral Coach Factory	8
The Integral Coach Factory, Perambur	14
The Integral Coach Factory—Manufacture and Furnishing of Broad Gauge Coaches	20
" Air Conditioning System Operating in the Administrative Offices of the Integral Coach Factory "	26
The Economics of Reinforced Concrete Frame Buildings	30
Manufacture of Railway Iron Fittings in France	35
Surface Alloying in Brazing and Related Technique	37
Electric Lamps	40
Six-Axled Twin Car Diesel Train in Stainless Steel ' V2a ' Light-Weight Construction with Underfloor Engine	44
The Mysore Kirloskar Ltd., Harihar	51
The efficient handling and movement of goods & materials	53
Traverser without Portal for Transport of Diesel-Engine Driven and Electric Rail Motorcars and Coaches	55
A Locomotive with Diesel Pneumatic Transmission	60
Compressed Air System	66
Are Rail roads getting the most out of their Materials Handling Equipment ?	68
Range of Armstrong Whitworth Pneumatic Tools for Railway Workshops	77



MAN

**Assisting
Hindustan Aircraft
Private Ltd.
(A GOVT. OF INDIA ENTERPRISE)
In Manufacturing
Integral Coaches**



**Always at the
Service of India's
Five-Year Plans**



ESCORTS (AGENTS) PRIVATE LTD
PRATAP BUILDINGS, CONNAUGHT CIRCUS - P. O. BOX 187 - NEW DELHI
Branches: MADRAS - BOMBAY - CALCUTTA - PATNA - KANPUR

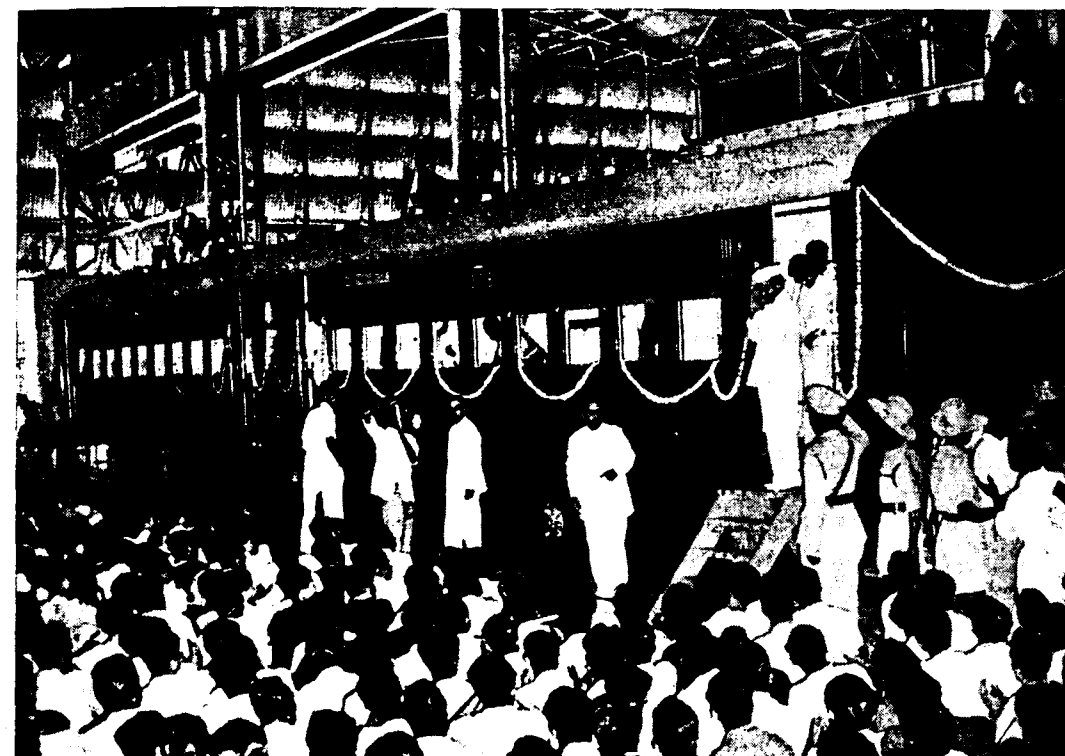
A Peep into the Integral Coach Factory

By Our Special Correspondent

THE Integral Coach Factory has made good progress in recent years. Mr. K. Satagopan, Chief Administrative Officer and his able team are leaving no stone unturned to see that the Factory becomes a model one for others to follow. The Factory has very successfully completed a year of production in January, 1957 and against the target of 20 coaches set by the Government, they had not only completed 40, as revised by the Government, but have even exceeded that figure and completed 43 coaches. During the second year they have a still heavier and more ambitious programme to fulfil and there

is no doubt the Integral Coach Factory will rise to the occasion.

It was to meet the twin problem of replacing a large number of over-aged stock and, at the same time, adding substantially to the present holding of the passenger coaches that the Government of India decided to establish a separate railway coach building factory. After a comprehensive survey of several alternative sites for locating the factory, the vacant railway land to the west of the Locomotive Repair Shop of the Southern Railway at Perambur, in the suburbs of



H. E. the Governor of Madras Mr. A. John alighting from the first furnished coach manufactured at the ICF after inspection.

Madras, was chosen in June 1951. By September 1952, the Engineers had completed the survey and had come into full swing in the field for construction of the factory buildings. The factory was completed, ready for inaugurating production in October 1955, in a record period of 3 years – a record which even the industrially advanced countries of the West with unlimited resources of men and material will find difficulty in accomplishing. The factory costs Rs. 7.35 crores and spreads over an area of 51.5 acres.

The integral coach to be manufactured is the most modern type of coach design in Europe and combines three major factors ensuring comfort and safety to the travelling public, viz, smooth running, light weight and strength. The design incorporates the all-welded trough floor system integral with the body and permits the forces sustained by the coach to be borne by the entire body including the skin. It is this feature which gives it the name 'Integral Coach'. Another advantage of the coach is that it incorporates anti-telescopic construction and this feature reduces the possibility of the coaches telescoping in the event of an accident. The tare weight of the equipped third class coach is 35 tons against 42 tons of the conventional coach and the carriage has seating capacity of 80 passengers in third class.

Production of 350 body shells a year at the rate of one body shell per six working hours, is the target of the Integral Coach Factory and this would represent perhaps the largest output of any single coach building Factory in the world. According to the Technical aid Agreement entered into with Messrs. Swiss Car and Elevator Manufacturing Corporation Ltd., Schlieren-Zurich, Switzerland, this was to be achieved in progressive stages in 5 years as indicated below :—

First year	..	20 coaches
Second year	..	100 ..
Third year	..	200 ..

Fourth year	..	300 ..
Fifth year	..	350 ..

From the production experience gained since October last, it has become possible to double the target of out-turn in the first year, from 20 to 43. It has also been possible to rearrange the whole Production Plan with a view to attaining the maximum production target of 350 coaches a year, one year ahead of schedule, that is, in the 4th year of production, instead of fifth year.

In the matter of establishing indigenous manufacture of parts, components and sub-assemblies, it has been possible to achieve very considerable progress in this direction. The coach body shell consists of 1169 items of which 1120 components are either manufactured in the Integral Coach Factory or purchased indigenously. The remaining 49 finished components are at present being imported from abroad but it is proposed to develop the indigenous capacity to manufacture 47 of these components also in the country leaving a balance of two components to be still imported. These two items which present difficulty for manufacturing indigenously are the Axle Box Roller Bearings, demands for which will not interest any manufacturer in producing these bearings in the country at present.

A completely indigenus coach shell from the details, sub-assemblies and assemblies manufactured in the I. C. F. was turned out from the Main Assembly Shop by the President on the 14th of August, 1956 and since then seven more have been turned out.

Sufficient machinery and plant numbering 608, for the production of 250 body shells have already been installed and, based on the experience gained, 417 extra machines inclusive of 220 portable welding sets have been ordered to step up the outturn from 250 body shells to 350 body shells a year. To obtain economical processing and

interchangeability and easy assembly, almost all the details and sub-assemblies are manufactured on jigs and fixtures. 750 jigs and fixtures have had to be specially designed for the manufacture of these components.

Handling and storage have also been given careful attention in order to save on unnecessary handling costs and economise on the floor space. Most of this shop equipment has been manufactured in this Factory itself.

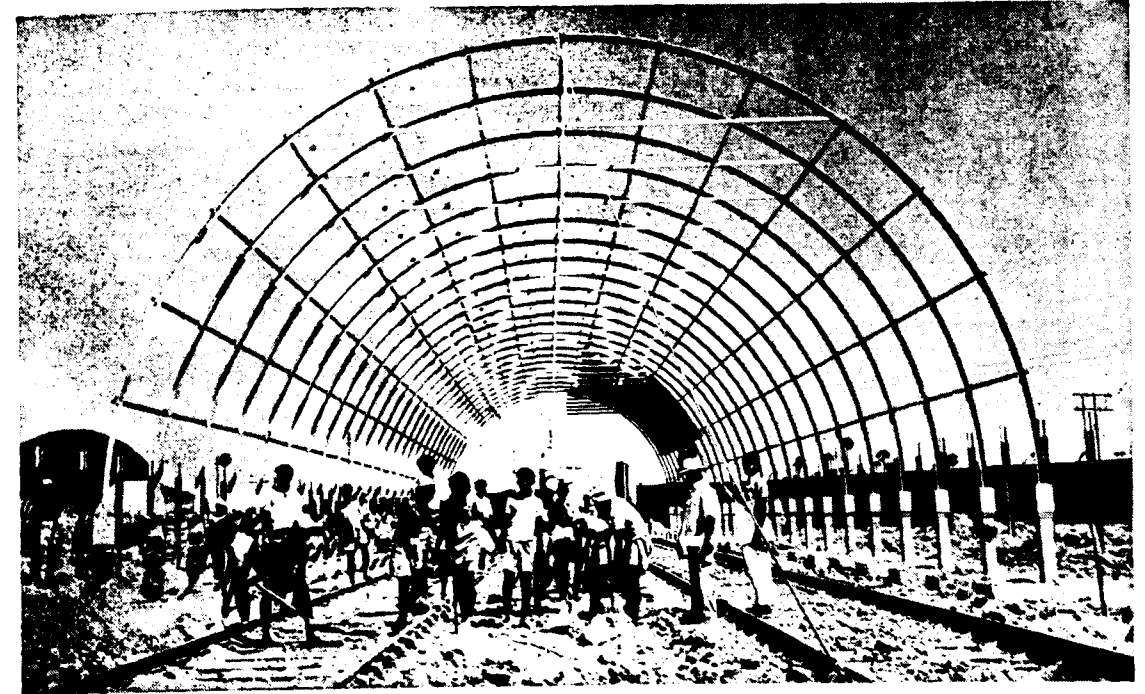
The Factory will employ 4000 men when in full production. It was foreseen to train these men well in advance of the production and the Technical Training School for training the technicians to the required skill was started as early as March, 1954. This school has already produced 4 batches of Apprentices numbering 665 men and the 7th batch of 190 boys is now undergoing training in the Basic Training Workshops attached to the school.

A Hostel to accommodate 250 boys has already been completed and the boys have moved into the hostel from the 1st of August, 1956.

A proper Theoretical Training School has been completed subsequently and is functioning since November last.

A Colony of 400 quarters has been provided to accommodate the essential staff. All the modern amenities are included in this Colony, which has a Primary School, a Children's Park, a Recreation Club and a Co-operative Stores.

It has been the aim of this Administration to provide good working conditions for workmen in the Factory. Lighting and ventilation of the shops have been given special attention. Staff canteens run on a co-operative basis have been provided near the Main Entrance as well as in the Office. Water coolers to supply cooled drinking water have been installed in the shops. Bathing places and



A Nissen Hut in the temporary furnishing factory is taking shape

lavatories have been provided at convenient places.

Now let us see the expansion program of the Integral Coach Factory. The integral shells manufactured in the Integral Coach Factory were originally planned to be furnished in Railway Workshops. On account of the Second Five Year Plan requirements and large expansions necessary on the Railways, the capacity in Railway Workshops is now required for timber coach building and for their increased needs for repairs and maintenance. Further, it was logically most economical to have the factory furnishing on mass production methods and produce the complete units, viz., a coach ready for use. Hence, a furnishing unit has been sanctioned by the Government of India at a cost of Rs. 3.69 crores. This unit will be located close to the factory - South of the New Avadi Road, where about 240 acres are being acquired for the factory including some land for future additional quarters.

The proposed Furnishing Factory will have a covered area of 5.5 lakhs sq. ft. The factory buildings will be of modern design similar to the Integral Coach Factory with ample lighting and ventilation and will cost Rs. 102 lakhs. There will be about 260 machines to enable a target production of 350 coaches of all types per year. To obtain economical and speedy work, jigs and fixtures will be used extensively for details and sub-assemblies.

A number of details and fittings will be obtained from the trade. Adequate storage has been provided for and the entire design of storage and lay out has been made to suit an economic handling of material.

It is estimated that the factory will employ about 2400 men when in full production. The training of the men required is also being planned by suitable expansion of the Technical Training School of the Factory at a cost of about Rs. 4 lakhs.

A Colony of 200 quarters is being provided to accommodate the workers of the Integral Coach Factory.

requirement of additional quarters has also been envisaged and a provision of land adjacent to the Factory has been made. The standards of amenities for good working conditions, cooled drinking water, bathing places and lavatories and also canteens and co-operatives will be planned on similar scales to those already planned for the Integral Coach Factory.

In order to expedite bringing into full production of the furnishing unit and also to find additional coach building capacity so badly needed for the expansion requirements of the Second Five Year Plan, arrangements have been made to commence furnishing work immediately. Development of technique and staff will be done gradually during this furnishing work. It has been started in a small free space available in the Integral Coach Factory. Temporary sheds have been sanctioned and are under construction in which further furnishing work will be undertaken. A small amount of machinery and plant costing about Rs. 6 lakhs will be obtained for the interim work which will all be subsequently utilised by the Unit. The interim furnishing programme has been so made that the workshops of the furnishing unit will be utilised immediately they are completed and the staff of the furnishing switched over to the Unit. Thus, the unit will be brought into full production as soon as it is complete.

In accordance with these plans, the first coach has been furnished in the Integral Coach Factory and has been launched into service by His Excellency the Governor of Madras on 21st February 1957.

This coach has been furnished for 3rd class. It has 4 lavatories, 2 in the middle and one at each end. The coach is divided into two halves by the middle lavatories and

the seats are arranged as one row of single seats along one side, a passage by the side of these single seats and transverse long seats on the other side. Each of these long seats takes 4 passengers. Two fans are provided for each pair of seats facing each other seating 8 persons in the long seats and 2 persons on the single seats. Two night lights have been provided on each half of the coach. There are two shutters on each window, one of Aluminium venetians and the other of glass in an aluminium frame. The lavatories have been provided with mirrors and wash hand sinks. The commode is of Indian style and made of stainless steel. The flooring of the compartment and the lavatories is of oxy-Chloride Cement which gives a pleasing red smooth surface and lasting hygienic qualities. The coach body doors as well as lavatory doors are provided with chromium plated handles and spring loaded catches, while additional locking has also been incorporated. The interior has been finished in light biscuit and buff colours relieved by aluminium mouldings giving a bright clean appearance.

The Integral Coach Factory produces new type of coaches which is new to the Indian Railways. So a one week training course was held during the first week of February 1957, for the Mechanical Officers deputed by the various Railways for providing them with information regarding the design and manufacture of the Integral coaches and the maintenance problems they may have to tackle in such coaches in use on their Railways. The new coach design is something new to the Indian Railway Engineers as the whole construction is on new lines.

HIGH TENSION INSULATOR FACTORY

According to a statement made recently by the Industries Minister, Madras, a private entrepreneur has been granted license to start a high tension insulator factory using by-products likely to be available from lignite mining in Neiveli, South Arcot. The Minister said the subsidiary industries would be left to be organised by private entrepreneurs using by-products of Neiveli lignite mines such as synthetic petrol, tar, phenol, cement, porcelain, etc., but, he added, steps could be taken to set up these industries only after conducting pilot plant trials.

With reference to the welding process at the Integral Coach Factory it has been stated that it would be a matter for careful consideration to reduce the maximum demand of the Factory as much as possible and build up a good Load Factor in the interest of reducing the electricity bills and that proper staggering heavy equipment like furnaces and other plants including the heavy welders would prove a great advantage in that line.

Inspection and testing of welded bogie bolsters and underframes is very important for which a non-destructive method of testing is invaluable, it is stated. Radiographic inspection i. e., by adopting X-Rays, is proposed and the necessary equipment is being processed through, besides magnetic crack detectors.

With the latest equipments they have in the Factory and the technical skill being developed locally in the Integral Coach Factory Basic Training School, there is ample scope, it is stated, for more perfection and advancement in not only the technological aspects of welding but also its allied electrical and other problems.

There are 1,169 components for the coach manufactured at the factory, out of which 1,120 components are either manufactured in the Integral Coach Factory itself or purchased indigenously. The remaining 49 components are at present being imported from abroad. The Government of India are exploring ways and means of manufacturing these 49 components also indigenously.

The 'SCHLIEREN' Bogie for the new Integral Coaches for the Indian Railways, manufactured by the Integral Coach Factory

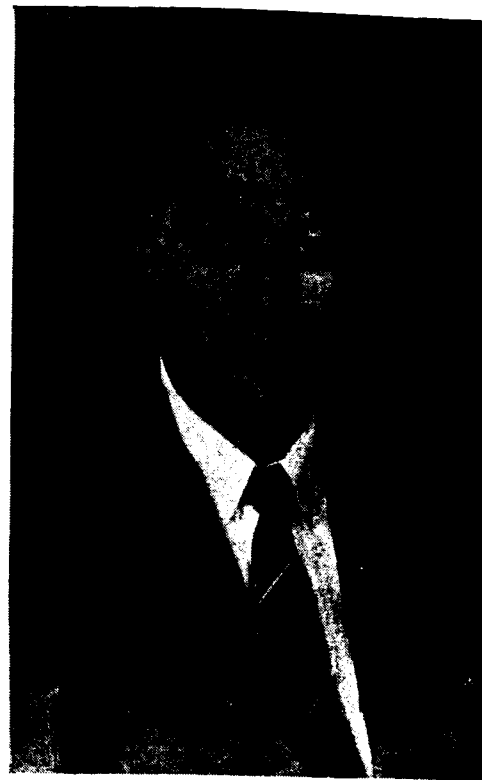
By W. J. Bræm,

Chief Technical Manager, Integral Coach Factory

ONE hundred years ago, the first Railway link between Bombay and Thana was inaugurated. Since then many changes have taken place in Railway services being the public utility service, have to march with the times and cannot stand back. Considering the big enterprise the Railways generally form in a country, and specially where Railways are Government-owned and they should even take a leading part and should, therefore, try not only to go with the times but to go ahead of time. The Indian Railways, with their new schemes, are just about to reach this stage.

"In the initial stages all-wooden coaches similar to horse-driven carriages of that age were used. Then in the second stage also all-wooden coaches, but better adapted to Railway purposes, were in service. In the third stage, and this is about the beginning of the 20th century, wooden bodies were built up on steel underframes, and in the fourth stage, round about 1920 and the later years all-steel coaches of a rather very heavy design were adopted. During this period, opinion was held that only a heavy type of coach would give good riding qualities and would be rigid enough to give ample security to passengers in case of Accidents. This was specially influenced by the American Railways Engineering Practice at that time.

Now in the fifth stage since 1937, lightweight rolling stock designs have been evolved in mild steel, stainless steel or even aluminium alloys incorporating the features of improved riding facilities and security to passengers. However, keen pioneer work was needed to make such a design possible. It also needed some enterprising and broad-minded Railway Administration which were



W. J. Bræm.

prepared to accept coaches of such an entirely new design in order to try them out and prove their advantages compared to the preceding rolling stock of heavier construction. It is only in this fifth stage that Railway coach building has been started on a somewhat scientific basis.

"The light-weight steel coach for the Indian Railways, which will be manufactured in the I. C. F. in future, incorporates many new features and inventions as compared to the Railway Coaches built previously.

"It is needless to point out that the bogies are the exceptionally important parts of a



Schlieren

Schlieren Lightweight Steel Coaches for Travelling Comfort in India

Swiss Car and Elevator Manufacturing Corporation Ltd. Schlieren-Zurich (Switzerland)

Railway coach. The riding comfort depends nearly 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 long, uninterrupted and maintenance-free service.

"In designing and constructing the Schlieren bogie, attempts have been made to incorporate all these requirements. It has been possible by taking advantage of new processing methods, welding techniques, etc., to develop a new standard type of bogie which became a pioneer in this field. Preliminary studies for this new design and already started more than 20 years ago.

"The set aims at that time for bogie construction were, increased riding qualities, lesser weight, and a greater dependability, i.e., less maintenance, and it can be said that all these aims have been achieved by now.

"The following are some of the important constructional details of the Schlieren bogie :-

"In the first instance, the saving in weight per bogie which amounts to about 23% in comparison with the IRS bogie in use till now on the Indian Railways. This has been achieved specially by restoring to a reliable welded construction throughout the bogie frame and the bogie bolster. Wheel sets come next in contributing to the weight-saving, as the special aim was also to reduce the unsprung weights as far as possible. The bogie of the new light-weight steel coach of the Indian Railways has wheel sets according to the European standard of 3 feet wheel diameter only, against 3' 7" of the conventional IRS wheels. It may be noted that as the total weight of the Schlieren coach is approximately 7 tons lighter than the conventional one, the axle load is reduced by nearly 2 tons and therefore a somewhat smaller wheel diameter can be adopted without any disadvantages.

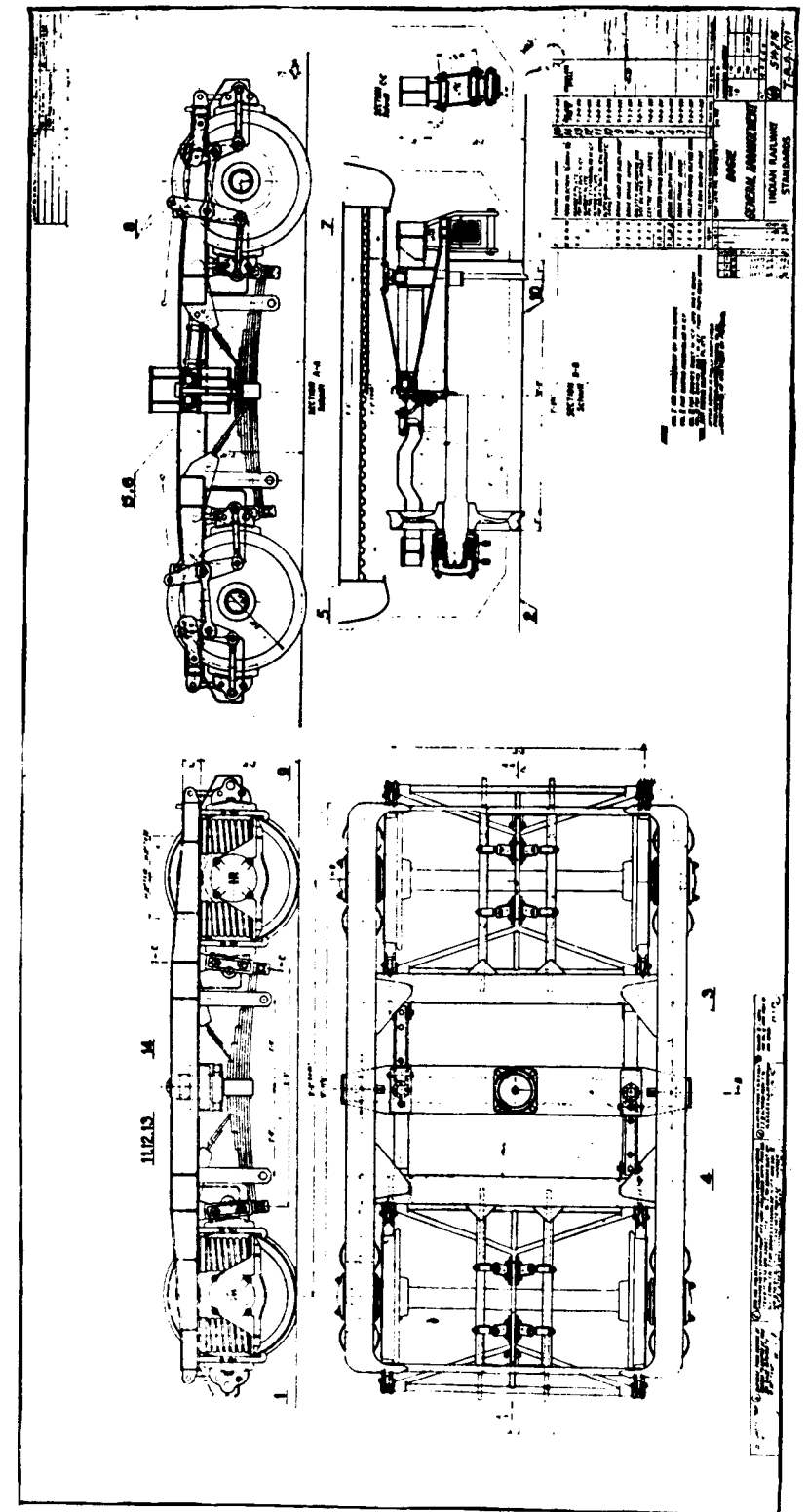
"Great care is being given nowadays to the reduction of unsprung weights to the greatest possible extent. This results in less wear and tear of the permanent-way wheels and other parts of the coach in general. Shocks from rail joints transferred to the coach body, which cannot be absolutely eliminated, can be reduced appreciably.

"Modern Railways prefer already for there new coaching stock, wheel sets of a special light design, with double corrugated wheel discs pressed in dies and equipped with hollow axles.

"The Swiss Federal Railways have come to know from experience that the higher costs of these light wheel sets are largely compensated by the reduction in cost on account of the lesser wear and tear on the wheels and the permanent way and, further by the better riding comfort achieved. The additional saving in weight with such light-weight wheel sets of 3' diameter is half a ton per wheel. When compared with the IRS wheel sets with 3' 7" wheel diameter, the unsprung weight would be reduced by nearly 40%. The first two prototype coaches, which were delivered by Schlieren (Switzerland) to the Indian Railways in 1951, have been fitted with such special light-weight wheel sets to enable the Indian Railways also to gain experience. For the I. C. F. production, however, no such special light-weight wheel sets are going to be used at the moment as the manufacture of such wheel sets has not yet developed in India.

AXLE BOXES AND AXLE BOX GUIDES

"As a result of the Good experience with axle boxes fitted with roller bearings, these new bogies have also been equipped with roller bearings. For the axle box guides, a special patent construction, which has been developed in Schlieren (Switzerland) and which has proved very successful in service since many years on various Railways, has been adopted. With this axle box guide the



play between the axle box and the guide has been eliminated and this ensures a better riding quality of the coach. These axle box guides are working in an oil bath sealed against dust and water, thereby resulting practically in no wear and tear. They are further so constructed that they also act as shock absorbers for the axle box helical springs controlling the deflection of the spring similar to the shock absorber arrangement in an automobile.

"The experience with such axle box guides has shown that the maintenance is minimised requiring only periodical checking and topping up of the shock absorber oil.

SPRINGING

"Besides the axle box springs which are arranged on each side of the axle box, the bogie has also two bolster laminated springs arranged longitudinally, on which the bogie bolster is directly supported. By arranging the laminated springs longitudinally on the bogie, long springs could be applied which results in softer action of the spring. Further, Schlieren have used for the longitudinal spring, leaves having channel profile.

"This special channel profile provides the spring with a cavity throughout the whole length of the blades after they have been assembled. These cavities provide an ideal means of permanent lubrication as they are capable of storing a considerable amount of a lubricant. This ensures an improvement of the spring in its shock absorbing capacity enabling a softer cushioning of the coach—so important for comfortable travelling. Further more, it has to be noted that the spring leaves, before being assembled, are passed through the so-called "overstraining process" which makes it possible to load such a spring to such an extent without its showing any permanent deformation that the stresses, calculated in accordance with the usually known bending formula, will be much

higher than the yield point or even the tensile strength of the steel.

BOLSTER SPRING SUSPENSION

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

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

"The bogie bolster is connected by means of two anchor links in the longitudinal direction to the bogie frame. These anchor links communicate the pull and braking forces resulting from accelerating or braking from the coach body to the bogie frame. The bolster springs are therefore being completely freed from such additional forces which again count and are very important for the soft action of the spring.

"A further feature is that the centre line of the anchor links coincides with the centre line of the centre pivot. Due to this feature the pull and braking forces transmitted through the centre pivot to the bogie frame do not result in a bending moment requiring a bigger centre pivot.

"These anchor links are also an improvement over the up-till-now-known sliding plate guides located between the cross-member of the bogie frame and the bogie

bolster. The new anchor links are also much less susceptible to wear and tear and have the great advantage that an absolute-play-free-connection between the body bolster and bogie frame could be achieved which eliminates additional jerking while the coach is running.

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

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

BRAKE GEAR

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

tear and the free play of the bogie is unaffected during the braking period.

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

CONCLUSIONS

"The outstanding features of the new bogie of the Indian Railways light-weight steel coaches can be summarised as follows:

- (1) The total weight of the bogie has been reduced by 23% against the old IRS bogies.
- (2) The unsprung weight has been reduced by 20% as compared to the conventional IRS bogies resulting in much lesser wear and tear of the track and coaching stock.
- (3) The wear and tear of the axle box guides has been completely eliminated.
- (4) The movements of the axle box helical springs are being controlled by built-in-shock absorbers.
- (5) The centre pivot is completely released of any additional reaction stresses from the brake gear.
- (6) The conventional rubbing blocks for the bogie bolsters have been replaced by the anchor link arrangements which eliminates the jerky movements of the bolster."

THE INTEGRAL COACH FACTORY, PERAMBUR

By H. Bänziger,
Dy. Chief Tech. Manager, I. C. F., Perambur

THE biggest coach building unit in Asia is located in Madras, the Integral Coach Factory, Perambur, manufacturing all steel light weight coaches for the Indian Railways. The I. C. F., as it is called in short, reached its first stage of development on October 2, 1955, with the inauguration of production by Prime Minister Jawaharlal Nehru. With this, the start was initiated for a set target of 350 all metal light weight coaches per year, to be reached in 1960, when every 6 hours an all metal light weight coach will leave this factory. By the combined efforts of the Swiss and Indian engineers, the output in the second production year has already reached the manufacture of one coach every 12 hours, in this way proving the success of this collaboration.

The Indian Government and with it the Indian Railways were compelled, soon after reaching independency in 1947, to compensate for the big deficiency of rolling stock. The lack of rolling stock resulted from over age, since there was no replacement during the war, and the traffic increased tremendously ever since 1939. The Indian Railways were therefore forced to renovate their complete rolling stock which, as an immediate remedy, could be accomplished by imports only.

Due to the growing industrialisation of India it was obvious to also take into consideration the construction of a coach building factory. The decision for the construction of a coach Factory for the manufacturing of broad gauge coaches was taken in 1948 by the former Railway Minister, Mr. N.G. Ayengar.

Enquiries were then started in order to find out which coach design should be adopted as the future standard design for the Indian Railways. For this reason, a delegation of Indian Railway engineers visited all the



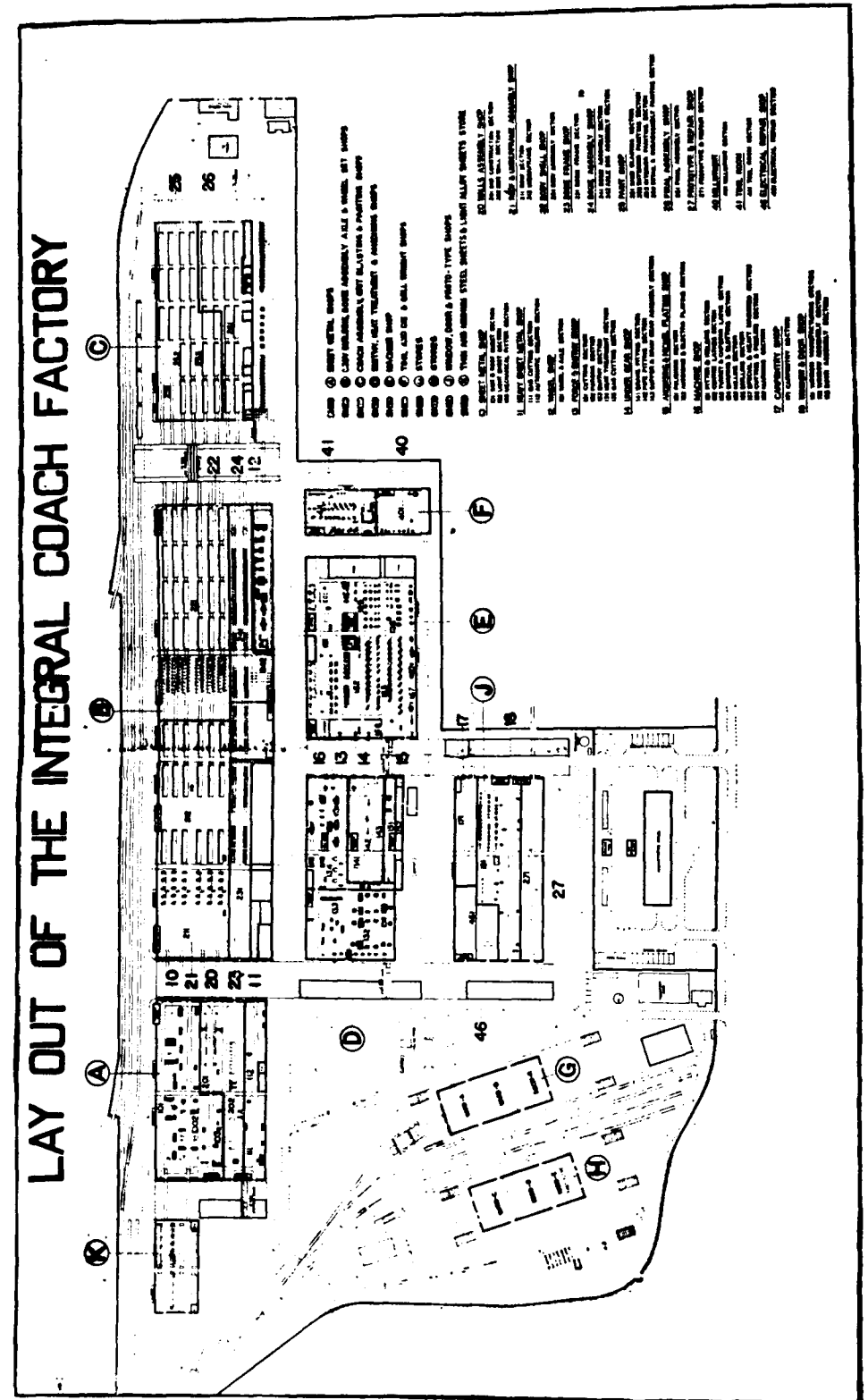
Mr. H. Bänziger.

important coach factories in Europe as well as in the U. S. A.

After a through investigation, decision was reached that the all metal light weight coach built by the Swiss Car and Elevator Manufacturing Corporation Ltd., Schlieren, Zurich, should be accepted, it being the most suitable coach design for India.

"INTEGRAL DESIGN"

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 of providing 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 up 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 manufacture, 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".

Birth in Switzerland: This new method of construction had its birth in Switzerland, the first execution of which dates back to 1933, when Messrs. Swiss Car and 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 railway administrations as an ideal design of modern coach building.

Special feature: The apparent characteristic feature of this new construction lies in the unique constructional design 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, only had to serve as a carrying unit or a supporting bridge resting on the running gears or bogies at both ends. The 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 coach.

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 together constitute an integrated structural body which can, in a certain sense, be 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 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".

Seven tons savings per coach: With this type of construction, savings in weight upto 30 per cent can be achieved. In the case of the new light weight passenger stock designed for the Indian Railways, seven tons of steel will be saved for every individual coach, the new third class coaches weighing 35 tons only against 42 tons for coaches of the old design. 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, has all the properties for sound "weldability". When the new Government 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 Louvre 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 receives 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 smooth flow of work on the various assembly lines.

Riding Quality: In developing this new integral all-welded light weight 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 design. 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.

The "Schlieren" bogie that has been adapted by the Indian Railways, incorporates several new features. Taking advantages of the new processing methods, welding techniques etc., it had been possible to reduce its weight by 23 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.

Cushioning effect in riding: The axle boxes which play an important role, are fitted with spherical roller bearings. The old jerky axlebox 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 the long run. This improvement of the spring 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.

Coach seats 80 Passengers : The new third class all-steel coach seats 80 passengers. It has four lavatories and four doors per side. The length of the coach body is 70 feet, while its width is ten feet eight inches. The width of the compartment is five feet seven inches, while the space between seats is one foot and nine inches.

The seats are made in wooden strips placed transversely to the length of the coach. Above the bunks are luggage racks which can be utilised as upper berths.

An agreement was concluded in May 1949 between the Indian Government and the Swiss Car and Elevator Manufacturing Corporation Ltd., Schlieren. Accordingly, Schlieren was compelled to first build two prototypes. After extensive tests in India on the Indian Railways net, orders for the supply of light weight steel coaches were placed on "Schlieren".

Furthermore, Schlieren had to supply a project study for a coach factory with a capacity of 350 unfurnished all metal light weight coach bodies and bogies per year.

Based on this project study, a suitable site had to be selected. Bangalore was considered before a decision was taken in favour of Perambur, offering advantages which could not be overlooked, having the big repair shop for locomotives and carriages in its vicinity, road and rail connections in existence, and being in the proximity of Madras which meant it was not necessary to build a colony for the entire staff.

Building started in September 1953 with the driving in of the first pile for the shop building foundations, standing on 2500 piles.

The plant of the Integral Coach Factory consists of 10 workshops arranged for unidirectional production of the all metal light weight coach. The Shops of sheet construction with north-light sheds are covered with corrugated, well ventilated asbestos sheets, a requirement for the South Indian climate. The production flow for the coach shell and bogie starts from the Sheet Storage building at the west, goes through the Sheet Metal Shop into the Assembly Hall and from there to the Paint Shop.

The production of parts flows on a parallel line from the heavy steel store at the west into the Smithy and then to the Machine Shop, which delivers the finished parts into the Assembly Hall.

The Door and Window manufacturing unit is housed in a separate shop and delivers the finished products directly to the Paint Shop where they are fitted to the Coach.

Adjacent to the Machine Shop is the Tool Room and the Millwright Section. For the storage of the semi-finished products, consumable goods, etc., two store buildings are provided.

Besides these production units and store buildings, provision for a 4 storey administrative building, a workers' canteen, and

artisan training school and a colony with 400 staff quarters were built.

The Sheet Metal Shop is arranged for the shearing, forming and the welding of sheets and plates. Complete sidewalls, floors and end constructions are assembled in huge complex welding jigs. These prefabricated coach parts are then transported on special vehicles into the 1000 feet long Assembly Hall, one of the biggest industrial buildings in India. In this Assembly Hall, the coach shells take shape on six separate lines simultaneously in a breath-taking pace. The roof is produced in a gigantic rotating, 70 feet long welding jig, followed by the assembly stand for the underframe. In the last step these sub-assemblies, i.e. underframe, sidewalls, and construction and finally the roof are welded together in the ingeniously arranged assembly jig of Schlieren design, forming the self-supporting shell. A self-supporting coach shell is lifted out of this assembly jig every 36 hours (4½ days) and lowered on to diaphanous rollers for its further transport over a traverser into the track of the Paint Shop where the grit blasting plant is installed.

The coach shell passing through the grit blasting plant is cleaned and now ready to receive its first coating. While the coach shell is pushed through the different stages in the Paint Shop, paint is applied, insulation carried out, complete doors and windows are delivered, ready for assembly, from the door and Window manufacturing Shop; these are fixed on and the finished coach shell is lowered on to its bogies. Passing through a final inspection, the coach is ready to leave the Integral Coach Factory, over a second traverser on the connecting main track.

Bogies : The bogie frames for which the parts are delivered from the Sheet Shop are welded together on two parallel lines adjacent to the coach shell assembly lines in the assembly hall.

In the first stages the frame is built and then transferred to fixtures supported on diaphanous rollers till the frame is completely assembled. From the opposite side axles and wheels are manufactured and assembled to wheel sets, receiving the last machining operation on a wheel lathe and delivered for the erection of the bearing. The parts for the final assembly of the bogies are delivered from the Machine Shop.

The wheels with their bearings are then transferred to the bogie assembly line which is a continuation of the bogie frame line, for their final erection. From the Assembly Hall the finished bogies are moved on their own wheels into the Paint Shop, where the coach shell is lowered on to them. This now is the final product of the Integral Coach Factory, the "all metal light weight coach".

The procurement of the machinery and plants required for manufacturing the all metal light weight coach at the Integral Coach Factory in Perambur started in 1954. On January 20, 1955, the erection of the machinery started in presence of the Railway Minister. The initial production began on October 2, 1955.

Further procurements to bring the machinery and plants in step with the production requirements and the increase of staff to its full capacity of 600 machines for the manufacturing of 350 all metal light weight coaches were made in 1956 and 1957.

Artisan Training School : For a production unit of the size of the Integral Coach Factory, steps had to be taken in good time for training the required staff of approximately 4000 men. In March, 1954, the Artisan Training School was opened by the Railway Minister for the training of the first batch of 260 apprentices, i.e., 60 as machinists, 100 as fitters and 100 as welders, with an instruction period of 6 months' basic training, followed

(Continued on page 20)

The Integral Coach Factory— Manufacture and Furnishing of Broad Gauge Coaches

IT was to meet the twin problem of replacing a large number of over-aged stock and, at the same time, adding substantially to the present holding of passenger coaches that the Government of India decided to establish a separate railway coach building factory. After a comprehensive survey of several alternative sites for locating the factory, the vacant railway land to the west of the Locomotive Repair Shop of the Southern Railway at Perambur, in the suburbs of Madras, was chosen in June 1951. By September, 1952, the Engineers had completed the survey and had come into full swing in the field for construction of the factory buildings. The factory was completed, ready for inaugurating production in October 1955, in a record period of 3 years—a record which even the industrially

advanced countries of the West with unlimited resources of men and material will find difficulty in accomplishing. The factory costs Rs. 7.35 crores and spreads over an area of 51.5 acres.

DESIGN AND ADVANTAGES OF THE INTEGRAL COACH

The integral coach to be manufactured is the most modern type of coach design in Europe and combines three major factors ensuring comfort and safety to the travelling public, viz., smooth running, light-weight and strength. The design incorporates the all-welded trough floor system integral with the body and permits the forces sustained by the coach to be borne by the entire body including the skin. It is this

feature which gives it the name 'Integral Coach'. Another advantage of the coach is that it incorporates anti-telescopic construction and this feature reduces the possibility of the coaches telescoping in the event of an accident. The tare weight of the equipped third class coach is 35 tons against 42 tons of the conventional coach and the carriage has seating capacity of 80 passengers in third class.

PRODUCTION

Production of 350 body shells a year at the rate of one body shell per six working hours, is the target of the Integral Coach Factory and this would represent perhaps the largest output of any single coach building Factory in the world. According to the Technical Aid Agreement entered into with Messrs. Swiss Car and Elevator Manufacturing Corporation Ltd., Schlieren-Zurich, Switzer-

land, this was to be achieved in progressive stages in 5 years as indicated below :—

First year	..	20 coaches
Second Year	..	100 coaches
Third Year	..	200 coaches
Fourth Year	..	300 coaches
Fifth Year	..	350 coaches

From the production experience gained since October 1955, when the factory was inaugurated by our revered Prime Minister, it has become possible to double the target of outturn in the first year, from 20 to 43. It has also been possible to rearrange the whole Production Plan with a view to attaining the maximum production target of 350 coaches a year, one year ahead of schedule, that is, in the 4th year of production, instead of in the 5th year.

(Continued from page 19)

by one year of improvement in the shop floor.

Specific training in coach building was accorded to already skilled and specially selected men (78+4 officers) through 6 to 12 months' stage at the Swiss Car and Elevator Manufacturing Corporation Ltd., Schlieren, Zurich, Switzerland, and these men have now been placed in key positions in the manufacturing process at the Integral Coach Factory.

India has a right to be proud of the Integral Coach Factory, bringing this country a step forward in its aim towards independence.

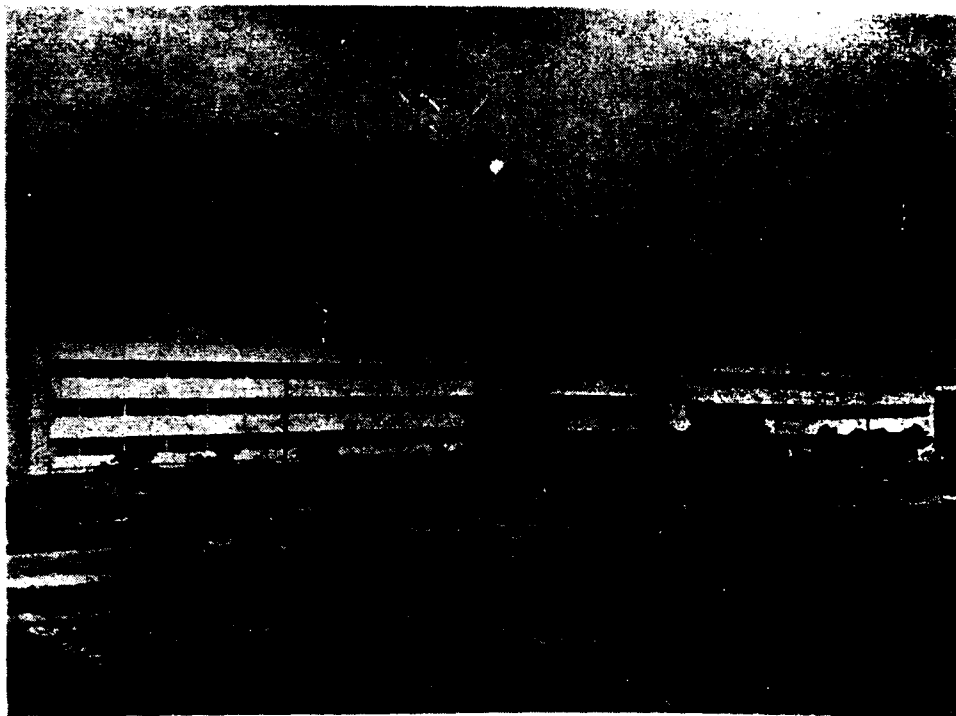
The Integral Coach Factory in brief :

covered area in the shops	8,48,600 sq. ft.
number of sheds	10
Tonnage of steel	9,500 tons

length of rail lines	12 miles
roads inside shops	3.4 miles
roads in colony	3 miles
houses	400 miles
water supply pipes	16 miles
consumption of cement	19,500 tons
general purpose machines	540
special purpose machines	60
jigs and fixtures	750
pipe lines, cooling water, oil,	
compressed air	8.4 miles
compressors	8,250 cft./min.
20 ton overhead cranes	4
5 ton overhead cranes	26
75 ton traversers	2
number of workmen (to be employed)	4,000
annual output in single shift	350 unfurnished coaches
total consumption of electrical units per annum	60,00,000 units
total cost of project	Rs. 7,35,00,000



An aerial view of the Integral Coach Factory area.



A view of the Technical Training School Apprentices Hostel.

In the matter of establishing indigenous manufacture of parts, components sub-assemblies, it has been possible to achieve very considerable progress in this direction. The coach body shell consists of 1169 items of which 1120 components are either manufactured in the Integral Coach Factory or purchased indigenously. The remaining 49 finished components are at present being imported from abroad but it is proposed to develop indigenous capacity to manufacture 47 of these components also in the country, leaving a balance of two components to be still imported.

A completely indigenous coach shell from the details, sub-assemblies and assemblies manufactured in I. C. F. was turned out from the Main Assembly Shop by our revered President, Dr. Rajendra Prasad on the 14th of August, 1956, and since then indigenous coaches are manufactured simultaneously with the assembly of knocked down components.

MACHINERY AND PLANT

Sufficient machinery and plant numbering 608, for the production of 250 body shells have already been installed and based on the experience gained, 417 extra machines inclusive of 220 portable welding sets have been ordered to step up the outturn from 250 body shells to 350 body shells a year. To obtain economical processing and interchangeability and easy assembly, almost all the details and sub-assemblies are manufactured on jigs and fixtures. 750 jigs and fixtures have had to be specially designed for the manufacture of these components.

Handling and storage have also been given careful attention in order to save on unnecessary handling costs and economise on the floor space. Most of this shop equipment has been manufactured in this Factory itself.

WORKERS AND THEIR TRAINING

The Factory will employ 4000 men when

in full production. It was foreseen to train these men well in advance of production and the Technical Training School for training the technicians to the required skill was started as early as March, 1954. This school is producing skilled technicians in batches at a rapid pace.

A Hostel has been built to accommodate 250 boys undergoing apprenticeship at the school.

A proper Theoretical Training School has been completed subsequently and is functioning since November last.

AMENITIES

A colony of 400 quarters has been provided to accommodate the essential staff. All the modern amenities are included in this Colony, which has a Primary School, a

Children's Park, a Recreation Club and a Co-operative Stores.

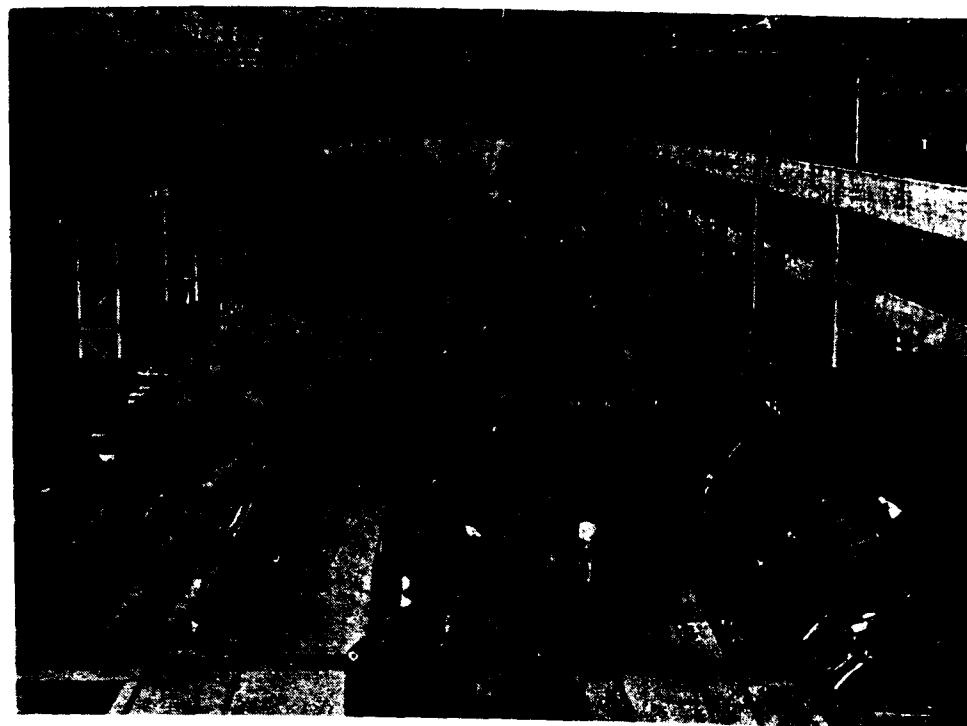
It has been the aim of this Administration to provide good working conditions for workmen in the Factory. Lighting and ventilation of the shops have been given special attention. Staff canteens run on a co-operative basis have been provided near the Main Entrance as well as in the Office. Water coolers to supply cooled drinking water have been installed in the shops. Bathing places and lavatories have been provided at convenient places.

FURNISHING PROJECT

The integral shells manufactured in the Integral Coach Factory were originally planned to be furnished in Railway Workshops. On account of the Second Five Year Plan requirements and large



An inside view of the Integral Coach Factory workers' Canteen where the workers are having their lunch.



A view of the Main Assembly Shop—1000' long—220' wide—with the three assembly jigs.

expansions necessary on the Railways, the capacity in Railway Workshops is now required for timber coach building and for their increased needs for repairs and maintenance. Further, it was logically most economical to have the factory furnishing on mass production methods and produce the complete unit, viz., a coach ready for use. Hence, a furnishing unit has been sanctioned by the Government of India at a cost of Rs. 3.69 crores. This unit will be located close to the factory where about 240 acres are being acquired for the factory including some land for future additional quarters.

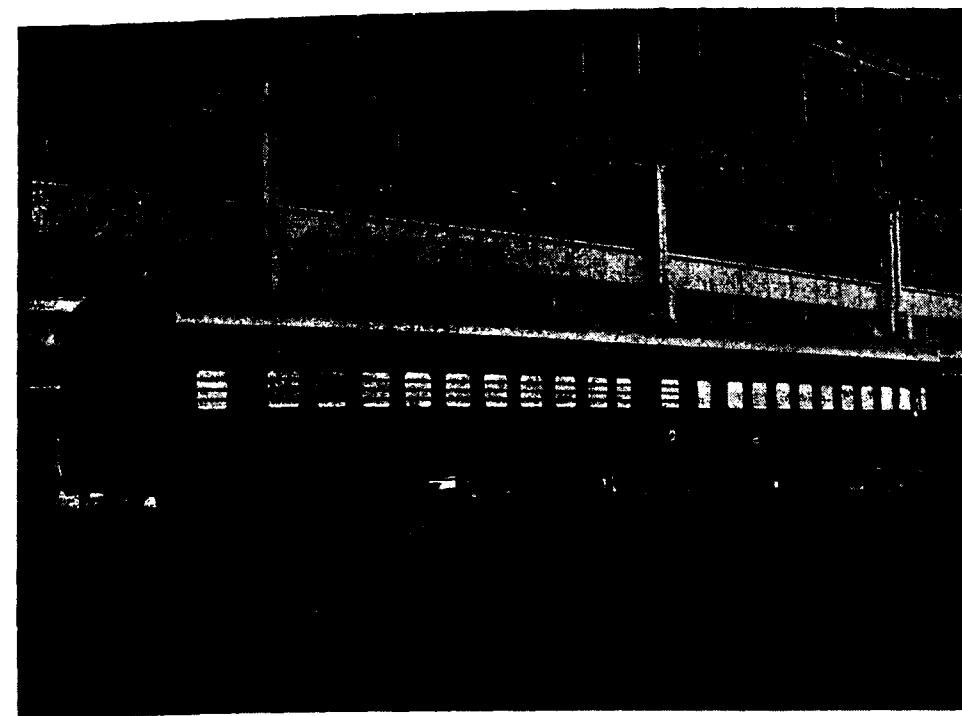
The proposed Furnishing Factory will have a covered area of 5.5 lakhs sq. ft. The factory buildings will be of modern design similar to the Integral Coach Factory, with ample lighting and ventilation and will cost Rs. 102 lakhs. There will be about 260 machines to enable a target production of 350 coaches of all types per

year. To obtain economical and speedy work, jigs and fixtures will be used extensively for details and sub-assemblies.

A number of details and fittings will be obtained from the trade. Adequate storage has been provided for and the entire design of storage and lay-out has been made to suit and economic handling of material.

It is estimated that the factory will employ about 2400 men when in full production. The training of the men required is also being planned by suitable expansion of the Technical Training School of the Factory at a cost of about Rs. 4 lakhs.

A colony of 200 quarters is being provided to accommodate the essential staff. This Colony will be located adjacent to the present colony of the Integral Coach Factory. Future requirements of additional quarters have also been envisaged and a provision of



A view of the Integral Coach Manufactured in the factory.

land adjacent to the Factory has been made. The standards of amenities for good working conditions, cooled drinking water, bathing places and lavatories and also canteens and co-operatives will be planned on similar scales to those already planned for the Integral Coach Factory.

INTERIM FURNISHING

In order to expedite bringing into full production of the furnishing unit and also to find additional coach building capacity so badly needed for the expansion requirements of the Second Five Year Plan, arrangements have been made to commence furnishing work immediately. Development of technique and staff will be done gradually during this furnishing work. It has been started in a small free space available in the Integral Coach Factory. Temporary sheds have been sanctioned and are under construction in

which further furnishing work will be undertaken. A small amount of machinery and plant costing about Rs. 6 lakhs will be obtained for the interim work which will all be subsequently utilised by the Unit. The interim furnishing programme has been so made that workshops of the furnishing unit will be utilised immediately they are completed and the staff of the furnishing switched over to the Unit. Thus, the unit will be brought into full production as soon as it is complete.

The first coach furnished in the Integral Coach Factory was launched into service by His Excellency the Governor of Madras on the 21st Feb. 1957.

This coach has been furnished for 3rd class. It has 4 lavatories, 2 in the middle and one at each end. The coach is divided into two halves by the middle lavatories and

(Continued on page 26)

"Air Conditioning System Operating in the Administrative Offices of the Integral Coach Factory"

THE completion of the Integral Coach Factory at Perambur is a milestone in the economic progress of this country and the fulfilment of an ambitious plan for the Indian Railways. In planning this factory great attention has been paid to providing the finest living and working conditions for the—several thousand people employed. Adjoining the factory is the residential colony for workers with 400 homes, parks and play grounds, a club house and many modern amenities for recreation after the day's work.

The spacious modern Administrative Building with a floor area of about—45,000 sq. ft. houses a staff of over 500, who work in air conditioned comfort provided by a fully automatic latest type Worthington Central Air conditioning plant engineered and installed by Blue Star Engineering Co. (Bombay) Private Ltd. Before going into the details of the air conditioning system installed in the Integral Coach Factory, let us understand what air conditioning means. The popular conception of Air conditioning is that it cools in hot weather. However, anyone really concerned with Air conditioning

will realise that this is a totally inadequate description and that true Air conditioning is an year round proposition. The main basic functions of Air conditioning are to control temperature and humidity, to clean and filter air, to provide adequate ventilation by introduction of outside air and finally to agitate the atmosphere sufficiently to prevent stratification.

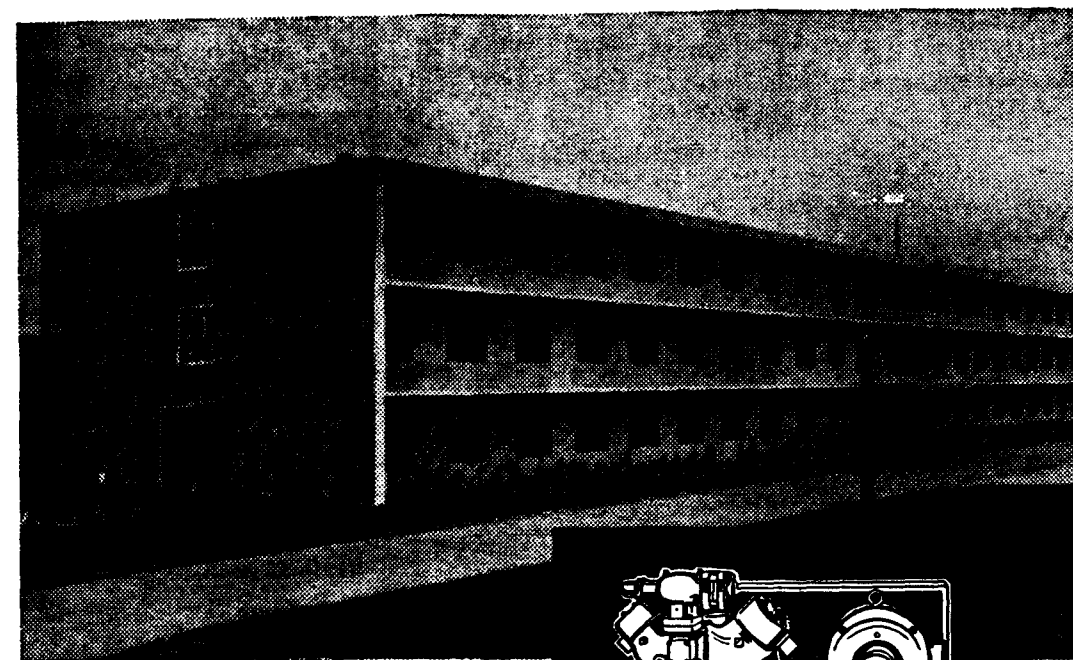
Space does not permit an elaborate discussion of process and industrial air-conditioning which may involve special temperature, humidity or other requirements. We shall therefore confine our discussion to comfort Air conditioning which means maintaining atmospheric conditions that are conducive to efficiency and health.

It is now universally accepted that optimum comfort conditions for summer months are a dry bulb temperature of 76° to 80° F with relative humidity of 50% to 60%. Air movement in the conditioned space should be between 20 to 40 FPM. It is, of course, possible to produce the same degree of comfort by a different combination of temperature, humidity and air

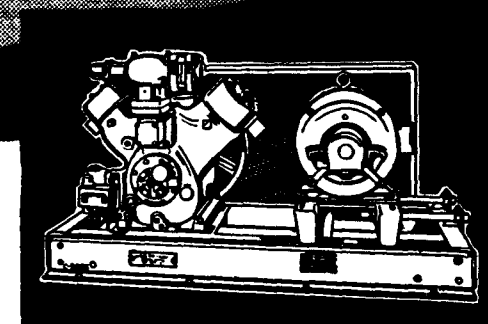
(Continued from page 25)

the seats are arranged as one row of single seats along one side, a passage by the side of these single seats and transverse long seats on the other side. Each of these long seats takes 4 passengers. Two fans are provided for each pair of seats facing each other, seating 8 persons in the long seats and 2 persons on the single seats. Two night lights have been provided on each half of the coach. There are two shutters on each window, one of Aluminium venetians and the other of glass in an aluminium frame. The lavatories have been provided with

mirrors and wash hand sinks. The commode is of Indian style and made of stainless steel. The flooring of the compartment and lavatories is of oxy-Chloride Cement which gives a pleasing red smooth surface and lasting hygienic qualities. The coach body doors as well as lavatory doors are provided with chromium plated handles and spring-loaded catches, while additional locking has also been incorporated. The interior has been finished in light biscuit and buff colours, relieved by aluminium mouldings, giving a bright clean appearance.



**Round-the-year
'fine weather'**



thanks to BLUE STAR

THE INTEGRAL COACH FACTORY at Perambur — the largest in Asia and a sister project of the huge Chittaranjan Locomotive Works — is another giant achievement in India's economic progress.

The 260-ton Worthington air conditioning plant that provides cool comfort in the large administrative Building marks yet another Blue Star achievement.

WORTHINGTON

Air conditioning & Refrigeration

Engineered and sold exclusively in India by:

BLUE STAR

Climate Engineers to Industry, Business and the Home.

BOMBAY . CALCUTTA . DELHI . MADRAS

Main office: Kasturi Buildings, Jamshedji Tata Road, Bombay, 1

movement. Large scale comfort Airconditioning did not achieve popularity until the 1920's. Theatres were the first to realise the economic value of Airconditioning. Then followed Airconditioning of office, department stores, commercial establishments, public buildings and residences. In India an impetus to the growth of Airconditioning Industry has been noticeable during the last two decades, particularly since the end of World War II. As the living standards have risen, the public have become accustomed to asking for and enjoying comfortable living, working and recreational quarters. Airconditioning of multi-storeyed buildings poses several problems to the design engineer. He must first survey the site, study the sun exposure to determine how the movement of the sun from East to West will affect the Airconditioning load in the different parts of the building. The next step would be to divide the building into contiguous zones, calculate the heat loads and select the equipment which would be economical not only in initial cost, but also from the point of operating expense and maintenance cost. The most common type of Airconditioning systems are :

1. Direct refrigeration system in which the refrigerant is evaporated in an

evaporator placed so that the air to be cooled passes directly over it.

2. Indirect refrigeration system in which the refrigerant vapour cools a circulating medium such as brine or water which in turn is used to cool the air.

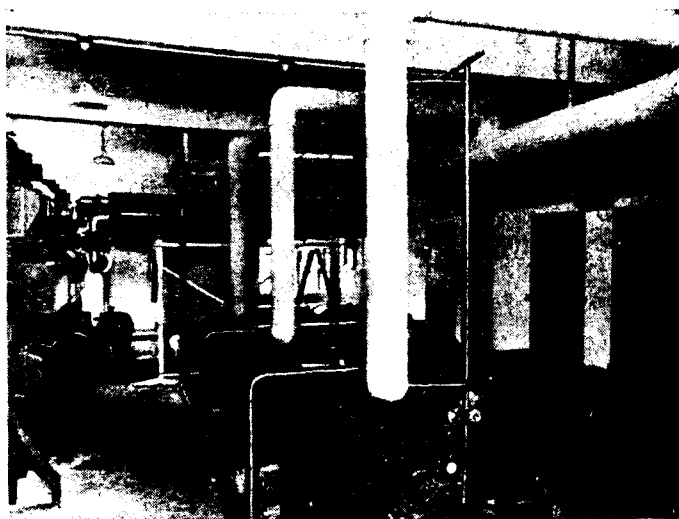
Both the above systems employ mechanical refrigeration equipment. In certain parts of India, during extreme dry months, it is possible to produce comfort conditions without mechanical refrigeration. This is known as the *evaporative cooling system*. An Evaporative Cooler is an Air Washer or similar device presenting a large amount of wetted surface in the air stream. Evaporative cooling is an adiabatic process where—the total heat content of the air remains the same.

All these factors were carefully considered when designing an Airconditioning system for the Administrative Office of the Integral Coach Factory. The building faces north south and is divided into two zones, east zone and west zone. It was found that the most economical system would be the Direct Expansion System with a battery of Reciprocating Compressors and two separate Air Handling units, one for each zone.

The entire equipment is installed in a separate machine room located at the rear of the Administrative Building.

The heart of the Airconditioning installation is four

The machine room showing three of the four Worthington Freon-22 Reciprocating Compressors. The main shell and Tube Condenser is shown in the rear of the machine room mounted above the condenser water circulating pumps.



Worthington Freon-22 Reciprocating Compressors incorporating many exclusive features. The air is filtered, cooled and dehumidified and re-circulated through the building by means of concealed ducting. Proper air distribution in an—Airconditioned space is always a very critical factor as draughts or dead spots can be intolerable. In this respect Blue Star engineers have achieved a perfection not very common. An unusual feature of the installation is that both the supply air to the building and the return air from it are conveyed between the machine room and the main building by underground masonry ducting.

Another point of note is that a large proportion of air, fully pre-conditioned is continually injected into the system maintaining the building under a slight pressure. This eliminates the possibility of infiltration of outside dust and hot unconditioned air into the airconditioned space.

The Airconditioning Plant is completely automatic in operation. An elaborate system of Honeywell controls maintain inside conditions at 78° FDB and 60% RH all the time irrespective of changing outside conditions. In addition to temperature and humidity controls, several fool-proof safety features have been incorporated in the control circuit, safeguarding the installation mechanically and electrically in every way that human ingenuity can devise.

DESCRIPTION OF EQUIPMENT

There are Four Worthington Freon 22 Reciprocating Compressors each driven by a 75 H. P. wound rotor motor. Only three Compressors are required to take care of the full load. The fourth unit has been installed as a standby for—emergency use. Isolating valves have been provided to permit the standby unit to be isolated from the system.

The hot gas from the Compressors is condensed in two Worthington Shell & Tube Condensers. A third condenser is now being installed as a standby. Each Condenser is equipped with Liquid Outlet Valve, Relief Valve, and Test Valve. Water for the Condensers is drawn from a masonry tank of size 30×15×10 ft. by independent suction lines through suitable foot valve strainer assemblies. The outlet water from the Condenser is discharged into the main railway reservoir. As already stated, there are two Air Handling units, one for each zone. Each Air Handling unit comprises of a bank of 6-row deep direct expansion—evaporators, a centrifugal fan of capacity 29,000 CFM and a set of heavy duty cleanable air filters. The fan is driven by a 15 HP motor. Necessary bypass dampers have been incorporated in the Air Handling Unit to ensure proper control of the temperature and humidity conditions.

VISITORS TO LONDON EXHIBITION WILL SEE FURNACE IN ACTION

Visitors to the forthcoming Engineering, Marine, Welding and Nuclear Energy Exhibition in London's Olympia, during August 29 to September 12 will be able to see a holding unit for pouring molten aluminium and zinc-based alloys. It will be seen actually operating with a machine producing aluminium die-castings.

The machine's swift, automatic operation enables the rate of production of aluminium die-castings to be raised to the level achieved with zinc. It is rated at 20 kW and has an average consumption of 10 to 12 kW. Its useful molten capacity is 300 lb.

The unit is remarkable for its simplicity of operation. Once the timing dials are set, the required quantity of metal is delivered directly into the chamber of the die-casting machine on the pressing of a button. By eliminating ladling, it ensures far greater efficiency of timing and metallurgical control.

The Economics of Reinforced Concrete Frame Buildings

By E. A. Nadirshah, O.B.E., B.A., B.E., B.Sc. (Eng.), M.Inst.C.E., M.I.E. (India), F.I.S.E. (Lond.)

UNTIL a few decades ago, buildings were constructed with load bearing walls. Because of the increasing thickness of such walls, the number of storeys were restricted. It was the growth of population in cities which brought the high framed building. In the framed or "skeletal" form of construction it was no longer necessary to have thick massive walls at frequent intervals to support floors and roof. Instead, steel members formed a frame which supported the building and carried all loads — the floor slab transmitting its load to beams which carried it to the column, and through it to the foundation. The thick supporting outer and inner walls were eliminated and replaced by thin panel and partition walls, thus not only considerably reducing the dead load of the building but providing the much needed additional usable floor space. These framed buildings could also be taken to much greater heights than was previously possible. In fact, the skyscrapers of America became possible only because of the steel frame. The reinforced concrete frame came a little later than the steel frame, and is now extensively used in other countries because of its advantages of low first cost and negligible maintenance. Even skyscrapers have been constructed in reinforced concrete frame, one such example being the 34-storeys skyscraper in Brazil with a height of 507 feet. In India a 16-storied building is now being built in Madras for the Life Assurance Corporation of India and this has also a reinforced concrete frame.

With the large building and expansion programmes that we have on hand under the National Plans, and the definite limitations to our resources of money and of material, particularly steel, it is desirable to adopt the

type of construction which is economical in cost and also in the quantity of steel. Here, we are reminded of the remark which M. Khrushchev, First Secretary to the Soviet Communist Party, made during his famous tour of this country with M. Bulganin —

"India can use 80 per cent of the steel used for construction; you are a poor nation and cannot afford to waste steel where concrete can do the job."

Engineers should bear what he said in mind. The various factors which make for economy in the execution of structural engineering work need careful study before a decision is made as to the type of construction to be adopted. The relevant factors, generally speaking are :

1. Initial cost
2. Cost of maintenance
3. Economy of materials of construction, particularly those in short supply
4. Freedom in design and aesthetic values
5. Ease and rapidity of construction
6. Durability and improvement with age
7. Security against fire, seismic forces, and bombs.

INITIAL COST

The consideration of first cost is of prime importance in any structure. In this respect, reinforced concrete compares very favourably with steel inasmuch as steel invariably has to be encased in concrete, masonry, or plaster for reasons of fire-safety as well as of

aesthetics and this appreciably increases the cost of steel construction.

STRUCTURAL ECONOMY

From the structural point of view, the following comparison may be made between steel and reinforced concrete members. Considering members subjected to pure compression, the strength of a concrete column in compression made with 2000 psi concrete and 1 per cent reinforcement, i. e. say 1½ sq. in. of reinforcement steel, a 12" × 12" concrete section will carry approximately 109,400 lb. The corresponding area required for a steel section would be 6 sq. in. For a one foot height of column of these comparative sections, the approximate costs (assuming a rate of Rs. 6/- per cu. ft. for reinforced concrete and Rs. 40 per cwt. for fabricated steel) would be Rs. 6 and Rs. 6.6 respectively without encasement of the steel sections. If the steel column is encased, the cost will be say about Rs. 9.

MONOLITHY AND CONTINUITY

In case of reinforced concrete, it is very easy to obtain rigid connections between various members of a framework and take advantage of reduced moments in case of beams due to restrained end conditions. In steel, however, unless welded construction is adopted (and site welding is an intricate and specialised job), no advantage through rigidity can be obtained. The beams are, therefore, required to be designed for a higher bending moment.

COST OF MAINTENANCE

Insofar as maintenance is concerned, the danger of corrosion is ever present. The largest maintenance item in steel structures is painting, unless the steel frame is encased in concrete or masonry. The protective coat of paint has to be in perfect condition and renewal at short periods is essential,

entailing heavy maintenance costs. If the cost of painting is capitalised, it adds very much to the cost of the structure and for this reason the annual cost which covers the first cost, maintenance charges, depreciation, etc. and which should be the correct basis for comparison, is much less for reinforced concrete frames. On the other hand, a reinforced concrete structure requires practically no maintenance beyond an occasional wash to cover accumulated grime.

ECONOMY OF MATERIALS OF CONSTRUCTION

The factor favouring the adoption of reinforced concrete and which may be considered of national importance, is the appreciable saving in steel possible. Although three new steel plants and large scale extensions to existing plants envisaged in the Second Five Year Plan will raise the total production of steel in our country from a little over a million tons to 5 or 6 million tons, there are possibilities of demand outstripping production even then. Reinforced concrete frames use only about one-third to one-half the tonnage required for equivalent steel structures, the percentage of steel required for reinforced concrete structures when compared with steel structures being as follows :

Residential and office buildings	— 50 per cent that of steel frame
Factory buildings	— 44 per cent that of steel frame
Warehouses	— 37 per cent that of steel frame.

These are very substantial savings in steel.

FREEDOM IN DESIGN AND AESTHETIC VALUES

Concrete being a material which can be moulded to any desired shape lends itself to any architectural requirements. For example, rolled steel columns in a building, unless

encased in concrete, would be aesthetically poor. In the case of reinforced concrete columns any shape according to architectural requirements may be obtained. The column may be round, square, rectangular, octagonal, or any other shape. In case of beams also, those in concrete can be proportioned to have the required dimensions so as to fit in with architectural considerations such as depth, width, etc. In parts of structures, where massive appearance is desirable, concrete sections can be dimensioned suitably.

EASE AND RAPIDITY OF CONSTRUCTION

Arguments have sometimes been advanced that a steel frame is more rapidly erected than a concrete frame. Although a certain period is required for hydration of the cement in concrete, judicious planning of the construction schedule results in the completion of a reinforced concrete frame almost as quickly as a steel frame. Moreover, the introduction of precast concrete units which are now popular in other countries and the large-scale use of which is inevitable in India (they are already been used with success in a few cases) is likely to reduce substantially the construction period.

DURABILITY AND IMPROVEMENT WITH AGE

The durability of reinforced concrete, that is to say, its resistance to deterioration, is also much greater than that of steel.

The strength of concrete increases with age. In case of steel, however, no such possibility exists. Thus, a concrete building which is designed for strength at 28 days has a higher factor of safety after a year. In case of steel, however, no increase of strength due to age can be expected. On the other hand, if proper attention is not paid to maintenance, the strength may be reduced due to corrosion.

SECURITY AGAINST FIRE, SEISMIC, FORCES, AND BOMBS

From the fire-resisting point of view, reinforced concrete is infinitely superior to steel or any other building material. The rigidity of a reinforced concrete frame affords enhanced protection against seismic forces and against damage from aerial attack as was amply proved during the war. Hiroshima showed that concrete frames sustained the least damage of all structures through atomic blast. Repairs to bomb-damaged reinforced concrete buildings are also much easier to carry out, and more economical in cost.

Experience has shown that steel structures, unless fireproofed through encasement in concrete, are liable to destruction in a fire due to the steel members losing their strength at high temperatures. Moreover, the water applied for quenching the fire leads to further damage through development of cracks. Reinforced concrete is able to stand temperatures of 600° to 700°F. without serious deterioration. Experience of buildings damaged by fire show considerable damage caused to steel beams and the ability of concrete to withstand fire.

INVESTIGATIONS IN U. S. A. AND INDIA REGARDING THE ECONOMICS OF STEEL AND REINFORCED CONCRETE FRAMES

The Portland Cement Association of America has carried out detailed investigation on the relative economy of steel and reinforced concrete structures. Five different types of buildings of large magnitude were investigated and the percentage savings of reinforced concrete over steel was found to vary between 25 and 34 per cent, namely an average of 30 per cent.

Similar investigations were carried out some time ago by the Concrete Association of India for an office building in one of our

big cities. The results showed that by employing a reinforced concrete frame, it was possible to effect a saving of 22 per cent in the cost of the skeleton. It was also possible to make a saving of about 50 per cent in the weight of steel which, in the present days of steel shortage, is of utmost importance.

PRESTRESSED CONCRETE

It would be interesting to consider prestressed concrete construction also in connection with the economics of buildings. We saw above that reinforced concrete uses from about 37 to 50 per cent of the steel in comparable steel construction. Prestressed concrete uses one-third of this quantity or, say, around 14 per cent of the steel in comparable steel construction. This is, indeed, a staggering saving in the quantity of steel and although for prestressed concrete construction we require high tensile steel which may be 2 to 2½ times as expensive as mild steel, an economy in the overall cost is still possible.

The economy of using prestressed concrete in bridge construction has already been appreciated and during the past five years a large number of bridges have been carried out using this technique. It has, however, not been very much used in building construction although it has

perhaps as much scope here as in bridge construction. The National Building Organisation has lately undertaken a survey to find out how prestressed concrete can be applied to building construction, and we are sure its findings will lead to a greater appreciation and greater use of prestressed concrete in building construction. An obvious first use for it would be in precast floors and roofs.

CONCLUSION

The adoption of concrete frames in place of steel frames results in the following advantages :

Substantial economy is effected both in first cost and in maintenance charges. It enables the builders to make appreciable savings in steel economy in the use of which is important at present. It gives increased employment to labour engaged in quarrying aggregates and collecting sand. There is reduced haulage in the transport of steel.

It gives greater freedom to the architect and the designer to produce structures in accordance with requirements and with a high aesthetic value.

The increased adoption of reinforced and prestressed concrete frames for buildings is, therefore, of national importance.

EXPORT PROSPECTS FOR ENGINEERING GOODS

According to a spokesman of the Indian trade delegation in West Asian countries, Indian engineering products have prospects of a good market there. The delegation representing the Indian engineering export promotion council has toured Afghanistan, Iran, Kuwait, Iraq, Lebanon, Syria, Jordan and Egypt, making a first-hand study of trade prospects for engineering goods in these countries. He is reported to have observed that Indian engineering goods conform to international specification and their prices are competitive.

INTEGRAL COACH FACTORY SUPPLEMENT

Manufacture of Railway Iron Fittings in France

WHEN a foreign visitor comes to the French Ardennes having in view business transactions in Railway iron fittings what does he expect to find here but the usual scenery of an industrial country: chimney stads smoke black sky, a gloomy dark atmosphere.

He is ready to retrace his steps thinking that he took the wrong road when he finds himself in a beautiful greenne country, when he sees rivers and torrents winding their course amongst old heavily treed mountains. He, nevertheless, looks for the factories he has come to see, and suddenly he sees them, hidden in a scenery which surprises him and is, for his eyes, an unexpected enchantment.

Why is nature so intimately blended here with the industry? It is because, in the Ardennes, nature gave birth to industry.

A very long while ago, men discovered the need to manufacture iron implements. They found in our country both the ore and the fuel, this fuel was the trees of our forests, the ore was there, just by scratching the ground, in the limited quantities sufficient for their needs.

Our iron industry was born then, and its continuous growth was due to the lucky fact that coal and iron mines were in the immediate vicinity.

The very first railways made use of the Ardennes' iron forging and stamping industry for their fittings. Thus, being specialized in these forged fittings manufacture, the industry followed the growth of the railroads adapting itself to its ever increasing need.

This industry supplies all the French Railways' fittings and its exports towards foreign countries are increasing yearly.

The end of the last world war with the necessity of a total reconstruction of the French Railway system, demanded an ever increasing production. Individually our factories, which are small and medium size, were unable to answer to these enormous needs. But these needs had to be met and the only solution to this problem was the creation of the COMPTOIR DES FERRURES. This company studied a global working plan, and, specializing each plant in the manufacture of the kind of fittings best adapted to its possibilities, got the result it looked for: Heavier production, reduction of the manufacturing costs.

The COMPTOIR DES FERRURES associated factories employing more than 2000 workmen have been now organized for ten years and they deliver fittings to most of the whole world's railways.

Amongst the COMPTOIR DES FERRURES Foreign Customers, India occupies the very first place For Years, fittings used in the manufacture of MC, MOX, O, CR Wagons and carriages have been supplied by us and our workmen know them just as well as they know the fittings supplied to the French Railways (S. N. C. F.). Tens of thousands of pieces, from the cotter Pin (W20) of but a few ounces weight to the heavy and strong draw hooks (W445) have been made in our works. I. R. S. Inspecting Officers visit us almost weekly and their presence there does not surprise more than the calls of the French Railways Inspecting Agents.

By the use of a complete and modern range of forging hammer and presses and drop stamps, our equipment for heat treatment ensures for our customers a

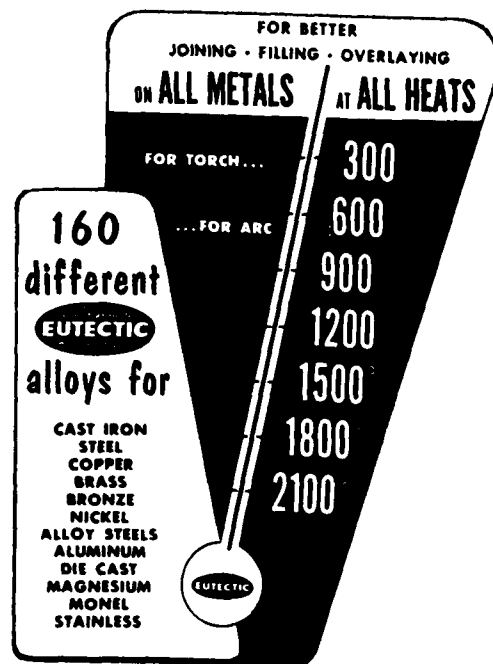
(Continued on page 37)





Solve your Welding Problems at your door

Insist on **EUTECTIC** Welding Alloys



OFFERS YOU
higher strength
less stresses
less warping
matching colour
ease of handling

For further particulars contact

LARSEN & TOUBRO LIMITED

BOMBAY P. O. BOX 278 - CALCUTTA P. O. BOX 619 - MADRAS P. O. BOX 5247
BANGALORE P. O. BOX 98 - COCHIN P. O. BOX 55 - NEW DELHI P. O. BOX 323

Surface Alloying in Brazing and Related Technique

A Revolution in Metal Joining!

INTRODUCTION

THE study of the union of two metals is a fascinating subject which has received considerable attention. So far no completely satisfactory explanation has been given of the mechanism underlying bonding of the two metals.

The mechanism of metallic bonding is primarily related to attraction forces between atoms of the two metals. These forces are also associated with the electron configuration of the metals involved. Metallic bonding is aided by diffusion, which is the movement of atoms within the molten metal—usually from regions of high concentration toward regions of low concentration. The rate of diffusion in metal is normally considered to be a function of pressure, temperature and con-

centration. If the temperature of metal is raised, the diffusion rates are increased and ability to form metallic bonds is facilitated, as for example, in the welding together of two bars of iron raised to the required temperature.

It would seem that there are gaps in the atomic structure, more than sufficient to accommodate the passage of many other moving atoms.

BRAZING

Bonding two similar or dissimilar metal surfaces with a filler metal that has a melting point above 800°F, but lower than those of the metals being bonded is termed "brazing".

In fusion welding both edges of the metal are melted and are allowed to run together

(Continued from page 35)

full guarantee of a manufacture fulfilling their requirements.

Our mechanical and chemical laboratories, equipped with the most modern apparatus are constantly checking the quality of the various steels. It is at the disposal of all Inspecting Officers for any test they wish to make.

As our factories are all specialized we are able to insure deliveries required by our customers. Large orders are shared among several works in order to avoid any shipping delays even in the case of difficulties in one particular factory.

The COMPTOIR DES FERRURES keeps a complete watch over the manufacture and

it is its duty to see that promised deliveries are made in due time.

The COMPTOIR DES FERRURES makes forgings and stampings for all the rolling stock made in Europe for, India (France, Belgium, Austria, Holland, England). We feel sure that our knowledge of the Indian market in these line and our producing capacities will enable us to become a supplier of the Indian States Railways. We shall always be happy to study and answer all inquiries.

Our works manufacture also all stampings, forgings and ironwork used in various industries (mines, marine work, motorcars) and in particular galvanized or non-galvanized pieces used in Railways electrification and in the telegraphic and telephone services.

with or without a suitable filling material. In brazing the edges of the metal, being joined, are *not* brought to the melting point; but, a low-melting alloy is introduced between the edges of the metal being joined and when the temperature is raised sufficiently a 'tinning' effect takes place and a joint is produced by adhesion. Most brazing processes are conducted open to atmosphere with the aid of satisfactory fluxing methods; or in a controlled gaseous atmosphere. The filling metal, when molten and in contact with the metals that are being joined and have been raised to a suitable temperature, adheres to the surface by virtue of surface tension and produces the 'tinning effect'. Satisfactory "Wetting" of the metal surfaces by the fused filler metal is one of the prerequisites for ensuring strong metallic bonds. The alloy characteristics of the filler material appear to determine their wetting qualities or the ability to spread.

THE EUTECTIC ALLOYS

An alloy in a metallic system which possess the lowest transformation point on passing from solid to liquid is called "Eutectic".

Brazing or welding, if carried for excessively long periods at high temperature, may lead to serious deterioration, such as excessive grain growth, porosity, burning, etc. EUTECTIC brazing compositions tend to minimize these objectionable physical properties because they solidify or freeze quickly from the fused or molten state.

In solidifying from the fused state, they do not pass through a range of temperature where both solid crystals and liquid phases occur simultaneously prior to complete freezing. However, the use of pure eutectic compositions is often not practical since excessive quenching strains may result in cracking. To minimize these defects, alloy compositions approximating to the eutectic composition are used to provide improved brazing properties. These alloys due to their low melting point, require much less heat input during a bonding operation; thus

they far surpass other alloy mixtures which exhibit undesirable post bonding results.

SURFACE CONDITION

In metallic bonding the preparation of the surfaces is of major importance. The surfaces of commercial metals are usually covered with films of varying densities and compositions. Chemical analysis has shown that these films consist mostly of oxides and, in addition, may contain other materials such as sulphides, sulphates and carbonates. The oxide film acts as a barrier in brazing and must be removed either chemically or mechanically to permit satisfactory metallic bonding.

There are three major methods of cleaning metal surfaces prior to brazing. These are: (1) fluxing with salts that dissolve and absorb the oxide films; (2) reducing the oxide films with reducing gases; (3) immersing in molten baths of flux that combine both absorption of the oxides and an oxide-reducing action. To do a satisfactory job, the molten flux must possess proper physical as well as chemical properties. The flux should blanket the brazing alloy upon liquefying, thereby minimizing oxidation. It should be sufficiently viscous to serve as a blanket and not run off or spread too thin. It should also be clear to allow the operator to examine his work. This last property is convenient but not absolutely essential.

A good flux should be durable, water soluble and capable of being applied by brushing, dipping or spraying methods. In addition, it should wet the metallic surfaces and should not streak or spread in lumps.

Oxides and other contaminations on the base metal and brazing alloy should be dissolved and absorbed by the molten flux. The unsaturated portion of the flux should be adequate to permit through metallic cleaning during the brazing operations. A clean surface can also be obtained by reducing the oxides to the metallic condition.

NEW FLUXES WITH DETERGENTS

Certain chemical compounds possess the properties of reducing the surface tension of liquids, enabling them to wet completely foreign surfaces. They are called "detergents". Similarly, certain activating compounds are often added to brazing fluxes, enabling them to produce similar effects. A well-balanced flux usually contains fluorides, chlorides, borates and small quantities of these activators. The flux should have the following characteristics:

1. produce no excessive run off,
2. melt at temperatures below the melting point of the brazing alloy,
3. reduce or dissolve the oxide films,
4. wet completely both the base metal and the brazing alloy,
5. protect the base metal against oxidation during heating,
6. activate or clean the surface prior to brazing,
7. be displaced by the brazing alloy when liquid.

ACTIVATION OF SURFACE

Activation of a metallic surface is most important for good metallic bonding. We have seen how two Johanssen blocks, when brought into intimate contact, have exceptional holding power. We may term each block as having its surface activated to permit strong metallic forces to be brought into action. A good flux behaves similarly.

As the atoms at the surface of a base metal are thermally agitated by heat all foreign matter is removed by means of the molten flux. Thus the virgin metal becomes exposed, permits the molten brazing alloy to diffuse or penetrate into the base metal. This results in the formation of strong bonds.

NEW OBSERVATIONS IN BONDING

Strong metallic bonds by brazing are possible when a rapidly diffusible metallic layer is deposited on the base metal prior to brazing. The resulting accelerated diffusions of results in strong bonds. These intermediate layers of monatomic metal may come from the filler rod or from the flux mixture itself. The flux

may contain metal ions which can be reduced and deposits upon the base metal. The deposition occurs at temperatures far below the melting points of the brazing materials. The deposited layer has the opportunity to diffuse into the base metals. This is especially true when the deposited ions are low melting elements, easily alloyable to the base metal. In this manner, brazing takes place readily, because: (1) The diffusion occurs into automatically clean surfaces having high surface mobilities; (2) The two surfaces of the base metals, alloy with the fused brazing material by means of a low melting interface. These metal ions are important brazing carriers and the layer deposited follows the law governing the electromotive-force series.

CONCLUSION

In summation, we find that strong metallic bonds by brazing depends upon the degree of diffusibility of the metals, which in turn is a function of pressure, temperature and concentration. The surfaces of even compatible metals must be treated before they can be brought into a condition favouring diffusion and the formation of strong metallic bonds. This treatment can be accomplished by mechanical means, specific atmospheric treatment, chemical reducing action or by the use of scientifically designed fluxes.

The process of "surface alloying" or "tinning" by the alloy was adapted to the bonding of metals at a heat below the melting point of the base metal by J.P.H. Wasserman in 1906. Research in this field was continued by his son, Rene D. Wasserman, who, in 1940, established the Eutectic Welding Alloys Corporation in New York. Thanks to this Research in Metal Joinings Process, it is now possible to bond metals below their melting temperatures by "SURFACE ALLOYING TECHNIQUE".

It is hoped that this technical presentation helps in the understanding of the basic principles underlying the distinctive characteristics of the welding alloys manufactured by this firm.

Electric Lamps

By A Correspondent

THE History of ELECTRIC LAMPS dates back to the time of Alwa Edwin Edison (1879). As a result of his repeated Researches he was able to produce the Incandescent Lamps making use of Carbon Filaments achieving a life of about 500 hours. Ever since that time, the Industry has developed with new improvised Techniques making larger production with increased light out-put, all such lamps giving 1000 hours of burning life.

By 1911 Lamps were produced with Tantalum Filament and later by 1912 drawn Tungsten Wire came into use as a filamentary body. It was the endeavour of the Lamp Engineers to search for a material of a very high melting point so that they could raise the operating temperatures to the

filaments. The success was achieved by 1914 and the modern gas-filled lamps came into vogue. The straight wire that was originally used was coiled into a helix and subsequently to a double helix which is commonly called as Coiled Coil. Further Researches are taking place in the advanced countries to make Coiled Coiled Coil. This is yet to come to production in our country. Thus, we see the History of the Electric Lamps is the History of the evolution of the technique of vacuum and starting from Carbon Filaments they have reached Tungsten Wire Filaments passing through the stages of Osmium and Tantalum.

The principle of Electric Lamp is fairly simple. With the electric current passing through a metallic wire it results in heating

and the matter is raised to incandescence. It is this light out-put which a Lamp Engineer attempts to conserve to simply increasing the efficiency of the lamps, other qualities being equal. It is therefore apparent that the high melting point of Tungsten (3400 Deg. C) has a very important advantage in the economic production of light. Though Tungsten is ideally suited as a filamentary body, the technique of drawing the material into a thin wire involves the entire engineering skill at command. The Wolfram Ore is crushed and brought to a powder form. This powder is pressed into a small bricklet and these bricklets are pressed into bars (10×10 mm. Square) and from 8×24" in length. The strength of the bar is increased by heating it in hydrogen. These bars are further subjected to a treatment known as "Sintering". The sintered bars are further subjected to a process "Swaging" where very rapidly rotating hammers around the axis of the tungsten rod convert tungsten into thick wires. These thick wires are passed through Diamond Dies through special lubrications to various required sizes and these are called drawn tungsten wire. Tungsten while it is yet in powder form it is customary to add certain Oxides so that the growth of the crystals can be controlled to maintain the luminosity. It is at this stage various grades of wire are developed meant for various types of lamps depending upon the efficiency of the lamp required.

Simultaneously the tungsten filaments a special wire was devised so that it could be pinched into a glass making it vacuum tight. Such an economical alloy is "Dument". This revolutionise in working out the cost of the Lamp production.

It was found that if the filament inside the lamp was subjected to an increased pressure it could be operated to a higher temperature for the same wattage and in

consequence the Gas-filled lamps were developed. The straight wire that was used in the vacuum lamp had to be re-designed into a single coil or coiled coil as the case may be to minimise the loss of heat by way of convection when it was surrounded by gas pressure inside the lamp. Needless to mention that the gas must be inert in view of the high temperature of the filament inside the lamp. Hence, normally Argon and Nitrogen are the chief Gases required in this Industry. Sometimes, "Helium" and "Xenon" Gases are also used to get higher efficiency lamps in special cases. Each of these inert gases in various proportions at various pressures inside the lamp exhibit special characteristics in luminosity and every Factory has its own special proportions. Inspite of such improvised techniques in Lamp Engineering, it may appear strange that in a 100 W. Incandescent Lamp, the Lamp Engineer has utilised about 12% of the input energy while 88% is converted into heat and removed from the lamp by radiation, by evacuation and by conduction.

In view of the Tungsten being at a high temperature within the lamp and also its sensitiveness for reaction of the moisture it is absolutely necessary that the inside of the lamp must be moisture dry. The reaction is very sensitive and the presence of moisture will result in rapid evaporation of the lamp and consequently very early blackening. It is for this reason in the Lamp World, moisture is said to be the enemy of the Electric Lamp during production. It is said that one drop of moisture may spoil 50,000 lamps if the system is not free from it.

PRODUCTION: The first stage during manufacture is Stem Making. The two Electrodes, the evacuating glass tube, the flare and the cane are aligned properly and they pass through a process wherein a vacuum is made at the Dument. At this stage a small bore is made at the pinch to facilitate evacuation at the Exhaust. These

MYSORE LAMPS

BEST IN THE MARKET

AWARDED GOLD MEDALS & CUPS AT SEVERAL EXHIBITIONS

UNDER GOVERNMENT OF INDIA RATE CONTRACT.

ALL TYPES OF LAMPS MANUFACTURED.

THE MYSORE LAMP WORKS LTD.

MALLESWARAM, BANGALORE-3.

Telegram: "MYSORELAMP"

Telephone: 2026

stems are passed on to the Anchoring Machines where a small button is made at the tip of the cane and the Molybdenum Wire is inserted. It is very interesting that small lengths are cut and at the end of each the pit-tail hooks are made at a fairly fast rate at the automatic machines. These Machines are designed to accommodate from 1 to 24 supports, depending upon the type of the lamp. These anchored stems pass on to the Mounting Mill where the filaments are automatically picked up, clamped and mounted. Generally such mounting mill is very costly and hence it is the normal practice to use leg-operated mechanical Clampers engaging more Operators. This is typically suited for our Indian conditions, where unemployment is a problem in our country. Moreover, even for lesser labour we are fortunate to get more intelligent and skilled labour in our Country. For this delicate process Girls are specially suited.

The mounted stem passes on to the Sealing Machine wherein in Bulbs are sealed to the Flare and the extra cullet is automatically removed and the sealed bulb passes on to the Vacuum Pumps. At this stage of Exhausting, the Lamp passes through a heating temperature and simultaneously suction is going on. In this process all the gases from the glass walls are released and pumped out. After a sufficient high degree of vacuum is attained, the inert gases are filled in and finally the exhaust tube is sealed off automatically. Now the lamp is ready to receive the Brass Cap. This is the finishing stage where the Brass Cap with a thin ribbon of the bakelite cement at the neck will be fitted and subjected to baking. This will result in glass to melt still and finally they are soldered at the eye-let and outside. It is the commercial practice to give a coating of Red Phosphorous on the filament itself before it is sealed. After finishing of the lamp, the lamp is lighted up

in very low voltages, so that the phosphorous may get pulverated into small highly reactive particles and as a result electrically charged. In such a condition, the highly reactive phosphorous will absorb the extraneous matter within the lamp. This process being a surface absorption is called as "Absorption". This pressure comes from high vacuum and the process is called "Flash Ageing".

The Day's production undergo systematic check-up at regular intervals at the Photometry. These lamps at present are being designed for the British Standard Specification, the normal average life being 1000 hours. It is important that every process during manufacture must be rigorously controlled and inspected. periodically sub-standards are got from the authorised Testing Laboratories so that the production is standardised for its uniformity and high quality.

Though there are more than 10 Major Factories in India and a few small Factories manufacturing the Electric Lamps, in South India the Mysore Lamp Works is the only one of its kind. It has a modern Automatic Plant for the production of General Service Lamps and also they have added a few more Machines to manufacture Miniature Lamps like Bicycle, Torch and Automobile Lamps. At present they are manufacturing Lamps from 15 Watts to 1500 Watts which is the maximum in the B. S. S. as far as General Service Lamps are concerned. A Personnel in the Works has undergone special training under American Experts in production technique.

The Factory was started in 1937 with a production capacity of 2000 lamps per day and now it has an installed capacity of 4.8 million per annum (16,000 lamps per day). It is successfully catering to the needs of the Electrical Departments of Mysore, Hyderabad, Bombay and Madras and also

some of the Electrical Corporations in the South. The Lamps are very popular for its quality.

The Sales Organisation has its Distributors throughout India including Kashmir and Nepal. The Mysore Lamps are on the approved rate contract for the Railways and General Service. The Country for the first time is meeting its demand of High Wattage Lamps like 750 W., 1000 W. and 1500 W. Due to their quality, these high wattage lamps enjoy full confidence of the D. G. S & D. in matters of Rate Contract. It has also met the full demand of lamps like Headlights, Train Lighting Lamps, Coloured Lamps, Cab lights, etc. In addition to these types, Series Type of Street Lighting is a speciality for Mysore Government and Hyderabad Electricity Departments. For a visitor who has seen this Factory in 1937 and who visits in 1957 he will be impressed with the rapid progress made at the Works in increasing the production and also the methods of production control. Simultaneously with the progress of lamp making it is a happy sign there is perfect co-operation between the Management and the Labour in the Day to Day administration. Certain amenities like Canteen, Club Room with facilities for Outdoor and Indoor Games are worth noticing and the activities after the day's labour are thrilling,

at the Club. The Sports Club has won many Trophies and Medals in Basket Ball and Ping-Pong.

The relations between labour and the Works are highly democratic and as a result the Management is enjoying full confidence of the labour. In short it is a model Factory in the South with regard to production maintenance and labours relations, with all aesthetic environment at the surrounds. In India, the Annual requirement was 18 million and in 1952 it was 20 million and just now it is 30 millions. By 1961 our Country may have an annual demand of 35 millions and with a little exaggeration it may even be 40 million per annum. Much depends on the development of Hydro-Electric Schemes for generation of electricity and its transmission to the consuming Centres which ultimately results in rural Electrification and also providing adequate number of houses for raising the standard of living in general. With such a programme ahead, there is a bright future for Electric Lamp Industry. Though at present it is unfortunate we have to import most of the raw materials from abroad, serious effort is being made on a planned basis to start making most of the raw materials in our Country. Till then it is difficult to say that this Lamp Industry is self-sufficient in India.

PRODUCTION OF MACHINE TOOLS

As regards the Government of India's plans for increasing the production of machine tools in the country, it is now learnt that a recent investigation has revealed that against a total of 80,000 machine tools installed in the country at the end of December last, the number of machine tools that may be required by the end of the current plan period will approximate to about 170,000. It is estimated that by the end of 1960-61 imports are likely to be of the order of Rs. 15 crores to Rs. 17 crores. The Government is reported to be considering the question of production of machine tools as a side-line is well-established engineering works. According to a preliminary estimate, the industry needs an annual capital investment of about Rs. 1 crore to become self-sufficient.

Six-Axled Twin Car Diesel Train in Stainless Steel 'V2a'

Light-weight Construction with Underfloor Engine

THIS Twin Car Set is the first Diesel Train in Germany which is made of stainless steel V2A. The demand for railway vehicles of stainless steel exists especially in foreign countries. The American Budd Construction is well known for it. The entirely novel feature of this LHB Diesel Train, however, is the appli-

cation of a plain, non-corrugated stainless steel V2A sheeting in conjunction with an integral, stress-bearing shell construction.

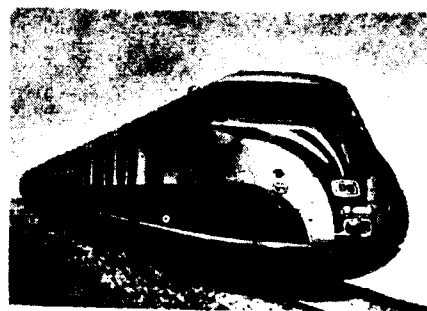
The Twin Car Set consists of 2 Diesel Rail Cars (Motor Coach "A" and Motor Coach "B") for two-directional run with the following seating capacity :

Motor Coach A :	93 upholstered	2nd cl. seats	+ 70 standing places
" " B :	93 " "	2nd cl. " "	+ 70 " "
Total	186 seats	" "	140 standing places
Total Capacity: 326 Passengers			

The interior finish and layout are similar to those of the Rail Buses of the German Federal Railways.

PRINCIPAL TECHNICAL DATA :

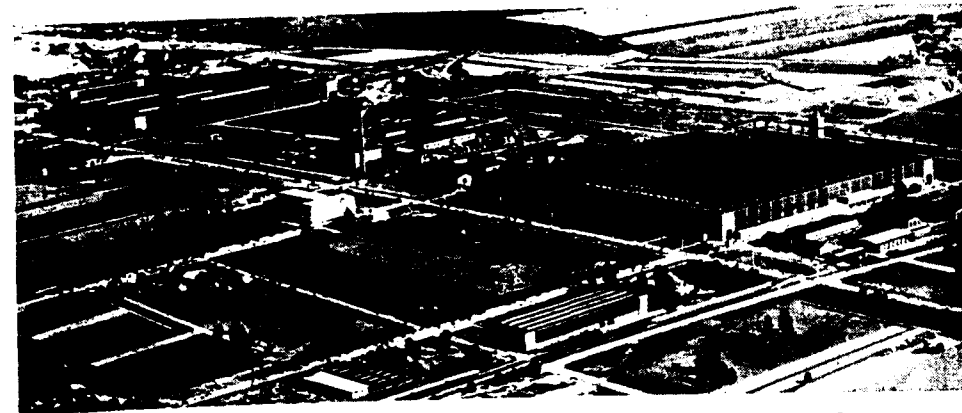
Total Length of the Twin Car Set (over Buffers)	= 38 264 mm.
Length of one car body, over sheathing	= 18 450 mm.
Maximum Width over sheathing	= 2 962 mm.
Height from top of rail to top of roof	= 3 400 mm.
" " of floor	= 1 150 mm.
Interior Height of passenger compartments	= 2 190 mm.
Wheelbase of the Motor Bogies (trucks)	= 2 000 mm.
Wheelbase of the Trailer Bogie (Jakob Type)	= 2 500 mm.
Diameter of wheels on tread (motor bogie & trailer bogie)	= 900 mm.
Gauge	= 1 435 mm.
Maximum Speed on level track	= 95 km/h
Permanent output of engine	= 2×135 HP.
Tare Weight (Empty)	approx. 40 tons.



Articulated seven-car Diesel Express Train in all-aluminium light-weight construction for the German Federal Railways.

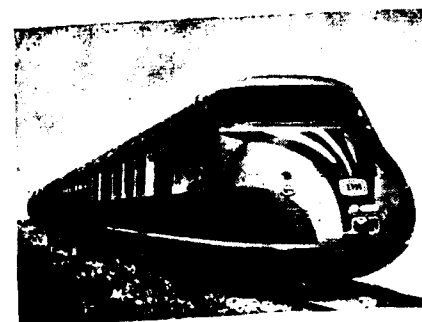
All the stress bearing members of the car body structure are made of best *stainless* special steel. Another special feature of this vehicle is that also the bogie frame of the "Jakob" Trailer bogie is made of corrosion-resistant stainless steel of the trade mark "Nirosta" V2A Extra".

Each of the two car units is provided with a complete mechanical driving equipment consisting of a water-cooled six-cylinder underfloor type Bussing U 10 Diesel Engine with attached hydraulic coupling FK 9—2. The transmission of the tractive effort is



Air View of the Linke-Hofmann-Busch Factories at Salzgitter-Watenstedt/Western Germany.

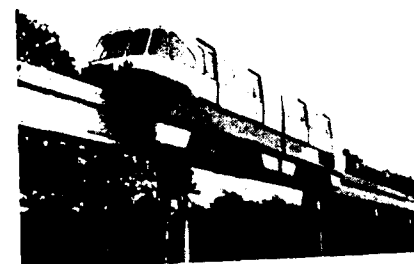
LINKE-HOFMANN-BUSCH
WAGGON-FAHRZEUG-MASCHINEN G.m.b.H.
SALZGITTER-WATENSTEDT. WEST-GERMANY



Articulated seven car Diesel Express Train in all-aluminium light-weight construction for the German Federal Railways.



Six-axled Twin Car Diesel Train in stainless steel 'V2a' light-weight construction, with underfloor engine.



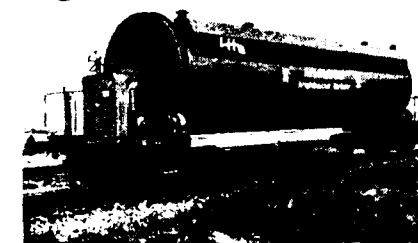
Motor Car for the 'ALWEG' Monorail Railway



A modern high capacity Tank Wagon for the 'VTG'.

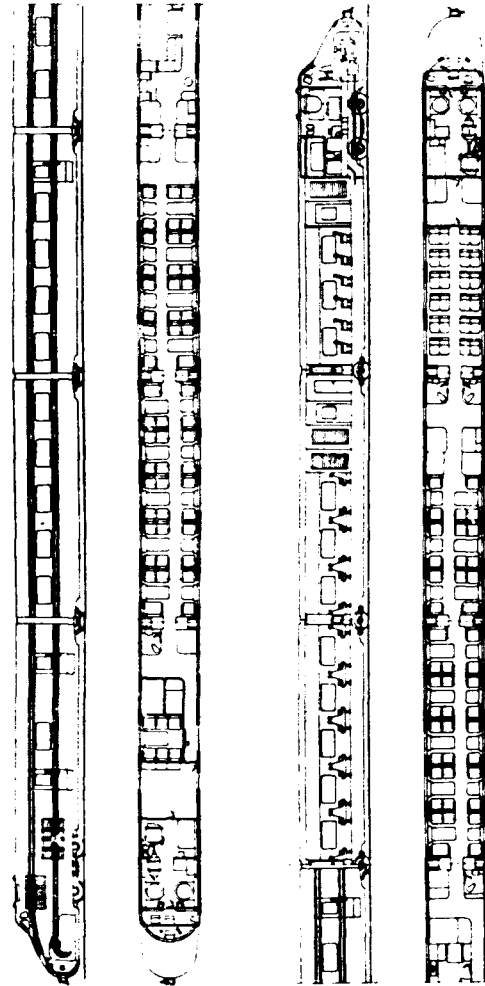
PRODUCTION PROGRAMME

Electric and Diesel Rail Motor Cars
Passenger Cars
Mail & Luggage Vans
Rail Buses
Tank Wagons, Goods Wagons and Wagons for Special Purposes
Express Carriages and Cars for Underground Railways
Tram-Cars
Railway Buses



Tubular Amphibian Container with transport trucks and discharging mechanism for the transportation of bulk goods by water and

Length of the train 317'
 Length of the power cars 59'-9"
 Length of the intermediate trailers 40'-0 3/8"
 Maximum width 9'-11"
 Maximum height above top of rail 11'-6 3/8"
 Height of top of floor above top of rail 2'-10"
 Wheelbase of the motor bogies 7'-2 3/8"
 Distance between centre pin of the motor bogie and the one-axled running gear 40'-0 3/8"
 Distance between one-axled running gears 40'-0 3/8"
 Wheel diameter on tread 2'-11 3/8"
 Number of seats 135
 Heating System Air conditioning system Stone
 Weight in service order 116 ts



Layout of the different car units :

Power Car "A" :	Luggage Room, 6 seats, Secretarial Service Compartment	Traction	4 MAN-Diesel Motors
Intermediate Trailer 1 :	30 seats	Power Transmission	Mechanic-hydraulic power transmission
" "	24 seats	Performance without pressure charger	4 X 160 = 640 HP
" "	Kitchen and Pantry	Performance with pressure charger	4 X 210 = 840 HP
" "	30 seats	Maximum Speed without pressure charger	75 MPH
" "	21 seats	Maximum Speed with pressure charger	100 MPH
Power Car "B" :	24 sleeperette seats	Brake System	Pneumatic Disk Brake and electro-magnetic Rail Brake
		Coupling System	Full-automatic "Scharfenberg" Couplers

effected from the engine through the attached hydraulic coupling and an elastic shaft to a 6-speed Mylius TG 70 change gear with attached coupling.

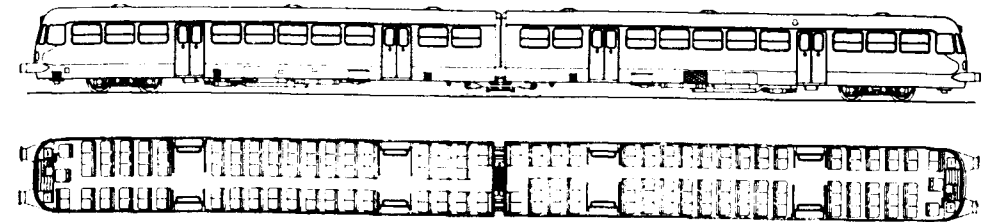
Both engine plants can be controlled half or full-automatically from one of the driver's cabs. In the middle of the train, the two coach bodies rest on the pivot bearing of the common trailer bogie, whereas motor bogies support the coach bodies on either end of the train set.

The brake equipment of the twin car train consists of a KNORR "KE" Type compressed air brake with air compressor



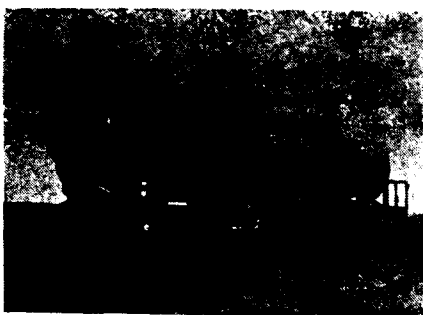
Six-axled Twin Car Diesel Train in stainless steel 'V2a' light-weight construction, with underfloor engine.

type V 70/155 and control valve type KEO a (p).



Gauge	4'-8 1/2"
Length over Buffer Gear	125'-6 1/2"
Length over Sheathing	2 X 60'-6 3/8"
Maximum Width over Sheathing	9'-8 3/8"
Height of Top of Roof above Top of Rail	11'-1 1/2"
Height of Floor above Top of Rail	3'-9 1/4"
Distance between Centre Pins of Bogies	2 X 49'-2 1/2"
Wheelbase of Bogies	Motor Bogies : 6'-6 3/4" "Jakobs" Bogie : 8'-2 1/2"
Wheel Diameter on Tread	2'-11 1/2"
Suspension of Swing Bolster	Laminated Springs

Suspension of Axle	Laminated Springs + Helical Springs
Weight in Service Order	42,3 ts.
Number of Seats	184
Heating System	"Webasto" Hot-air heating system
Coupling System	Screw Coupling
Brake System	Pneumatic Disk Brake
Traction	2 Diesel Engines "Bussing U 10"
Performance	2 X 133 BHP
Maximum Speed	59 Mph
Power Transmission	2 "Mylius" six-speed transmission gears

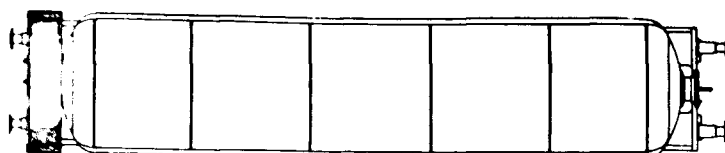
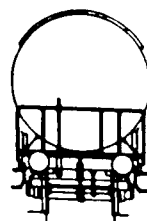
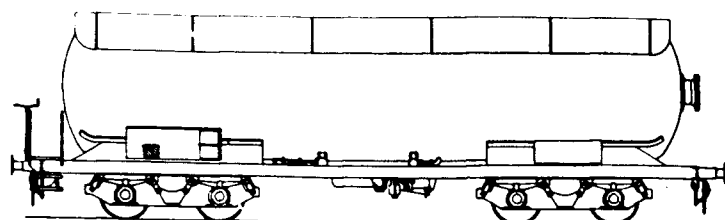


A modern high capacity Tank Wagon for the 'VTG'.

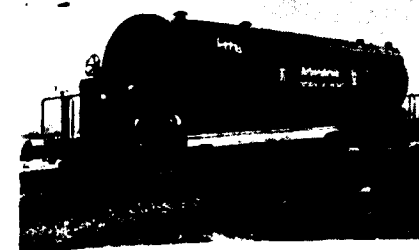
give access to the interior of the coaches. These doors are of a novel design and are made of stainless steel sheet metal ("Nirosta") and, when closed, they are flush with the body sides.

All of the side windows are of the same size and type. They are sliding windows and are equipped with a novel type of sash balance devices. When opened, the upper movable window section is sliding down above the lower section which is of the fixed type. The windows are embedded in special rubber profiles which ensure a dust & water-tight sealing; they are easily replaceable.

On either side of the vehicle, 4 electro-pneumatically operated parallel swing doors



Gauge	4'—8½"
Length over Buffer Gear	49'—2½"
Maximum Width	9'—6¼"
Maximum Height above Top of rail	13'—11¼"
Height of Floor above Top of Rail	4'—0¾"
Wheelbase Distance between Centre Pins of Bogies	26'—10¾"
Wheelbase of Bogies	6'—6¼"
Wheel Diameter on Tread	3'—3¾"
Suspension of Axle	Laminated Springs
Suspension of Swing Bolster	—
Weight in Service Order	36,4 ts.
Interior Length	42'—6½"
Interior Width	9'—4¾"
Interior Height	9'—4¾"
Loading Capacity	42,3 ts.
Volume Capacity	2825 cu. ft.
Coupling System	Screw Coupling
Brake System	Compressed Air
Test Pressure	384 lb. per sq. inch



Tubular Amphibian Container with transport trucks and discharging mechanism for the transportation of bulk goods by water and on rail

The interior equipment & finish of the coach units have been entirely adapted to the service requirements. In this connection the Bundesbahn Rail Buses have been taken as a guidance.

With respect to travelling comfort and general appearance, however, the Rail Cars have been adapted to 'de Luxe' Buses, which is especially visible in the equipment of the driver's cabs.

The seating accommodation in the Coach Units A and B consist of 17 three-place seats (each for 3 persons) and 17 double seats of the reversible type. The other seats are double seats of the fixed type.

In addition to the aforementioned sliding windows, three special double fans per carriage ensure an efficient ventilation. Each of the fans has a dynamic capacity of 550 m³/h. and a static capacity of 210 m³/h at a train speed of 60 km/h.

For heating purposes, each coach is equipped with three WEBASTO hot-air heating units 65 HL 3 of a total heating capacity of 19,500 kcal/h. The heating system can be operated from the driver's cabs.

Another characteristic of the interior finish of the carriages is, that all visible but
INTEGRAL COACH FACTORY SUPPLEMENT

non-paneled surfaces, such as door pillars, window sills etc., have got a buckskin-like finish obtained by spraying them with 0,5 mm. long flakes of cotton or artificial silk. The outside sheeting being of stainless steel, no exterior painting is required, and in its place a marble-like finish has been applied.

** ** *

The present LINKE-HOFMANN-BUSCH Company carries on the century-old tradition and experience of the Linke-Hofmann-Werke A. G., Breslau, and is one of the largest and most modern wagon factories in Europe.

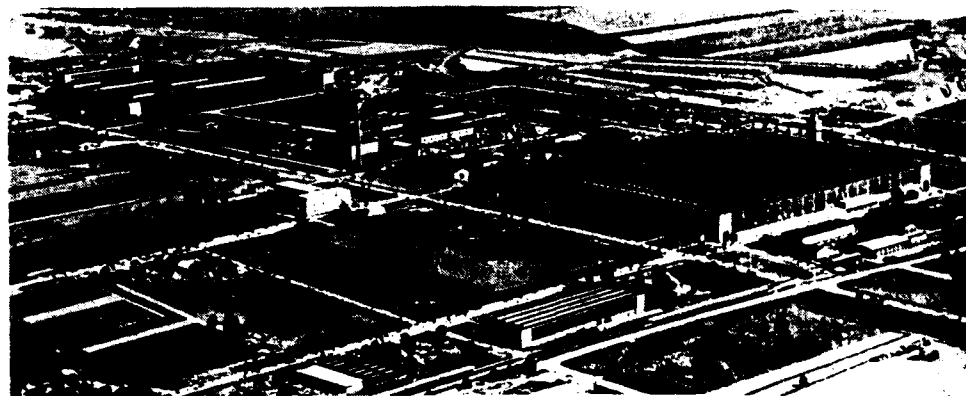
The works area covers more than 16 146 000 sq.ft. of which approximately 1 453 000 sq.ft. consists large floodlit shops equipped with the most modern machine tools and fabrication facilities. About 3 500 workers are engaged in the production of home and foreign orders.

This pamphlet gives brief information about the variety of the production programme.

Railway vehicles of all types are being manufactured, often in large batches, and are leaving the works daily for service in countries throughout the world.



Motor Car for the 'ALWEG' Monorail Railway



Air View of the Linke-Hofmann-Busch Factories at Salzgitter-Watenstedt/Western Germany

Since the post-war resumption of production, the Linke-Hofmann-Busch Company has supplied multiple-unit electric trains, diesel trains, diesel railcars, railbuses, ordinary passenger coaches, open saloon cars, sleepers, diners, mail vans, open and covered goods wagons, and special-purpose vehicles to Angola, Chile, Dutch Guiana, Mexico, Portugal, Spain, Sweden, Turkey and the United States.

Former superiority has been re-established and world-wide reputation has been restored.

LHB is contributing decisively to further development in the sphere of international traffic.

Utilising the methods of modern aeroplane construction, a novel type of articulated light-metal diesel train has been designed and built in shell form. This train, as depicted, has raised the greatest attention of experts in

Germany and abroad.

Maintaining the same principles of construction as employed in these articulated passenger trains, and thereby complying with the demand for light-weight and fast running, trains of this type are also suitable for express services, mail and goods traffic.

Low tare weight, reduced power consumption, excellent running qualities, high average speed and economy, combined with advantages in respect of shape, space and technical performance—these are the outstanding features of this most modern rail vehicle of the 20th century.

The all-steel twin-unit diesel-hydraulic trains, as supplied to Mexico, are air-conditioned and each coach has 52 comfortable revolving seats. An all-electric kitchen is included. These twin car sets can be used either alone or in multiple-unit.

TATA'S EXPANSION—PROGRESS

Tata Steel's expansion project to double output to two million tons is more than 52 per cent complete in 56 per cent of the total allotted time of 2½ years. A sum of \$61.24 million (about Rs. 30 crores) has already been expended or committed.

The project currently employs 11,000 Indians and 91 American specialists. Its employment potential at the peak period in September 1957 will be about 12,000. The project is scheduled to be completed by May 31, 1958.

The Mysore Kirloskar Ltd., Harihar

By G. K. Ruikar, B. Sc., B. E.

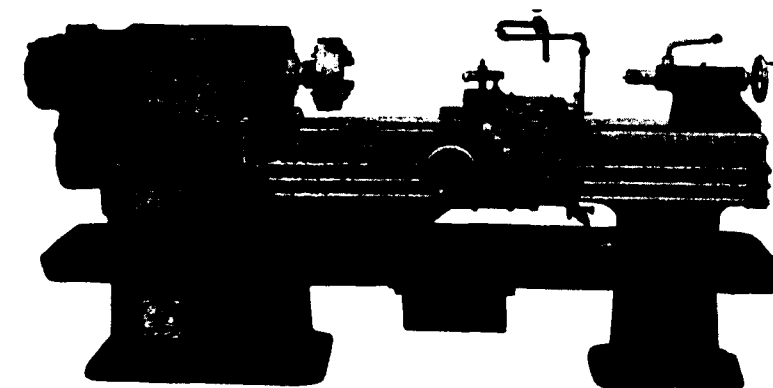
THE Indian Railways have achieved substantial progress during the first Five Year Plan period, and have also planned for enormous expansion programmes during the second Plan period. Of their overall progress made during the I plan period, the Locomotive Works at Chittaranjan and the Integral Coach Factory at Perambur, perhaps snatch the lion's share. The efficient planning and quick execution of these ambitious projects symbolise the march of the Indian Railways towards the goal of self-sufficiency.

As pioneers in the field of Machine Tool Industry in India, we have been watching this progress of the Indian Railways with keen interest and appreciation. We have

the privilege of serving the Railways with our first-class, precision machine-tools, and thus have contributed our humble mite in the task of equipping their workshops and manufacturing plants. Quite a number of our well-known machine-tools like the all-g geared-head RL lathes, Bombay lathes, Harihar lathes, Hacksaw machines, etc. have been installed and are working satisfactorily in the Railway-workshops all over India. More particularly, we have supplied a strong contingent of 19 reliable, precision, all-g geared-head lathes to the Integral Coach Factory at Perambur, where these have been giving a good account of themselves in the Production shops and the Tool Room.

R. L. No. 2 Lathe
(17½" Swing)

Of Proved
Performance
in
Railway
Workshops.



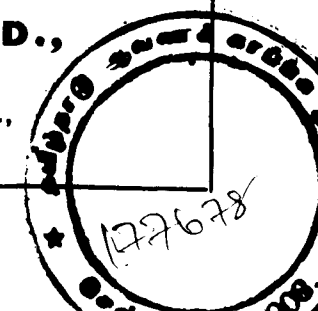
The workshops of Indian Railways are installing The Mysore Kirloskar—R. L. No. 2 Lathes, in increasing number as they are of proved efficiency and are best suited for heavy-duty facing, turning & screw-cutting jobs.

Manufacturers:—

THE MYSORE KIRLOSKAR LTD.,

P. O. YANTRAPUR, HARIHAR (Mysore State)

Sole Distributors:— **M. s. BATLIBOI (Private) LTD.,**
SILVER JUBILEE PARK ROAD, BANGALORE 2



Many of the components required for the Railways in general and locomotives in particular, are precision parts which have to be produced to correct sizes. Obviously such precision parts cannot be produced accurately, much less economically, on out-dated and obsolete machine tools. Precision parts require precision machine tools to produce them; and this is exactly we play our part.

RANGE OF OUR PRODUCTION

We have been manufacturing a fairly good range of lathes and other machine-tools, all thoroughly tested and certified by the Government of India as of I grade. A few details of these machines are given below:

Centre lathes:	(Geared head type)
Model	Centre heights
1. Harihar Hubli	6½"
2. Kolhapur	8½"
3. RL-No. 1	7"—8"
4. RL-No. 2	8½"—9½"
5. RL-No. 3	10"—11"
6. Bombay	12½"

Centre lathes:	(Cone pulley type)
Model	Centre Heights
1. Harihar Hubli 'MB' Type	6½"
2. Shimoga	9½"
3. Bhadravati	10½"

Hacksaw machines

1. 9" Cobra
2. 12" Cobra.

Our light-duty, Harihar and Hubli lathes are suitable for turning out small components; precision RL lathes, are eminently suitable for medium size jobs, and the Bombay lathe is specially designed for heavy-duty odd-size jobs.

Besides this ample choice in the centre-

heights, we have designed full flexibility in the modes of drive e. g., belt-drive from line-shafts, or individual motor (A. C. or D. C.) drive, etc. Extra longer beds are also available. To enhance the capacity of our machine-tools still further, we offer various extra attachments, such as taper turning attachment, hydraulic copying attachment, square-turret and Hex. turret tools posts, relieving attachments, thread chasing attachment, etc. etc. These attachments not only substantially increase the versatility of the machines, but they essentially save costly special machines, and valuable floor space.

These varieties of lathes and other machine-tools is only part of our story. Accuracy, that all important quality, is spelled out with a Capital "A" on all our products. We can therefore, confidently say that our machine-tools contribute materially for peak production at a profit.

To our many users in the Railway workshops, who have the privilege to operate our machine-tools we tender a few suggestions. Our Machine-tools, being precision machines, have to be handled with due care. Proper attention must be paid right from the installation and levelling of the machine, to its correct lubrication, cleaning, and operation. We are sure that if these machines are properly handled, and their full capacities are properly exploited, they will be able to give satisfactory service continuously for years and will pay off for themselves in a short time.

Indian Railways are perhaps the largest customers of our precision machine-tools. Our association with them will surely grow more and more intimate in the years to come. In fact, we think it is our privilege and primary responsibility to equip the Railway workshops with first class machine-tools, more particularly lathes. And we naturally aspire to be the largest single suppliers to them in due course of time.

The efficient handling and movement of goods & materials

By An Engineering Correspondent

TO-day as never before the tremendous importance of efficient methods of handling goods and materials is universally recognised. A power truck system, judiciously selected, will speed up handling and production, eliminate re-handling, and cut out bottle necks, with consequent increase in production and reduced costs.

Experience over many years has shown that in the majority of cases electric battery-powered trucks constitute by far the most satisfactory means of handling and transporting goods and materials in works, factories, mills, goods depots, warehouses and on the

dockside. Among their many advantages may be mentioned low running costs. A "RANSOMES" 1 Ton Platform truck requires only about 8 units for a charge which will give 8 to 10 hours' service while the 2-ton Ransomes Forklift will work for the same period on 28 units. Long life and low maintenance costs are other important points, while out of service time is reduced to a minimum. Moreover, the trucks will start instantly, there is little noise, and the absence of fumes and smell are vital considerations in cases where cleanliness is essential owing to the nature of the product or material being handled. Absence of fire risk counts for much in many situations,

Ransomes

BATTERY ELECTRIC FORKLIFT TRUCKS

- ▷ LOW RUNNING COST
- ▷ LOW MAINTENANCE
- ▷ LONG LIFE
- ▷ NO FUMES
- ▷ EFFICIENT
- ▷ SILENT • CLEAN



AGENTS FOR SOUTH INDIA:

GORDON, WOODROFFE & CO.
(MADRAS) PRIVATE LIMITED,

Post Box No. 42, MADRAS-1.

Phone: 2978

Grams: WOODROFFE

while finally, it can be said that the trucks are easily operated. No lengthy training is necessary and any unskilled person can learn to drive in a few minutes.

Ransomes Sims & Jefferies Ltd. of Ipswich were the first British makers of electric Industrial Trucks, and to-day they offer a wide range of forklift and platform trucks, tractors and runabout cranes. Their latest forklifts are among the most up to date trucks available on the British market. In addition to forks, numerous attachments can be fitted for dealing with different classes of loads, and among these may be mentioned crane attachments for converting the truck into a mobile crane, load clamps for bales, cases drums etc. bars for tyres and coils, special forks for bricks, pipes etc.

Turning to platform trucks, Ransomes offer two principal types which are available in a variety of models, with fixed or elevating platforms, high or low, long or short, wide or narrow. The TE pattern is a 3-wheeled truck for loads up to 1 ton, while the NU, which has four wheels, is for 2-ton loads and can have 2-wheel or 4-wheel steering. Special versions can be supplied with side or end tipping hoppers, and there is a larger model, built on similar lines, for loads up to 4 tons. In addition, the NU pattern can be supplied with a crane for lifting loads up to $\frac{1}{2}$ ton to and from the truck platform.

Two types of tractor are offered—the TE which will haul loads up to $2\frac{1}{2}$ tons on the level at a speed of 4 miles per hour, and the T. 4 which is of 10 tons capacity.

Editorial Notice

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

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

All contributions intended for publication in any particular issue should reach the Editor at least 30 days prior to the scheduled date of publication. This Journal is issued quarterly i. e. February, May, August, November.

All published contributions are paid for at our usual rates.

Editor.

Traverser without Portal for Transport of Diesel-Engine Driven and Electric Rail Motorcars and Coaches

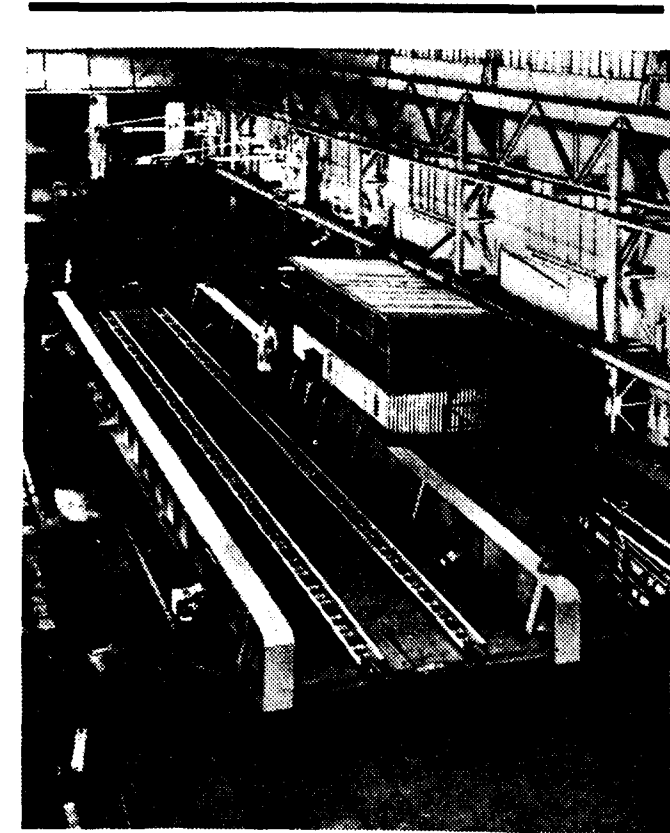
By An Engineering Correspondent

Western Germany is the centre of a highly efficient and long established Railway Industry. The following article by Messrs. Joseph Vægele A. G. Mannheim, reflects their views on the latest design of half-sunk traversers avoiding Portals and so especially advantageous for shifting electric driven coaches and other rail vehicles with extremely small bottom clearance. This modern Traverser is a recent innovation quite lately introduced in Germany. There may exist, therefore, the somewhat nebulous possibility that it has not yet been heard of in India. Even so, Messrs. Joseph Vægele's contribution is sure to interest the Engineering fraternity of the Indian Railways. Messrs. Joseph Vægele A. G. represented by Messrs. C. A. Willner & Co., Bangalore 1, have supplied many Traversers upto 170 tons capacity to the Indian Railways.

THE ever increasing demands made to the manufacturers of diesel-engine driven and electric rail motor-cars and coaches for enlarged capacity and higher efficiency of the cars pressed the designers to exploit to the utmost limit the railway clearance gauge as fixed by the German Federal Railways for rolling stock.

Consequently, the bottom part of the undercarriage of the cars was enlarged as far as possible. Formerly, the clearance between top of rail and bottom edge of carriage amounted to 125 mm. for coaches and goods waggons; with the new design of the diesel-engine driven and electric rail motor-cars this clearance was decreased to 65 mm.

This trend put many difficult problems to the manufacturers of traversers and led to noteworthy developments in the construction of traversers. At the beginning, the waggons were able to pass an inclination of 1:12 and later on of 1:15, resp. 1:16 at the approach ramps. Now-a-days, however, with the new design of the rail motorcars, conditions became



ONE OF THE THREE TRAVERSERS
(Two of 75 tons and one of 170 tons capacity)

Supplied to I. C. F. Perambur.

Manufactured by: JOSEPH VÆGELE A. G.

Mannheim, W. Germany.

Consultants: C. A. Willner & Co.

P. O. Box No. 59, Bangalore-1.



Fig. 1 Lower Part of Envelope Curve.

more unfavourable as the new cars only allow a very reduced inclination angle for climbing the traverser without affecting the envelope curve.

Hence it results that it is no longer possible to design surface-type traversers, i.e. a traverser which is running on the foundation level without pit, considering the present construction requirements of the Railway Authorities.

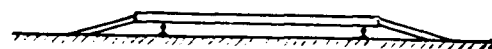


Fig. 2 Surface-type Traverser.

The Pit-Type Traverser, i.e. a traverser which is running in a pit (without ramps for climbing it) may be built without any difficulties according to the old principles also for rail motorcars. The conditions prevailing in the workshops of waggon factories, for example, as well as in many other factories using traversers, will often impede the installation of a pit-traverser as the field of action of the travelling platform must be crossed by other tracks and furthermore, it will be necessary that normal traffic could be handled in this area without difficulties.

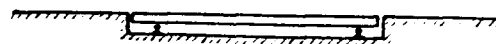


Fig. 3 Pit-type Traverser.

It was for these reasons that the so-called half-sunk traverser was developed.

The main feature of this traverser type is the fact that part of the necessary approach inclination is displaced to the foundation, i.e. downwards so that only part of the necessary

inclination must be taken into consideration for surface construction. Consequently, the approaching rails at the ramps of the traverser could be lowered. The remaining construction height will be bridged by comparatively short and plane ramps. By this means, the field of action can be crossed by any other tracks as well as by railless vehicles, such as trucks, etc., in any direction. There is no pit of the usual construction.

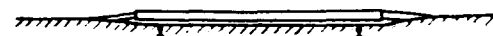


Fig. 4 Half-sunk Traverser.

It is a well-known fact that surface and half-sunk traversers are designed in portal construction. It must be taken into account, however, that these portals (two and more portals) are limiting the space beside and above the cars. Moreover, the portal traverser cannot be considered as up-to-date construction because the sight is hindered by the construction and thereby the danger of accidents is increased.

Besides this, portal type traversers cannot be used for electric rail motorcars because the trolley wires of the latter would have to cross the field of action of the traverser. Apart from this, existing buildings such as workshops, halls, crane installations etc., very often do not allow the construction of a portal-type traverser.

For all the before mentioned reasons, the design of a completely new traverser type suitable for diesel engine driven and electric rail motorcars was imperative. A solution was found with our traverser without portals designed as GIRDER-GRID CONSTRUCTION WITH TORSION-PROOF LONGITUDINAL GIRDERS.

For an effective platform length of 24 mtr. and a max. carrying capacity of 80 tons, the longitudinal main girders are constructed as *torsion-proof hollow bodies*. The latter are hermetically sealed. However, manholes are

provided for ease of maintenance and inspection of the interior.

The cross girders, which are connecting the two main girders, as well as the rail bearers for supporting, the rails on the traverser are also designed as torsion-proof hollow bodies. The different construction parts are connected with each other in form of a grid.

Naturally, the total steel work is of welded construction. For the before mentioned traverser, a height of 70 mm. for the approaches, from top of rail of the approaching track to top of running rail on the traverser was requested.

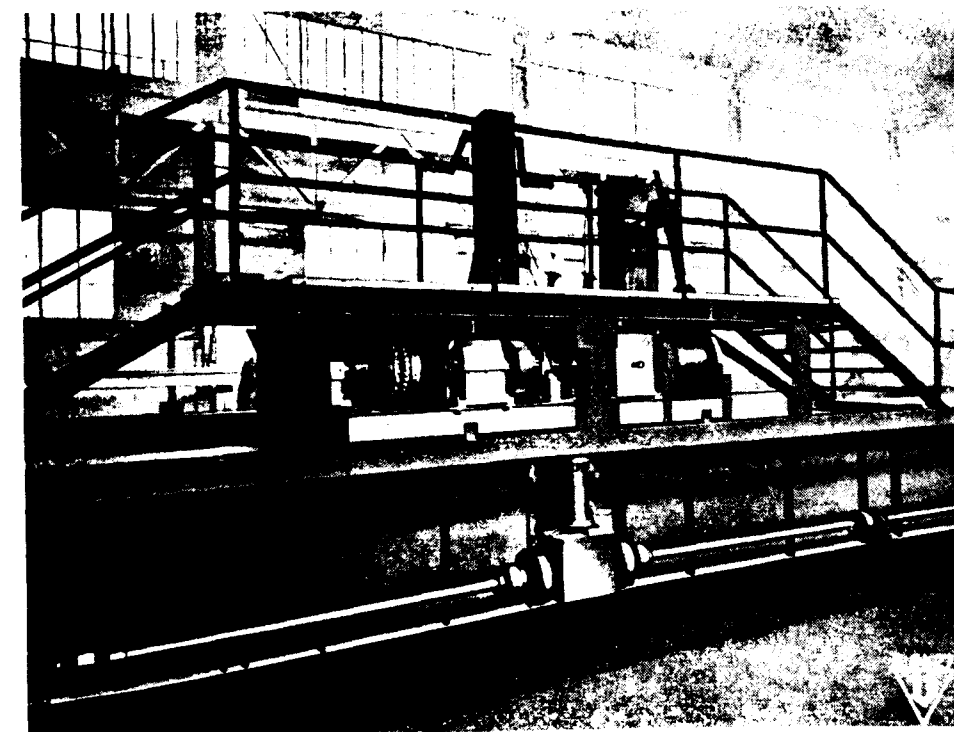
Due to the Girder-Grid Construction and the extremely favourable static distribution of load ensured by this construction it was possible to meet the requirements by lowering the traverser foundation by 65 mm. only. Giving due regard to the necessary ground

clearance material thickness amounted to 50 mm. only at the smallest point.

The drive of the travelling platform for a travelling speed of 60 mtr./min. is mounted on a comparatively small space and is combined with a rope hauling winch, which has a traction force of 3.7 tons at a rope speed of 30 mtr./min.

The high-speed back gears are of totally enclosed design and are running in an oil-bath. Drive is accomplished by the three-phase squirrel-cage induction motor with fluid fly-wheel. Since the driving unit was mounted on a hollow body, a heavy resonance effect was feared. For this reason, vibration dampers are installed between the main girder and the frame of the driving unit.

As the traverser runway would be crossed by other tracks the construction of a so-called shock-proof undercarriage was requested. This undercarriage consists of 4 swinging



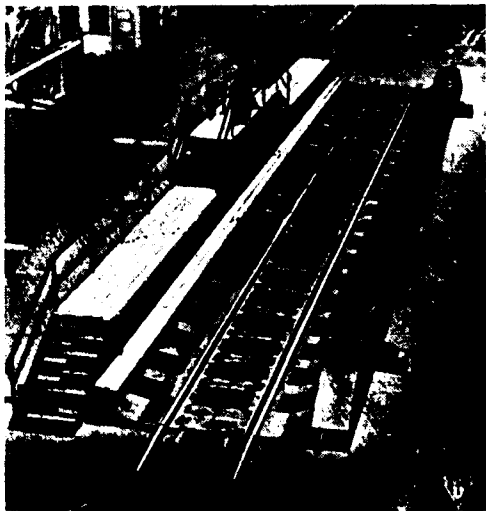
supports each of which is equipped with two running rollers and two supporting rollers. The running rollers are fitted with one-sided flanges for better guide of the traverser on the runway, whereas the supporting rollers have plane treads.

The special arrangement of the running and supporting rollers at each of the swinging supports guarantees the shock-proof travelling of the traverser and passing of the gaps at joints.

As a further novelty, the oil-hydraulic locking brake has been introduced to substitute the mechanic brake. The oil-hydraulic brake has the advantage of giving instant response and increased brake pressure at less effort of the operator.

Because the traverser in question was to a great extend of welded construction, the problem of transportation and assembly at site asked for special consideration and arrangements. The execution of welding works at site should be reduced to a minimum as the quality of the same could not be guaranteed under the difficult conditions at place of destination.

After careful reflection, we found out that the best solution of this problem and the best way for facilitating simple and quick assembly



would be ensured by dividing the traverser into two halves. The division was made between the travelling rails, for static and technical reasons, so that the cross girders were cut in the middle.

Connection of the two halves of the traverser at site was effected by a new connecting system by which the two traverser halves are connected beside the cross girders, since the requested construction height did not allow the usual fishing method.

The photographs give an impression of the described traverser.

HEAVY MACHINERY

Detailed project reports have been received from four firms—one each from Czechoslovakia and the United Kingdom and two from West Germany—for the manufacture of heavy castings and forgings required for the manufacture of heavy machinery.

After the recommendations of the Soviet team of experts and the British Heavy Engineering Mission were received, the Government of India recently decided to execute the following heavy machinery projects : a Heavy Machine Building Plant, a Foundry Forge Project, a Heavy Plate and Vessels and Heavy Structural Work, a Heavy Machine Tool Works, and a Mining Machinery Plant.

The Corporation has received preliminary reports for a project to produce special alloy and stainless steels required for the manufacture of industrial plant and machinery. These reports have been prepared by firms in Czechoslovakia, France, Italy and the United Kingdom. Discussions are now in progress regarding the size of the project and the method of its implementation.

Important Announcement

WE have pleasure in announcing to all our advertisers and readers that we are increasing the size of our technical journal with effect from our November, 1957 edition, but the advertisement rates remain unchanged. Our November (Annual Number) will be issued in increased size. Following are the mechanical details of our Magazine from November, 1957.

PRINT AREA	.. 9" × 7"
OVERALL SIZE	.. 10½" × 8½"
Col. Width	.. 3.5"
Col. Length	.. 9"
No. of Cols. for page	.. TWO
Screen upto	.. 120°

MATS, STEREOS, BLOCKS & ART WORK ACCEPTED

For further details please write to :—

The Advertisement Department,
THE INDIAN RAILWAYS WORKSHOP MAGAZINE

POST BOX 21
MANOJIAPPA STREET, TANJORE (S. INDIA)

A Locomotive with Diesel-Pneumatic Transmission

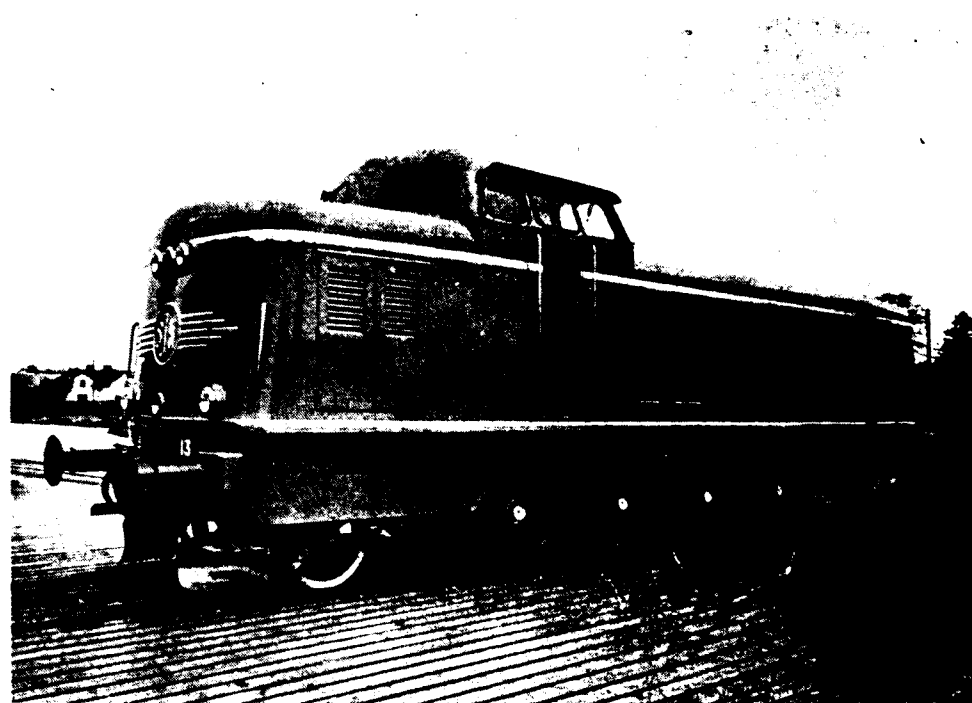
Swedish-built Unit on the Geislinger Principle

AKTIEBOLAGET Motala Verkstad, established in 1822 and now belonging to the large Axel Johnson organization, is one of Sweden's dominating engineering works. It built its first locomotive in 1861 and is since then one of the country's largest locomotive manufacturers. A couple of years ago the works delivered a loco. of new type to the Stockholm-Nynas Railway Company in Sweden.

The transmission system in this locomotive was carried out under licence from Doktor L Geislinger's patent. As shown by the adjoining picture the loco. is of type 1D1 with centrally arranged cab with two driving positions. In the front portion of the locomotive is located the cooling apparatus, whilst the engine is installed behind it, followed by the gearbox.

Compressor and turbine are mounted on this gearbox. The total weight of engine, gearbox, compressor, turbine, combustion chamber and auxiliaries is 11.4 metric tons.

In the loco., the engine has 16 cylinders and is constructed by Hedemora Verkstaeder, also belonging to the Johnson group, under licence from S.E.M.T.—Pielstick. It is a four-stroke engine of the pre-combustion-chamber type (bore 175 mm., stroke 210 mm.); normal output is 1,060 b.h.p. between 1,000 and 1,400 r.p.m. Features of the design include welded-steel engine frame, four-valve cylinder heads, manifolding within the vec between the cylinder banks, separate water pumps for (a) jacket circuit and (b) charger cooler and oil coolers. The engine is three-point mounted in the loco-frame, with fan air compressors at its "free" end. Two



flexible couplings are used between the engine and gearbox.

The gearbox connects engine, compressor, turbine and transmission shafts. The differential and the planetary gearing are of Stoeckicht patents. The differential is driven from the engine through a speed increasing gear.

Reducing gear on the turbine side is arranged symmetrically to the differential; it reduces the turbine speed in the ratio of 7.93 : 1.

On the output shaft are arranged two disc couplings giving change from first to second speed. Passing from the first to second speed, for instance, fuel injection in the engine is first reduced to zero; when the engine slows down the first speed is disengaged and the second engaged. Only when the second speed is completely engaged is the injection gear returned to normal working. Special measures have been taken to ensure

smooth gear changes without shocks. It is possible to change gear quite automatically as a function of the normal running speed. Drive to the axles is taken symmetrically on each side, using cardan shafts.

Compressor and turbine were constructed by Brown Boveri and Co., of Baden (Switzerland). The two groups are developed from a normal turboblower; all essential parts such as compressor and turbine rotors, inlet housing and outlet of turbine, have undergone no modification. The air conduit from the compressor is divided into two branches. One portion of this air passes through the air cooler and pressure-charges the engine; the remainder passes to the combustion chamber and thence into the turbine.

Now we turn to the general operating principles of the design. The output of pneumatic transmissions increases considerably if the heat contained in the exhaust gases of the engine is utilized. Moreover,

it is of advantage to combine the pressure-charging of the Diesel engine with the pneumatic transmission, so that part of the compressed air is absorbed by the engine. In fact, the output of an air compressor absorbing the whole power of a Diesel engine is much in excess of the amount of such air taken in by the engine, especially if the engine is of the four-stroke type and the charging pressure does not exceed from 14.2 p.s.i. to 28.4 p.s.i.

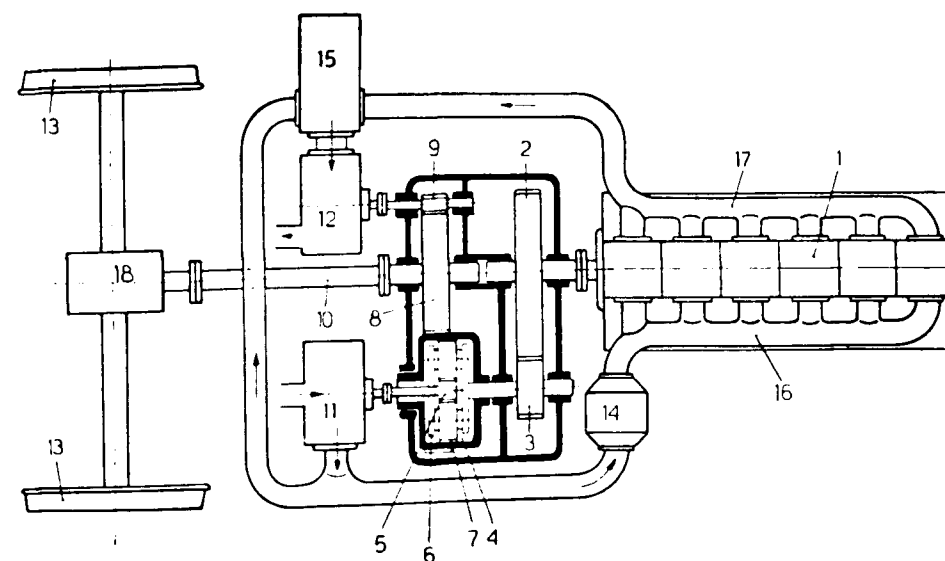
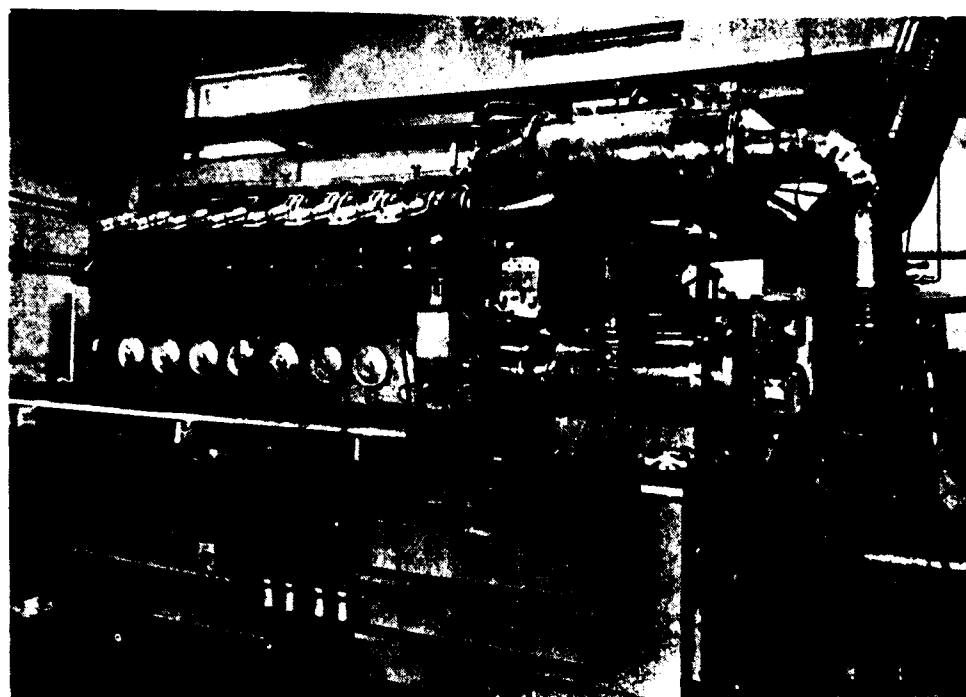
At high loads the charging pressure increases automatically if the engine speed decreases.

Development tests have shown, on the other hand, that a four-stroke Diesel engine works without difficulty against a back-pressure in the exhaust manifold equal to the charging pressure; in this case the engine can be considered as a non-pressure-charged engine working in a high-pressure atmosphere. With this method of working it becomes possible to mix the exhaust gases with that portion of compressed air not taken in by the engine; this mixture then passes into the turbine. The heat contained in the exhaust gases is thus recuperated, and increases the output of the transmission decisively.

Greater efficiency and output can be achieved if only a portion of the power developed is absorbed by compressor and turbine, providing one succeeds in transmitting to the driving wheels of the vehicle the remainder of the engine power without noticeable loss. The distribution of the power through a differential gear allows this idea to be realized. Such mode of transmission is known and is in use with hydraulic systems.

The general arrangement is shown in the accompanying diagram. The Diesel engine (1) drives through a speed-increasing gear (2) and (3) the planet-carrier (6) of the differential (4) Pinion (5) drives the compressor (11). The crown wheel (7) of the differential has two sets of gear teeth; the inside ones engage the planetary gear wheels, the outside ones engage the gear wheel (8) fitted on transmission shaft (10). The latter drives the rail wheels of the vehicle. A portion of the engine output is thus absorbed by the compressor and the remainder transmitted to the vehicle driving wheels. By means of a reducing gear (8,9) the turbine (12) transmits power to shaft (10) already referred to.

Part of the air delivered by the



compressor (11) is discharged into the inlet manifold (16) of the engine, passing through the air cooler (14). The remainder of this air passes into the combustion chamber (15). The increase in temperature of the air in this chamber gives a considerable power augment. The exhaust gases from the engine pass from the exhaust manifold (17) into the same chamber (15) where they mix with that part of the air not used in pressure-charging the engine.

By means of the differential gearing it is possible to transmit part of the engine power direct and without loss in conversion to the driving wheels at a high degree of efficiency. This division of driving power improves the efficiency of the Diesel-pneumatic transmission.

HEAT EMPLOYMENT

Let us suppose that at a given speed, 50% of the power is transmitted direct and the remainder absorbed by the compressor; the compressor then delivers half the quantity of air it would do if the power were not thus divided. The heat contained in the exhaust gases, on the other hand, does not vary. Since the weight of the gas plus air is only one-half, before the turbine entry is much increased, temperature i.e. there results, finally, an increase in the power developed by the turbine and a considerable increase in efficiency of the transmission. The power of the turbine can be possibly higher than that absorbed by the compressor, i. e., transmission efficiency exceeds 1; this is a definite advantage compared with all known transmission systems. This result is due, partly, to the fact that the useful heat of the exhaust gases at the super-charging pressures referred to is well over 40% of the heat contained in the fuel.

The temperature of the mixture of gas and air passing through the turbine is relatively low and only reaches 320 C at full load of the engine. This temperature can be raised by

injecting fuel into the combustion chamber. The power of the turbine is proportionate to the absolute temperature of the exhaust gas. This increase of power involves an increase in the specific consumption. Notwithstanding this, the power applied to the driving wheels is about 10% higher than that developed by the engine, taking into account the power required for driving auxiliaries. With all other transmissions this (driving) power does not exceed 75% of the engine power. Increase in specific fuel consumption is hardly more than 10% over that with other forms of transmission. At from 2/3 to 3/4 loading, i. e. the most important state for locomotives, consumption related to power of driving wheels is better than that with other forms of transmission.

Tests of the combination of engine, gearbox and combustion chamber took place at the works of Hedemora Verkstader. The power developed was absorbed by a water brake and measured the optimum consumption to approx. 190 gr. (0.41 lb.) per h.p./hour; from this it follows that losses in gearbox, compressor and turbine are low. With normal turbo-blower the engine consumption is 170-175 gr. (0.37 to 0.38 lb.) per h.p./hour at the same loading. The power delivered by the gearbox output shaft, without the combustion chamber in operation, is from 900 to 940 h.p. at speeds of from 50 to 90 km./hour (31 to 55 m.p.h.).

Summing up it can be stated that without the combustion chamber in operation the output of this transmission, from the points of view of power and fuel consumption, is slightly better than with electric or hydraulic transmission. With the combustion chamber in operation the power transmitted to the wheels of the loco. 10% higher than that of the Diesel engine itself.

As to the power at wheel rims, this locomotive corresponds to a Diesel loco. of 1,400 to 1,500 h.p. with either electric or

hydraulic transmission. One of the main advantages of this new loco. is the low consumption at moderate loads, viz. 60-80% of full, whereas the consumption at full load is slightly higher than that of a corresponding Diesel loco. with either electric or hydraulic

transmission but considering that full load is seldom used, this point is of small importance. Aktiebolaget Motala Verkstad is now building a somewhat larger four-axled bogie locomotive on the same principle for the Swedish State Railways.

PROTECTION TO WOOD SCREW INDUSTRY EXTENDED

The Tariff Commission has submitted its Report on the continuance of protection to the wood screw industry on the basis of an enquiry undertaken by it early this year.

The Government of India's resolution on the Tariff Commission's Report (1957) on continuing protection to the wood screw industry was published recently. The Government has accepted the Tariff Commission's main recommendation that protection to this industry should be continued for a further period of three years, that is till 31st December, 1960. Protection will be continued accordingly at the existing rates which have recently been rounded off to 35 per cent *ad valorem* or 35 np a gross, whichever is higher, under the Finance (No. 2) Bill, 1957. The Government has also taken note of other ancillary recommendations made by the Commission for assistance to the industry and will take suitable steps to implement them as far as possible. The attention of the industry has also been drawn in the resolution, to certain other recommendations made by the Commission about the need to use tested steel wire as far as possible, the desirability of adopting certain common specifications for steel wire, etc.

CENTRAL RAILWAY TAKES SPECIAL STEPS FOR MAXIMUM SAFETY

With the advent of the Monsoon, the Central Administration has put into effect the Monsoon precautions which include an intensified system of patrolling of railway line and of watching of bridges and other locations considered to be vulnerable.

Lines are being patrolled with greater intensity than ever before and special precautions have been taken to ensure that the maximum possible protection is afforded to every train. In respect of a large number of bridges, watchmen have been provided to maintain a round-the-clock watch to make assurance doubly sure that no train is allowed to cross them unless they are adequately safe for movement. Safe-limit marks have been indicated conspicuously on all bridges.

In the event of water passing the safe level whether as a result of floods, incessant rains or breach of tanks in the vicinity or even in the case of threatened damage or danger, the patrolmen and bridge watchmen have instructions to immediately stop all approaching trains and to allow them only after the site has been examined. Patrolmen and Bridge watchmen have been provided with electric torches to enable them to carry out inspections during the night. Weather warning telegrams forecasting storms, gales or heavy rainfalls in any of the 17 zones into which the Central Railway is divided, are being issued by the Meteorological Department of the Government of India to the railway and these are immediately relayed through control offices to areas expected to be affected.

Compressed Air System

MANY and varied operations in the production line at this modern factory are carried out by compressed air. This service is supplied by six Air Compressors each of a rated capacity of 1375 cu.ft./min. at 100 lb./sq. in. and is fed to the shops by an extensive net work of pipes ranging in size from 3" to 12". More than 4 miles of steel pipe were installed for the purpose. It is undoubtedly the largest of its kind in India.

In the largest shop there are seven main feeders each being over 800 feet long. These feeders are cross connected at both ends and in the middle of the building in the form of a grid. Special precautions were taken against the effects of thermal expansion in order to avoid damage to pipework, valves and machinery, the temperature of the air on leaving the after-coolers being in the neighbourhood of 140°F. The flexibility of each section of the system was carefully calculated and the layout planned accordingly, with anchors at pre-determined points to control the movements. The pipe supports were designed to allow the necessary freedom of movement in the pipework.

The expansion problem was particularly difficult as the pipe runs within the various

shops were laid in concrete trenches and it was not practicable to incorporate expansion loops. Sliding expansion joints were considered but fortunately it was found possible to avoid their use as they would have added to the cost considerably and would have involved additional maintenance.

Each pipe run was laid with a gradient for the draining of condensed moisture towards traps situated at suitable points in the system.

Flange joints were provided at intervals in the straight runs and also at valves and other connections. The majority of the pipe joints, however, were butt-welded at site, the pipe ends being bevelled in accordance with standard practice.

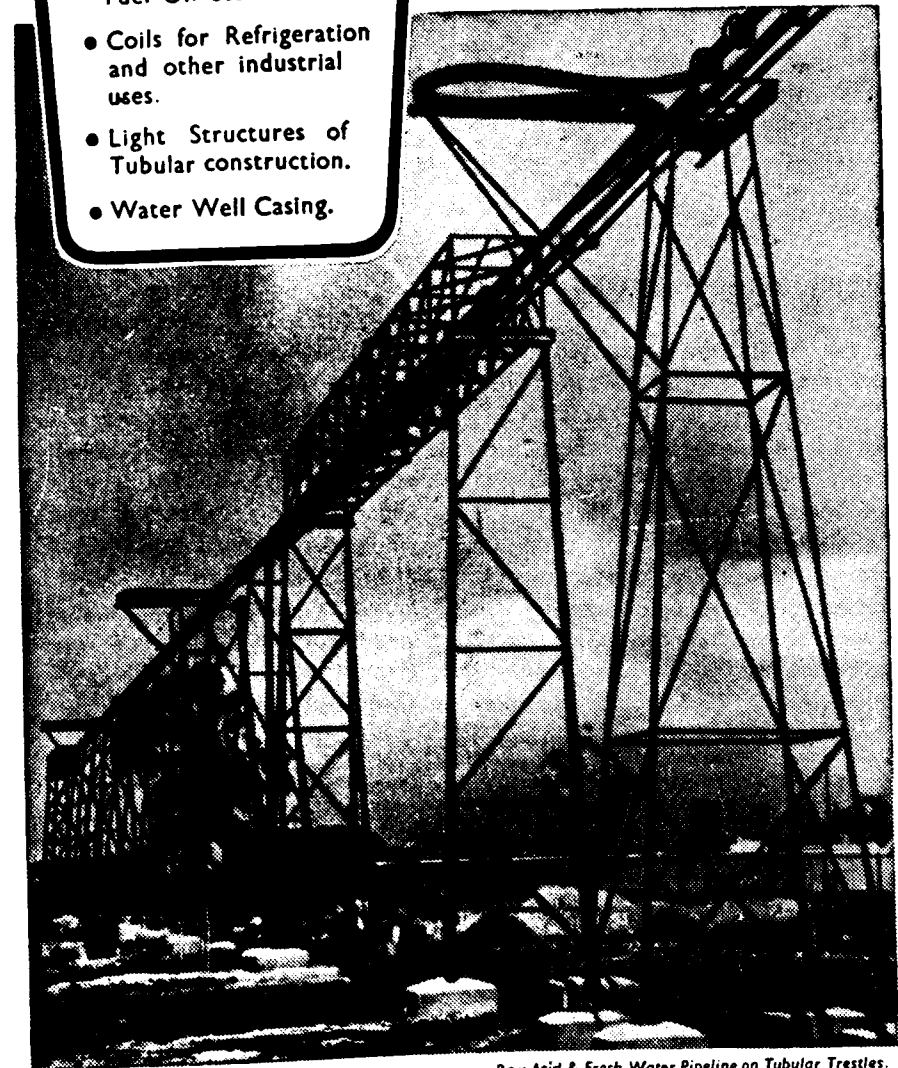
The entire installation was carried out in about six months by Stewarts and Lloyds of India, Private Limited with their field staff of erectors and qualified welders, the more complicated pieces being shop fabricated in the Kidderpore Works. The successful completion of the contract was, in large measure, due to the help and co-operation given by the engineering staff of the Indian Railways.

MINERAL RESOURCES OF NEPAL

According to a statement made recently by the Director of Nepal Bureau of Mines talks for the co-ordination of a mineral policy between India and Nepal have been started by Nepal Government. It may be mentioned that although Nepal is rich in minerals like iron, copper, zinc, lead and mica so long no progress could be made due to complete lack of communication facilities and inadequate power supply position. But with the development of communication facility and the availability of electricity from various projects already undertaken, Nepal for the first time under her first five year plan has undertaken projects for development of mines for which extensive surveys are now being made. With a view therefore to develop these industries, the Director visited the manganese mines near Nagpur before initiating the talks with the Government of India offices at New Delhi and for seeking co-operation to start some projects with Indian Capital.

THE INDIAN RAILWAYS WORKSHOP MAGAZINE

- Fabrication and Erection of complete Pipework Installations for Steam, Gas, Compressed Air, Fuel Oil etc.
- Coils for Refrigeration and other industrial uses.
- Light Structures of Tubular construction.
- Water Well Casing.



Raw Acid & Fresh Water Pipeline on Tubular Trestles.

STEWARTS AND LLOYDS OF INDIA PRIVATE LTD.

HEAD OFFICE :
41, CHOWRINGHEE ROAD,
P.O. BOX 270, CALCUTTA
TELEPHONE : 44-5224 (5 LINES)

WORKS :
39, HIDE ROAD, KIDDERPORE
CALCUTTA
TELEPHONE : 45-3515-16

Are Railroads getting the most out of their Materials Handling Equipment ?

By L. A. DePolis,

General Sales Manager, Industrial Truck Division, Clark Equipment Company.

GETTING the highest efficiency possible out of your mechanized materials handling equipment is basically a matter of good management. What are the major points to be considered in reaching this goal? It isn't difficult to enumerate them:

1. Select the right equipment for the job.
2. Use the equipment properly. Don't ask it to do too much (or too little).
3. Make use of special attachments and other devices which will increase the usefulness of the equipment.
4. Insist on proper maintenance and service of handling equipment.
5. Know when the "point of no return" is reached. Replace old machines

for new before heavy maintenance costs pile up.

SELECTING PROPER EQUIPMENT IS FIRST STEP

"Variety" is a one-word description of railroads handling equipment needs. Belt conveyors are necessary for receiving, classifying and manifesting freight as it arrives. Pallets are necessary for temporary storage of freight in holding areas. Pallet racks are necessary to assure best space utilization. Fork trucks are needed for pallet handling in freight terminals and in and out of freight cars. Trailers are needed to be used with tractors or fork trucks for horizontal movement. Dollies and rollers may be needed for handling heavy machinery. Hand pallet and powered pallet trucks are needed for use inside freight cars.



81-1005-Series 81 Ross Carrier transports boxed-load of trash and rubbish to the dump at the main shops and general stores division of the Milwaukee R. R. Division of the Chicago, St. Paul, Milwaukee and Pacific R. R. in Milwaukee, Wisconsin.

MATERIALS HANDLING EQUIPMENT

We take great pride in announcing having supplied in May 1957, The Integral Coach Factory of the Indian Railway with

9—CLARK DIESEL OPERATED FORK LIFT TRUCKS—

The Trucks have the following specification:—

- 2 Nos. Clark Model YARDLIFT 6024.—6,000 lbs. @ 24" load centre, 130" standard uprights. HANOMAG Diesel engine fitted with Standard Fork and SIDE LOADING ATTACHMENT. This SIDE LOADING device is for transporting and tiering unit loads at a 90° angle with the direction of travel of the Truck. This Side Loading feature provides greater utilisation of available space for storage as the width of the truck operating aisle is reduced approximately 68% in comparison to width required for standard fork.
- 2 Nos. Clark Model YARDLIFT 4024.—4,000 lbs. @ 26" load centres, 130" standard upright, Hanomag Diesel engine, fitted with standard forks and 360° Rotating Device.
- 5 Nos. Clark Model DCE 2024.—2,000 lbs. @ 24" load centre, 130" standard upright Mercedes-Benz Diesel Engine and fitted with Standard Forks.

These Trucks were made in Germany by the CLARK Licencees, Messrs. Ruhr Intrans Hubstapler.

PNEUMATIC INDUSTRIAL TOOLS

We have supplied the Integral Coach Factory with no fewer than 412 Pneumatic Tools manufactured by our Principals, Thor Power Tool Co., of the U.S.A., and their subsidiary Messrs. Armstrong Whitworth & Co. (Pneumatic Tools) Ltd., of the U.K. The Tools comprise:—

Thor/AW Scaling Hammers (300 Nos.) Grinders (45), Wire Brush Machines, Pneumatic Drills, Screw Drivers, Impact Wrenches, and also Electric Drills.

Reliance Petrol Operated AUTO TRUCK for INTERNAL HAULAGE. We have supplied over 60 Nos. of Elevating & Fixed Platform Reliance AUTO Trucks to the various Railway Workshops in India.

JOST'S ENGINEERING CO. LTD.,

Post Box No. 243,
BOMBAY

Post Box No. 64,
CALCUTTA

Of all these the fork-lift truck is the most common piece of equipment used by railroads. Its mobility, lifability and ease of operation make it an essential machine for the variety of handling chores found at freight terminals. It is n't necessary here to go into the fine points of fork truck selection—capacity, width, upright heights, and so forth—since these requirements differ considerably from one installation to another. It is desirable, however, to mention two points which railroads may not be giving adequate consideration—the types of fork truck power available, and the use of special devices and attachments.

FOUR POWER TYPES AVAILABLE

Most fork truck manufacturers offer four types of power—gas, electric, diesel and liquified petroleum gas (LP-gas). Again, gas power needs no elaboration here; it is by far the most widely used, and its advantages are well understood.

Other types of fork truck power, however, may be well suited to certain handling operations. If fuel cost was the only factor involved, all fork trucks would probably be electric, for electric power is the cheapest available. The low-cost operation and

longer life span of electric fork trucks usually off-set their higher initial cost.

Of equal importance, the operating characteristics of electrics offer unique advantages; they are quiet, clean, fume-free, and operate efficiently under extreme conditions of heat or cold. This latter feature could be of significance at terminals located in rigorous climates.

A variation of electric power is the "Ready-Power" unit. Ready-power is a gasoline or diesel engine powered direct-current generator adaptable to electric fork trucks. The unit is a completely self-contained packaged assembly, fully automatic after a push-button start, and is used instead of battery power where necessary. The motor generator unit is a source of ready power at all times, eliminating necessity of spare batteries, chargers and related accessories.

Where can electric fork trucks be used advantageously? Practice has shown that gas-power is more efficient for long-haul runs—carrying pallet loads from terminal storage to cars positioned several hundred yards away, for example. But not all operations are long-run. In short-haul

moving of palletized freight inside the terminal or in loading trailers parked next to the terminal the economical operation of electrics pays off. An important point to remember is that electrics, because of their fewer moving parts, require less maintenance than gas-powered trucks.

DIESEL POWER IS CHEAP

The principal argument for diesel power is its safety and low cost; although not as cheap as electric power, diesel fuel is less expensive than gasoline. And like gas-power, diesel is most effective for long outside runs.

THE NEWEST POWER TYPE—LP GAS

The newest development in fork truck power is liquified petroleum gas, or as it is commonly known, LP-Gas. In comparison to gasoline, LP-Gas has the advantages of lower fuel cost, less maintenance and longer engine life, and it does not produce harmful fumes. Originally designed for operation in areas where gas fumes would be undesirable, the economies of LP-Gas power have made it increasingly popular for many installations which normally would use gasoline.

In many instances where gasoline power is not desired, the choice lies between LP-Gas

power and electric power. When this situation arises an important point to consider is that LP-Gas trucks have a greater degree of flexibility than electrics. Battery-operated electrics are more or less restricted to areas which have battery-charging stations, while LP-Gas trucks can be moved at will.

LP-Gas powered fork truck (and electrics), because of their fumeless operation, are especially suited for work around people in closed areas—in terminals or at luggage pick-up points, for example.

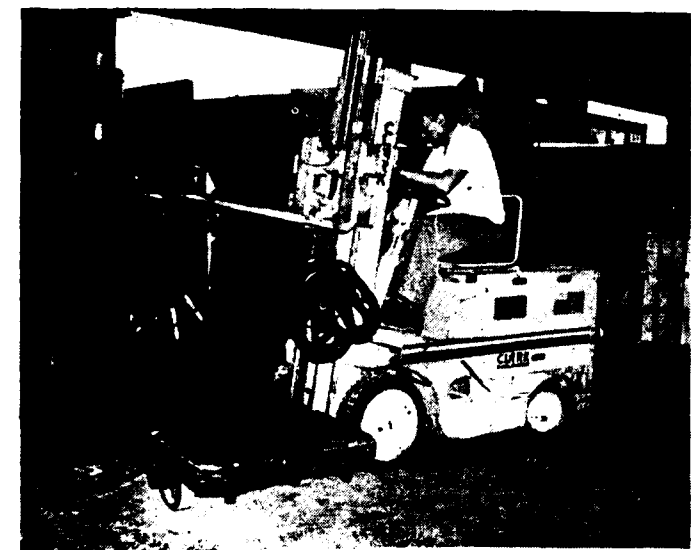
To summarize—it is probable, and properly so, that gas-powered fork trucks will remain as the backbone of freight handling equipment. Yet there are specific advantages in other types of fork truck power, and there are certain areas of materials handling in which these types can be advantageously employed. Determining the most efficient application is one step toward a more effective handling program.

AUTOMATIC SHIFT OR MANUAL SHIFT

A second point railroads may overlook is the desirability of specifying clutchless automatic drives for fork trucks. Most fork



81-1006—Series 81 Ross Carrier transports bolster-load of steel pilings at the main shops and general stores division of the Milwaukee R.R. Division of the Chicago, St. Paul, Milwaukee and Pacific R. R. in Milwaukee, Wisconsin.



ECL-1544—Elec-Carloader removes anchor chain links from a trailer and deposits them on a platform truck for delivery to a box-car at Pennsylvania R. R. Butler Street Station in Philadelphia, Pa.

truck manufacturers offer some variation of automatic drive. Clark Equipment Company's Hydratork Drive, as an example, utilizes the principle of torque conversion.

Hydratork consists of two basic elements: a torque converter and a new type of fork truck transmission which eliminates the need for manual or automatic gear shifting. Power from the motor is automatically multiplied to meet changing power requirements—initial acceleration of a heavy load from a full stop, for instance, or for climbing grades.

Automatic drive offers several important advantages:

- Easy operation. This is important where untrained drivers must be used, or where many different drivers use the same machine;
- Lower maintenance costs. Elimination of clutch wear-and-tear saves considerably on service bills;
- Smooth acceleration prevents load damage due to jerky starts, and reduces possibility of damage from

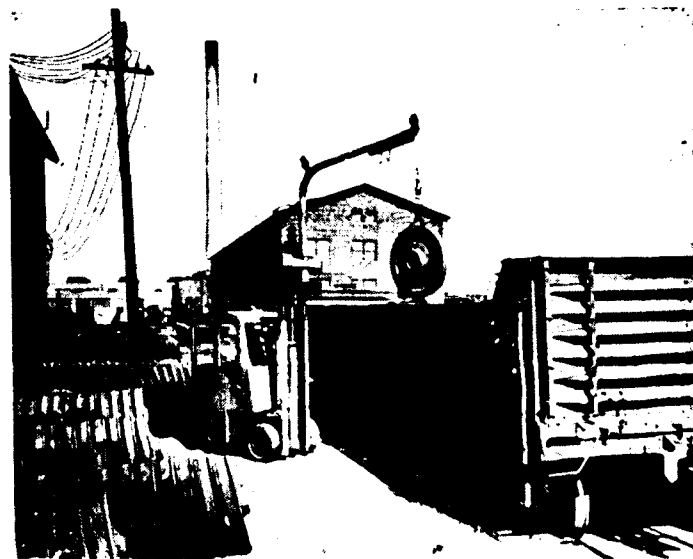
abrupt acceleration while loading freight;

- Greater controlled power for unusually heavy jobs.

Approximately the same advantages apply to fluid couplings used on towing tractors. This feature, available on some models, is standard equipment on Clark tractors. Use of a fluid coupling is especially advantageous when breaking away a heavy load from standstill since it insures smooth application of full drawbar pull. The fluid coupling prevents loss of torque from the engine, thus permitting full engine power to be applied to the work. When the initial pull is completed and the load is in motion, drawbar pull drops to about half of the starting effort, permitting the fluid coupling to operate at a low temperature. With a fluid coupling the clutch is disengaged only when entering or changing gears.

The advantages of both automatic drive for fork trucks and fluid couplings for tractors should be considered when planning or replanning handling procedures. In most instances economies can be gained through their utilization.

UT-1305—The Chicago, Rock Island and Pacific Rail-road solved their wheel handling problem in the Chicago Shops by designing and building a special crane attachment for their Clark fork-lift truck, a gas-powered Utilitrac. The attachment is used to load and unload single and double wheels, to place them in storage or to take them from storage.



THE INDIAN RAILWAYS WORKSHOP MAGAZINE

CAN FORK TRUCK ATTACHMENTS BE EFFECTIVELY UTILIZED?

Fork trucks are not only "fork" trucks. The list of attachments which can be substituted for forks is indeed a lengthy one. Clark alone manufactures more than 90 different handling devices. When unpalatized handling is desirable or necessary, special attachments can often be utilized. Several examples will illustrate this point:

- Machinery or other heavy, bulky items can be handled with a crane attachment quickly substituted for forks;
- Tires, wheels, round castings and items of similar shape can be carried and loaded with a ram attachment;
- Large cartons and bales are easily handled with any one of several clamp attachments;
- Use of paper pallets, with a Pul-Pac attachment for handling, can save an appreciable amount of valuable cargo space.

Don't forget that fork trucks need not be restricted to handling duties. With such attachments as sweepers or snow plows, they become utility trucks performing "extra" functions at little extra cost.

Consideration of fork truck attachments to increase machine utility is another step toward efficient utilization of handling equipment.

THOROUGH, CONTINUING MAINTENANCE IS ESSENTIAL

Above all else, the one activity which will increase the effectiveness of your materials handling fleet is the establishment of a thorough, consistent preventive

maintenance program. The importance of this cannot be overstressed. Too frequently no consideration is given to preventive maintenance and the cause of machine failures. It is too common a practice to operate a vehicle until it breaks down and requires a major repair. If a little foresight had been used, a major repair would not have been necessary.

A rigid preventive maintenance program is a major step in securing from your materials handling equipment all of the service which was built into it. To paraphrase—an ounce of preventive maintenance is worth many pounds of major overhaul cure. In order to maintain handling operations at the highest efficiency and prolong the life of each vehicle, it is compulsory that preventive maintenance be performed regularly and systematically. This work should be done by qualified mechanics under competent supervision. A complete record of all service done should be maintained, as only through such records can a proper check be kept.

The time and effort required to maintain a preventive maintenance program is mandatory to reduce to a minimum the time lost while a vehicle is in a repair shop.

DRIVER TRAINING REDUCES MAINTENANCE

Since a major cause of equipment breakdown is careless operation, a logical supplement to sound maintenance is an operator training program. Such a program is necessary for freight handlers on at least two counts:

- (1) Rapid turnover of fork truck drivers and other equipment operators brings a more-or-less constant influx of inexperienced, untrained labor;
- (2) Round-the-clock operation means that

each machine is subjected to the varying driving habits of several operators.

Admittedly, these same reasons make it difficult to implement a thoroughly comprehensive training program, yet adequate training can be obtained with some simple, inexpensive techniques. Fork truck manufacturers will gladly furnish driver manuals, safety suggestions and illustrative material on proper fork truck operation. Educational movies can be obtained free. Equipment suppliers are always available to give talks and lectures, and will even assist in setting up "obstacle courses" on which new drivers can practice.

It is advisable that, like preventive maintenance, driver training programs be continuing. From time to time safety quizzes, driver tests and similar devices can be utilized in "refresher" courses, not only to keep operators alert, but to weed out incompetent operators.

WHEN TO TRADE IN OLD EQUIPMENT?

The procedures and programs discussed so far are designed to increase the utility and

prolong the life of your materials handling equipment. But in spite of even the most tenacious adherence to these suggestions, the rugged daily wear-and-tear incurred by your machines eventually will raise maintenance and repair bills to the point where it becomes advisable to replace the machine. When is this point reached?

Speaking generally, a gas-powered fork truck will perform efficiently under normally heavy conditions for a period of five to seven years. Electric-powered trucks will last from seven to nine years. It must be understood however, that these figures represent a general average, and that wide deviations from this "normal expectancy" are common. Many electric trucks, for example, are still performing capably after 15 years of hard service.

It is not the age but the maintenance record and general condition of a fork truck—or any other piece of handling equipment—that determines its further usefulness. And these factors will always vary with individual trucks. As a general rule-of-thumb, however, the following pattern can be established:

Sometime between the second and fourth year of operation, a gas-powered fork truck will need a thorough overhaul. Two or three years later, a second overhaul will be required. It is at this point that an analysis should be made of the two factors cited above to determine the advisability of replacement. If the general condition of the machine is poor, and past maintenance records indicate that future repair bills will be high, then the machine should be replaced. If the opposite is true, then the expense of a second overhaul will be justified. Third overhauls are seldom advisable.

When a decision has been made to replace a machine, a thought should be given to the practicality of keeping the old machine as a "spare" rather than trading it in for a few hundred dollars. Semi-retired fork trucks need little or no maintenance, yet can be very useful for handling odd jobs, as extra equipment during peak periods, or as substitutes for machines tied up in the maintenance shop. Whether or not having a spare truck available for such emergencies is worth the sacrifice of a trade-in allowance will depend on the nature of the operation.

WHAT WILL TOMORROW BRING?

Obsolescence is a word well understood in the railroad industry. The most up-to-date equipment may become obsolete almost overnight as new designs and new theories become known. The same thing can happen in the materials handling field, and good management demands that new methods be examined and tried when higher efficiency can be obtained.

Two new materials handling techniques that have potentialities for railroad handling are the use of straddle carriers for fast horizontal movement of goods, and the "Mobilvan" system recently announced by

Clark Equipment Company.

Originally designed for carrying lumber, the highbodied, spidery-looking straddle carrier is now receiving industry-wide recognition as a highly efficient, low-cost means of transporting materials horizontally. With one man as operator, the carrier can load itself in five seconds, unload in three seconds, carry a payload of 50,000 lbs. and almost any length, and travel over the road at speeds up to 56 miles per hour.

These performance characteristics can be utilized in railroad handling at several points. As a substitute for tractor-trains, a carrier can pick up palletized freight in terminal storage and in a few moments deliver it alongside freight cars or trailers for loading. The carrier can be used to transfer freight (or maintenance supplies, parts and other materials) from one storage area to another—moving in a few minutes from one end to the other of even the largest Terminal.

MOBILVAN

The Clark Mobilvan System is based on the use of a lightweight van measuring 17'x8'x8' and having a capacity of 20,000 lbs. Automatic locking devices enable it to be fastened securely to the bed of a railroad flatcar or the body of a flatbed highway truck. The van is moved by fork truck or straddle carrier.

Merchandise is loaded into the van at a shippers' loading dock and the van is transferred to a flatcar or flatbed trailer for transport to its destination. Here the van is transferred to the dock and emptied at the convenience of the receiver. An important advantage of the Mobilvan is that, unlike a conventional highway trailer, it can be used for storage indefinitely.



YL-4-1425—Two Clark Yardlift-40 unload plywood to a position where one may handle it from box car at Coutu Lumber Co., West Warwick, Rhode Island.

STANDARDISATION OF RAILWAY TERMS IN REGIONAL LANGUAGES

Terms and expressions normally used in sign boards, notices, etc. at railway stations are to be standardised in regional languages other than Hindi, such standardisation in Hindi having already been completed. The object of this standardisation is to facilitate the use of identical expressions on the different zonal railways which serve the same language area.

The work of preparation of standard vocabularies in Tamil, Telugu, Kannada and Malayalam are being undertaken by the Southern Railway. The Central Railway is doing likewise in Marathi, the Western Railway in Gujarati, the Northern Railway in Punjabi and Urdu, the South Eastern Railway in Oriya, the Eastern Railway in Bengali and the North Eastern Railway in Assamese.

NEW RAJA-KI-MANDI STATION

OPENED

A new railway station with modern amenities at Raja-ki-Mandi was opened for passenger parcels and luggage traffic in August 1957.

An important suburb of Agra, Raja-ki-Mandi is situated 123 miles from Delhi on the Bombay-Delhi mainline of the Central Railway. It is served both by mainline trains of the Central Railway and by branch line trains of the Eastern Railway coming from Tundla.

The old station building was completed and brought into use in 1906. The platforms, built over half a century ago, were not sufficiently extensive to accommodate the longer trains of to-day which halt at the station and some of the coaches of these trains stood outside the platforms resulting in a considerable measure of inconvenience to passengers in such coaches. There were no waiting rooms for upper class passengers nor were there food stalls or a restaurant at the old station. The small waiting halls on the platforms were inadequate. To add to the inconvenience to passengers, the approaches to the station were narrow and lay through a

crowded locality. The old station had no circulating area or car park in front of it.

The proposition for the remodelling of the old station had to be abandoned as there was no scope for expansion in the heavily congested area in which it was situated. It was therefore decided as the only possible alternative, to provide an entirely new station in the fork formed by the diverging tracks going to Delhi and Agra City just north of the old Raja-ki-Mandi station.

The work of building the new station was undertaken towards the end of the first Five Year Plan and has now been completed in all respects, and opened to passengers, parcels and luggage traffic on the 7th August 1957. The new station has high level concreted platforms with roofs to provide weather protection. In the new station building with its simple and appealing lines built to a modern design there is a fine booking office with a large, airy concourse opening on to a small garden and a spacious class III waiting hall. There are also two upper class waiting rooms and food stall and lavatory arrangements with water-borne sanitation. The plinth area of the new station is more than four times as big as that of the old station.

Two foot over bridges have been provided one connecting all the main and branch line platforms at the Agra end of the station while the other connects the mainline platforms at the Delhi end of the station. A wide circulating area with approach roads and suitable stands for motor cars, rickshaws and tongas of a total area of 52,300 square feet has also been provided, an amenity that was totally absent in the old station.

The opening of the new Raja-ki-Mandi station fulfils a long cherished need of passengers who continued to use the old station long after the volume of traffic had outgrown the meagre facilities provided. It will also be a great boon to tourists using this station to whom the up-to-date amenities provided will be an attraction.

Range of Armstrong Whitworth

Pneumatic Tools for Railway Workshops

TO compile a list of tools for use in Locomotive, Carriage and Wagon Works would mean quoting almost every tool in the new Armstrong Whitworth No. 53 Industrial Catalogue, as there is not a tool in the Industrial range for which a suitable "Railway" application could not be found.

Armstrong Whitworth's experience in the design and manufacture of portable power tools ensures that each tool is built to the highest standards of engineering precision. The arduous conditions found in the Railway industries to which these tools have been supplied, have proved them to be robust in construction and trouble free in operation.

Armstrong Whitworth manufacture a complete range of reversible and non-reversible rotary air drills, from the 362 series with a capacity of 29/32" and 1", up to the 363 series with a capacity of 1 1/4", 1 1/2" and 2". These drills can be used for drilling, reaming and tapping, or adapted for tube expanding and flue rolling. Also in this range is the 362 series woodborers, which have capacities up to 4". Tools of practical necessity in the construction and maintenance of the permanent way.

The Armstrong Whitworth Size 3 RDC/35 Panel Saw is specifically designed and manu-

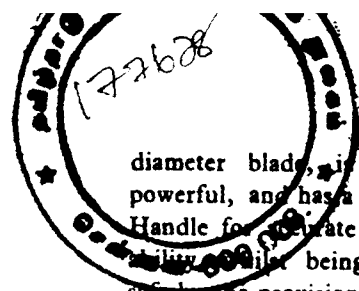


Drilling holes for Chair Screws with an Armstrong Whitworth Woodborer Size 362 RHW.



Stay Bolt riveting in a Locomotive Fire Box with Armstrong Whitworth Size 406 Riveting Hammers.

factured for repair work on Railway coaches, such as cutting out for patchrepairing panels in sheet metal, when they have become badly rusted. This tool is an ideal tool for fast accurate sawing of light timber, it has a 2 1/2"



diameter blade, is extremely powerful, and has a fixed Dead Handle for accurate manoeuvring. Being perfectly safe by the provision of a fixed guard. Armstrong Whitworth also manufacture a complete range of Rotary Air Impact Wrenches which have capabilities for nutsetting up to $1\frac{1}{4}$ " capacity bolt diameter, and can be effectively used with available attachments for screw-driving, tapping, drilling, grinding, wire brushing, and sanding. The Sizes 48 HG and 80 Impact Wrenches are particularly suitable for heavy duty work, such as the removal or running down of nuts with bolt diameter up to $1\frac{1}{4}$ ".

The 5V Series Grinders are ideal tools for use in Locomotive works for the grinding of horn cheeks. Their rugged construction and tremendous power make these tools first choice for cup wheel grinding. Their design includes a built in muffler which reduces the sound level to $1/6$ of that of similar machines.

Armstrong Whitworth manufacture a complete range of Riveting Hammers which are ideal tools for Locomotive works, for applications such as stay bolt riveting. The light Riveting Hammers sizes 76, 79, 712, 46 and 417, have capacities up to $\frac{3}{4}$ " Hot Rivets, and the Size 83S Close Quarter Riveting Hammer has a capacity of $\frac{3}{4}$ " Hot Rivets. The range of long stroke Riveting Hammers covers Sizes 43, 53, 83 and 93, which have capacities up to $1\frac{1}{4}$ ".

Another tool suitable for Locomotive work



Removing Stay Bolt rivets from Loco. Fire Box with Armstrong Whitworth Size 9300 Rivet Buster.



Cleaning up a weld after a repair job on a Locomotive Frame with an Armstrong Whitworth Size 246 Grinder.

is the Armstrong Whitworth Rivet Buster. This tool is manufactured in two Sizes, 6300 and 9300, and can be used with a wide variety of Cutting Chisels and Knockout Punches.



YOUR PROBLEM IS NO PROBLEM WITH ARMCO'S STEEL SHEETS

Armco is an International Organisation with branches throughout the world. Their engineers successfully designed the first strip-mill and the Armco strip-mill at Ashland, Kentucky, U.S.A., is the most up to date in the world. Intensive laboratory research and constant observation of service life under field conditions have achieved very high standards of efficiency in all Armco products. Research workers at Armco's laboratories are constantly studying the problems of the engineering industry and are developing the best possible grades of steel sheets. This 'know how' is contained in thousands of service reports which are, in turn, distributed to the different branches of the Armco Organisation.

Armco is proud of its contribution to India's Five Year Plans. Their steel sheets are being used throughout the country and India's rail coaches at Perumbur are being built with steel manufactured by Armco.

ARMCO SPECIAL STEEL SHEETS & TUBES

Stainless Steel - Electrical Steel - Enamelling Iron - Hot & Cold Rolled Sheets - Aluminized Steel Sheets & Tubes - Zincgrip & Zincgrip Paint-grip - Cold-rolled Paint-grip - Terne Plates and lastly Armco 'Bundy' Tubing.

ARMCO (INDIA) PRIVATE LIMITED

21, ESPLANADE MANSIONS, CALCUTTA

Telegrams: "INGOT" Phone: 23-6087

BOMBAY BRANCH:

Army & Navy Building, Mahatma Gandhi Road, BOMBAY

Telegrams: "CULVERTS"



Agents:

- 1 M S K. G. KHOSLA & CO. PRIVATE LTD.,
1 Deshbandu Gupta Road, New Delhi.
- 2 M/S. GARLICK & CO. PRIVATE LTD.,
Haines Road, Jacob Circle, Bombay II.