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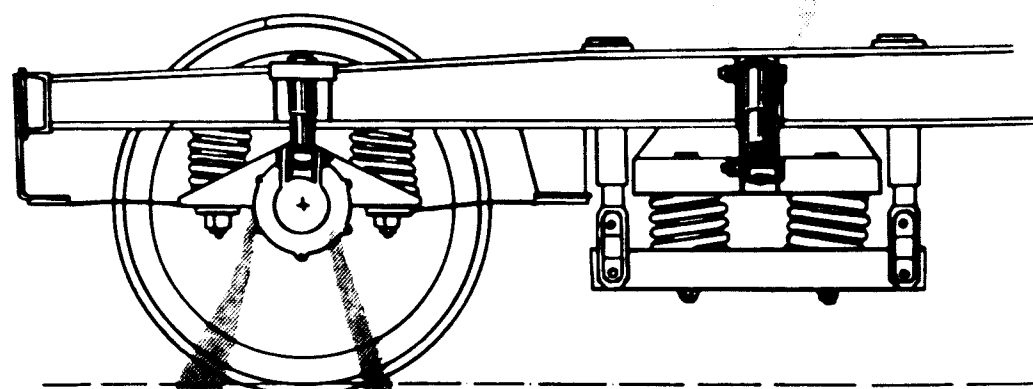
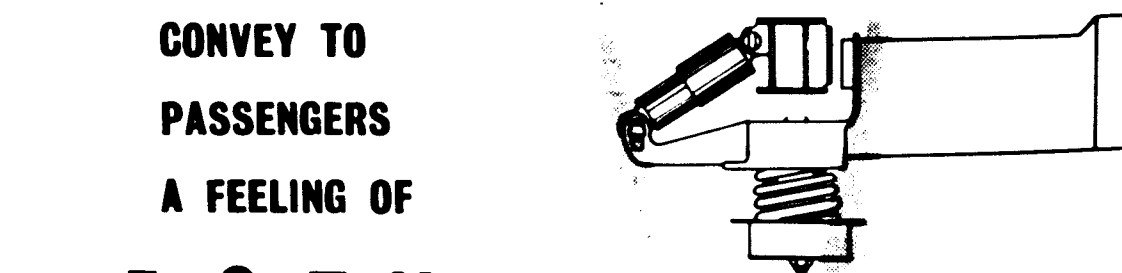
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INTEGRAL COACH FACTORY SUPPLEMENT

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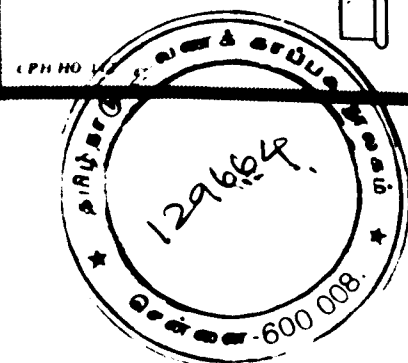
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WHAT THE PUBLIC EXPECT FROM THE INDIAN RAILWAYS

THERE is an old English adage which says that "he who pays the piper has the right to call the tune." The same saying may, with due modifications, be applied to the Railways of India. It is the travelling public and the tax payers who after all supply the funds which enable the Railways to run. They have therefore the right to certain expectations from the railways. Whether those expectations are realised or to what extent they are realised, is another matter, and may be dealt with later.

The first and most important thing which the public desires is "SAFETY" on our Railways. Accidents are constantly occurring on our railways and if they are minor ones they are not reported in the daily press. It is only the major accidents and disasters that find space in our daily newspapers especially if they involve deaths and disablement to a large number of train travellers, men, women and children. Sometimes the major accidents or disasters are the "act of God" over which we humans have hardly any control. If due to excessive rains, the rivers are in spate and wash away a bridge just about the time the train is in the vicinity, no power on earth can save the victims of that disaster. Undoubtedly precautionary driving and hundred per cent alertness on the part of the driver may avert a disaster. The travelling public is prepared to accept such an accident with equanimity. But it is the other major accidents such as head on collisions or the rear train raming the tail of the one in front due to wrong signals being given or major derailment due to bad condition of the tracks or the poor maintenance of the locomotive, carriage or wagons causing a serious failure resulting in derailment particularly of the mail express or passenger trains, this is what makes the people jittery and inclined to panic. Sabotage by criminal gangs for loot or political reasons are another cause. All these can be classified as avoidable accidents and are caused by somebody's lack of attention to duty or gross carelessness or negligence. Post mortem enquiries by the Government Inspector of Railways reveal this but the public hear very little on whom the final responsibility rests and what punishment has been meted to the culprit or culprits and what precautions are taken for the future, to avoid recurrence. It is this type of attitude of caring a hang for the public feelings that make people lose confidence in the Railways. It is vital, therefore, and the public expects it that a clear cut explanation be given for the cause of the accident or disaster, also the party responsible and what action has been taken or is proposed to be taken.

The second point which the public expects from the railways is punctuality in running their trains to schedule time. During the British regime this used to be the rule and late running an exception. Lack of punctuality was in every case thoroughly investigated and necessary action, whether it be punishment or rectification of fault was in every case taken. The Officers and the Senior supervisors were always on the alert, so to say on their toes, to see that they and those under them were not to be blamed. The picture today has lost all its glamour because punctuality has today lost its meaning, and it is the rule for trains to be late, and an exception for them to be on time. Undoubtedly there are reasons and often good reasons.

Tracks are in bad condition requiring repairs and therefore cautionary driving at very restricted speeds for large parts of many section has to be imposed. This is fair enough but what is its answer to the question, why has the track been allowed to reach the poor standard of maintenance. It may be said that locomotives are old and are working beyond their normal age, hence they break down with concomitant loss of time in running. This again is fair enough, but what the public would like to know is with such a large expenditure in the imports of locomotives from America, Canada, U. K. and construction of locomotives by Chittaranjan and Tatas when can the public expect a radical improvement. It is well known, that with the increase in population resulting in more railway travellers, increase in production of minerals, agricultural produce, industrial manufactures which the railways have to carry to their capacity is strained. While admitting these as causes the public would like to know when can we expect the railways to meet the loads and what is being done about: Here again it is the publicity and public relationship that is defective. Why not absorb one column of the daily newspaper to convey the necessary information to the people, who are in truth paying for the railways to run and run not any way but efficiently. Then we come to the question of cleanliness and courtesy. There was a time when the British ran our railways, that the personnel were spick and span. The Station Master, the Ticket Collectors and the Guards used to come on their duty in white starched clothes, their headgear with red bands was brushed, their shoes were shining their hair was neatly cut and brushed and their beards shaved clean. The red and green flags of the guards were spotless, their leather band well polished and in every way they looked so smart and alert that it was a pleasure to see them.

They were courteous even though they generally suffered from a superiority complex as far as the Indians were concerned. They may have been curt, but they were certainly helpful, they went out of their way to find accommodation for travellers in difficulties. The Europeans as well as the Anglo Indians, were a disciplined body of men, who appreciated their duty and responsibility and performed their task however distasteful with a high sense of public service.

What is the picture today? Railwaymen come to duty unshaved, unkempt, white clothes dirty and unpressed, headgear thick with oil or grease, shoes unpolished, giving the general impression of slovenliness and apathy. The contrast between the old regime and the new one as far as the appearance of the personnel alone, makes one weep.

As far as courtesy is concerned, it hardly exists. It is replaced either by gross inefficiency or arrogance. The meaning of the word "a public servant" is completely forgotten. To their illiterate brethren and sisters they are rude and harsh, many times behaving as if they are the masters expecting homage and subservience from the travellers.

This is with regard to the personnel. Now what about the compartments. Except for the air conditioned seats berths and lavatories, the rest of the compartments are shabby and very often really filthy. Many times the doors cannot be properly locked and the windows are jammed in the open position, making security precautions practically impossible. The seats and berths look antediluvian in appearance and as far as the lavatories are concerned one feels sick to use them. Fittings are invariably missing, the fans do not work and one or two lights in every compartment are pilfered. If alternative means of transport was available at the

same rate as the railways, it is felt that the revenue earnings of the railways would drop by fifty per cent.

On some Railways, inter departmental officers have orders to inspect trains for cleanliness, to check staff for courtesy and helpfulness and although they send regular and often critical reports, no action appears to be taken, because improvement if any is negligible. The reports probably gather dust in some musty files and pigeon holes until they are destroyed.

The public have a right to expect from the Railways cleaner trains, cleaner personnel who man them. When is that expectation likely to be fulfilled is the question that requires an answer.

When goods get lost or pilfered or damaged in traffic the sender is supported to prefer a claim against the railway. When this is done, even with all the disheartening formalities it takes months and even years to get a settlement. So many objections are raised, papers get lost, files cannot be found, so much so that merchants and businessmen are prepared to suffer a loss rather than tolerate the delaying tactics of the railways.

Further if contractors undertake construction or manufacture for the railways then bills are held up so long for payment that they get disgusted and finally resort to anti-social practices. Many a contractor who has learnt a bitter lesson would not touch railway construction or manufacturing orders with a barge pole. Corruption in Railways is so rampant that the majority of railwaymen expect something before they release a bill for payment after unnecessarily holding it up for weeks.

There is supposed to be vigilance and anticorruption staff on the railways but these antisocial practices taken place under their very nose and they are either in league or grossly incompetent to bring the culprits to book. The public would like to have statistical figures of the improvement made or is it a case of throwing good money after the bad?

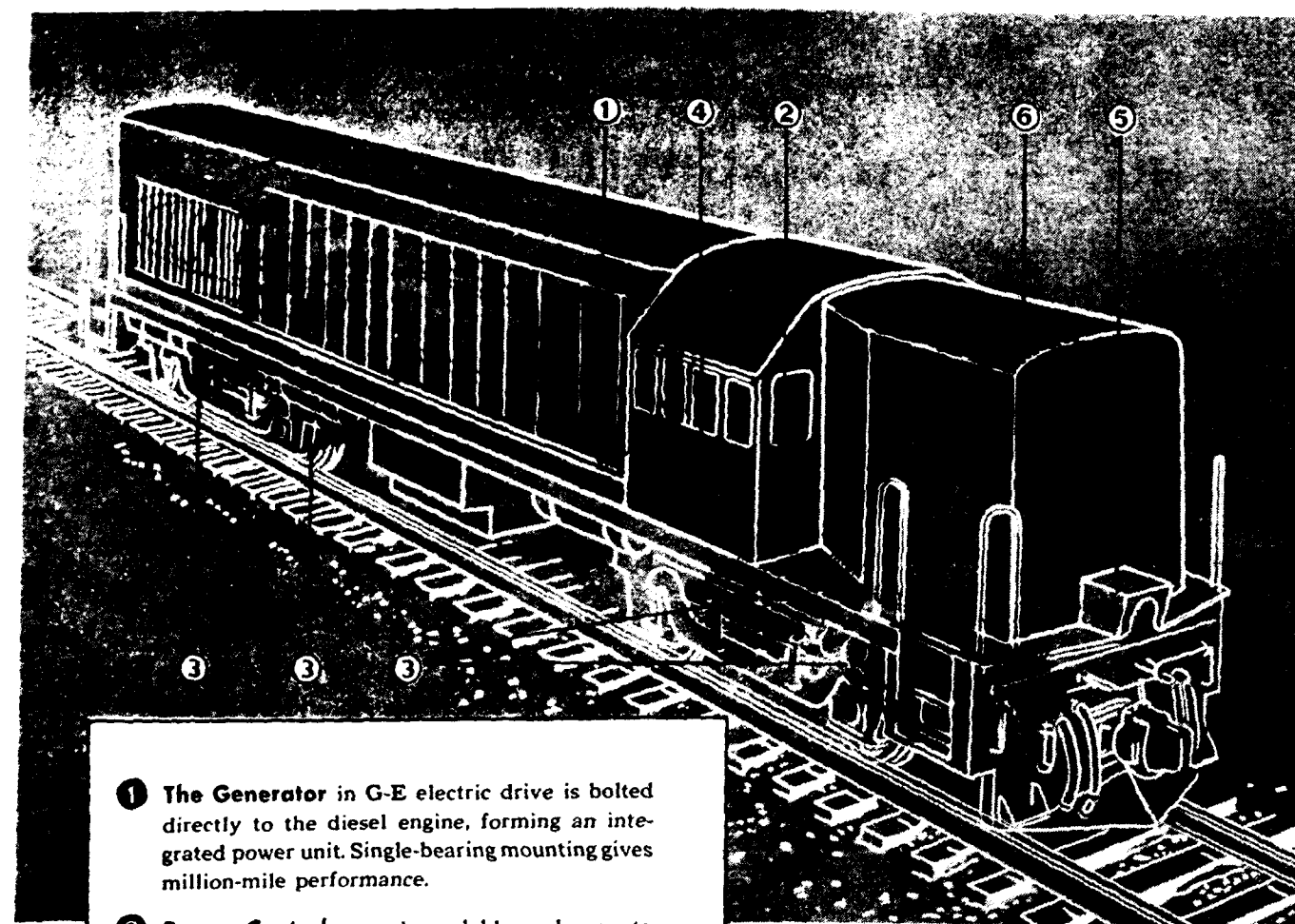
The public expect ticketless travel to be reduced and the drain on railway earnings to be stemmed. What statistical improvements have the Railways to show even when their campaign was in full force.

Finally the public expect to be taken into confidence and informed from time to time of the improvements made in many directions on our railways.

Are the Railways prepared to comply?

HUNGARIAN MINERS BEAT PRODUCTION PLAN

Hungarian coal miners overfulfilled their production plan by 2.4 per cent in the first six months of 1960. Mr. Bela Blaha, General Secretary of the Mineworkers Union told the Union's annual conference in Budapest. Other sections of mining also beat the planned figures—mineral mining by 17 per cent and ore mining by 9.5 per cent. Oil production beat the plan by 1.7 per cent. It was aimed to produce 4,100,000 tons more coal and 200,000 tons more oil.



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FIRES — TRAINING WILL REDUCE TOLL

By R. G. Hardikar

District Electrical Engineer, Chittaranjan Locomotive Works, Chittaranjan.

(This article is intended to be a supplementary to the former one on "Workshop Accidents" published in October last. The author was entrusted with A.R.P. duties, as a civilian railwayman. These duties covered fire fighting, including maintenance of equipment and training of personnel. He is, therefore, considered competent to write on this 'enemy' who takes a considerable annual toll of life and property from industrial India. — Ed.)

HAD I taken a couple of minutes longer to emerge out of the carriage bathroom I might not have lived all these 20 odd years to write this article. It was a hot April morning. Nearing noon. The carriage in which I was travelling, at full speed, was the 5th or 6th from the engine of the mail train. I began doing my bed and simultaneously heard a sudden "ting" from behind. I looked round and was attracted by a lighted cinder flying out of the fan at the back of my left shoulder. I was the sole occupant of the coupe. The cinder landed on the pillow. The pillow slip started burning. I smothered the burning with my wet towel. I had just then finished my shave and bath. The glowing cinder from the engine entered through one of the slots of the ventilator and struck the revolving blades and ricocheted on to the pillow below.

ACCIDENTAL IGNITION

Some couple of years ago an armed sentry patrolling in the front verandah of locked Cash Office noticed an electric light go out. This happened a little before changing guard at zero hour. Saturday/Sunday night. The outgoing company had entered this fusing of the lamp in their diary. Some three hours later another sentry from the second company reported emergence of thick smoke from the strong room (also locked) inside the Cash Office. The fire fighting squad, led by two Gazetted Officers, discovered a biri stump deep back in the pile of heavily card-board bound Registers inside the strong room. Could the biri have been planted there? The strong room was locked at 16.45 hours on Saturday. Over 10 hours before the emergence of the smoke and 2½ hours after the fusion of the metal filament and the bursting of the electric lamp.

Just imagine what would have happened either to the carriage or to the Cash Office had there been no eye witness available to smother the burning matter and timely put out what would have been a blazing fire in a matter of minutes. Being one of the members of the 3-man Fact Finding Enquiry Committee which

enquired into the second of the two incidents narrated hereabove, I have no doubts in classifying the causes of these two fires as purely 'accidental'.

INVITING TROUBLE

But the cause of fire that gutted a motor garage in Bhowanipore (Calcutta) some years ago because one of its mechanics was fool hardy enough to locate or look for trouble under the bonnet with a naked light, most certainly cannot be argued by any Portia to be purely accidental. A well trained and properly recruited mechanic would never have given cause for this fire resulting in loss of life and valuable property. More serious from the point of view of sheer negligence, than this garage fire, was the fire which broke out round about 02.00 hrs. in an IOW's godown in a Divisional Headquarters. The officially estimated damage due to this fire, also detected in time, luckily was a little under four figures. The fire was attributed to charging of motor car batteries without the knowledge of the electrical department. In this engineering department's godown there was timber (scantlings), cotton waste, umbrellas and benches for push trolleys, empty and half empty tins of ready mixed paints, oils, varnishes and methylated spirit. There was understandable unwillingness too, on the part of the engineering department, to hand over this battery charging to the electrical department after this fire. And what excuse could there be for an exactly similar fire on the very same Organization, but at another Divisional headquarter's station after a span of hardly half-a-dozen years? By this second fire inside a motor garage, where battery charging was being done within a couple of hundred feet of petrol tins, a lac of rupees-or-more worth of assets were gutted and had to be written off. The responsibility for these two fires can most certainly be fixed. It rested with the inspecting authorities. Not only that; but one has to admit that these two fires ought never have been given the cause to occur. They have been caused by both sheer ignorance and utter lack of forethought.

ERADICATE IGNORANCE

In matters of personal well-being and safety, ignorance is NOT bliss. It has to be eradicated by a high powered drive and campaign through all levels. On being asked by a breathless Works Manager who had run fast 200 yards or so to put out a rising fire from an electric motor, inside a boiler shop, the Nepali watchman on duty, standing there on the spot, calmly replied that he did not press the fire alarm as he thought "It was meant for Fire Drills only". And meant not to be pressed in the event of actual fire. In another instance a Foreman, transferred from Power House to Workshop replied that he did not segregate inflammables from combustibles in his Stores as the orders to do so were received by him when he was in the Power House. He did not think that those orders were applicable to Works as well. Official records will bear me out that a Divisional Operating Superintendent (Class II) on being called upon by his Senior Deputy General Manager to report on the Fire Fighting facilities available in Goods Sheds and Parcel Godowns in his Division mentioned that "the water was green" at a certain Station but failed to report

on its source, distance and quantity available in summer and winter.

The experience gained during the war years, as a civilian railwayman, in A.R.P. duties first in Chittagong and later on in Trans-Brahmaputra Danger Zone has thoroughly convinced me that men give better account of themselves if they are first trained in their specific duties in the language they understand. The importance and necessity of training supervisory staff in First Aid is accepted all over. Not only that, but their increment is often withheld if they fail to pass in First Aid. For the very same reasons none should look askance at my suggestion of training all stores and engineering staff in Fire Fighting duties. This must be done on the very same lines as were adopted in the training of civilian A.R.P. personnel.

In fact it will be worthwhile stretching this idea further to our schools and teach all boys and girls how to fight fires. Now-a-days we accept the idea of training school children on how to cross crowded streets in our cities. Why not teach them fire fighting too? It will save valuable lives and property.

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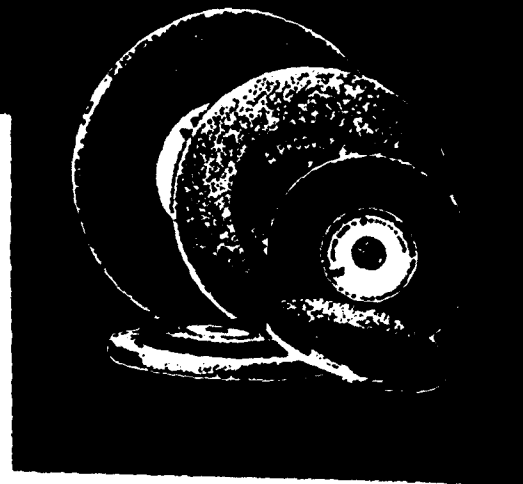
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Chemical Weed Control on Railway Tracks

By An Engineering Correspondent

THE elimination of weed growth from railway tracks is as important today, as ever before. With demands for higher standards of efficiency and maintenance, adequate ballast drainage becomes even more essential. As, however, railways can only devote a limited amount of expenditure to this problem it is interesting to see how chemicals can play their part in this never ending battle.

The post-war discovery of new and powerful organic herbicides, provide the Railway Engineer with an efficient means of achieving high standards of weed control at realistic cost. Indeed, in many cases, an annual systematic spraying programme with such materials, can ultimately achieve weed 'prevention' rather than weed destruction. Thus it becomes possible to reduce and even obviate the decaying vegetable matter in the ballast which so often creates an ideal germinating media, whilst simultaneously improving the drainage of surface water from the track.

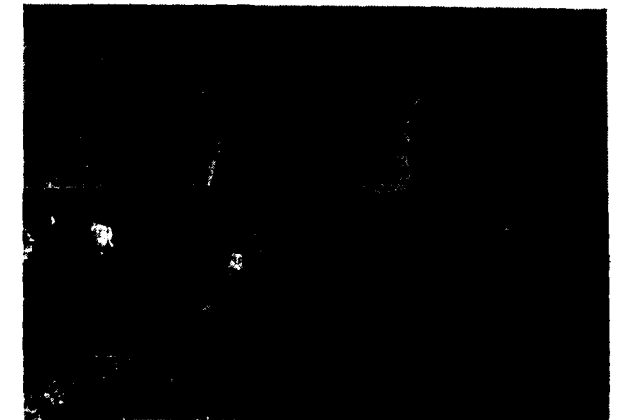
In the U.S.A., Canada and the U. K., the Chipman Companies have carried out railway weed control for many years, providing not only Chemical formulations to meet specific conditions but also the most suitable mechanical means of treatment.

From the technical evidence available to-date it is apparent that no single weedkiller will control all species in tracks and cesses at economical



Chipman Chemical Company's Spray Train No. 3

rates of application. The optimum quantity of any chemical which can be provided within the financial limits of a Railway budgetary system, invariably means that a degree of weed selectivity takes place. Repeated use of one chemical, therefore, can lead to the increased growth of the resistant species in the absence of other competing vegetation controlled. Realising this, Chipman found that a higher standard of allround weed control could be obtained by the application of weedkiller "mixtures", formulated to take advantage of the individual "strong-points" of each chemical to obviate the above mentioned selectivity.



Grani-Spreader applying Chlorea Granules

For many years Sodium Chlorate, with or without a fire-depressant additive has and still is being satisfactorily used for total weedkilling. Easy to mix and apply, this low cost chemical has been the only serious alternative to the use of poisonous arsenical preparations. "Atlacide" a saftened chlorate based product, universally known for its application on railways, is still extensively used in many countries. Its high solubility, however, particularly in wet seasons, tends to reduce its persistence in the ballast, often permitting late season germination of seedlings. Additionally, whilst effective against a wide range of weed species it is notably weak against some of the finer grasses.

With the availability of the substituted ureas, the long lasting insoluble organic weedkillers discovered by Du Pont, an entirely new conception of railway weed control becomes possible. Known briefly as

C.M.U. or D.C.M.U., these compounds are particularly effective against most grasses, whilst at the same time persisting in the upper soil limits as a barrier against seed germination. Widespread commercial use has revealed the advantages of such chemicals, although it is apparent that some deep rooted perennial growth will survive the rates per acre that railways can afford.



30 Gallon Portable Unit.

To overcome this situation in the Northern Hemisphere, Chipman supply a combination of "Atlacide" plus C.M.U., deriving the maximum benefit from the synergistic effect of these two chemicals in the total herbicidal reaction. Now registered as "Atlavar" this weedkiller mixture, incorporating if necessary a 2, 4-D hormone weed killer, offers one of the more effective answers to any total weed control problem. This is but one example of a weedkiller mixture. There are many others, specifically manufactured for the conditions existing in various parts of the world, following a series of comprehensive trials laid down to discover the most successful chemical combination for a given weed problem.

A further example of this work is the recent availability of a granular weedkiller—"Chlorea". This pellet-like herbicide contains sodium chlorate, C.M.U., and 2, 4-D and is ideal for use in congested areas or where water availability is a serious problem. Easy to apply and safe to handle, "Chlorea Granular" has become popular for the treatment of sidings and

marshalling areas where track possession is unobtainable.

Very encouraging results with Chlorea have recently been reported from Australia, New Zealand and some of the mid-African territories and it is believed that this product will find increasing usage on many overseas railways where limited water supplies are available.

In the appraisal of any railway weed problem it is necessary to consider the following points:—

- (a) Type of ballast.
- (b) Rainfall
- (c) Weed species
- (d) Water points
- (e) Cash per mile available for weed control.

Armed with this information it is possible to consider what suitable formulations can be provided within the economic limits prevailing.

The next step would be the introduction of small scale replicated trials, to evaluate the results of the materials initially selected, followed by any necessary adjustments to chemical ratio and dosage rates. Unfortunately such work cannot be finalised in a short period of time, and several seasons may elapse before the acceptable answer can be found.



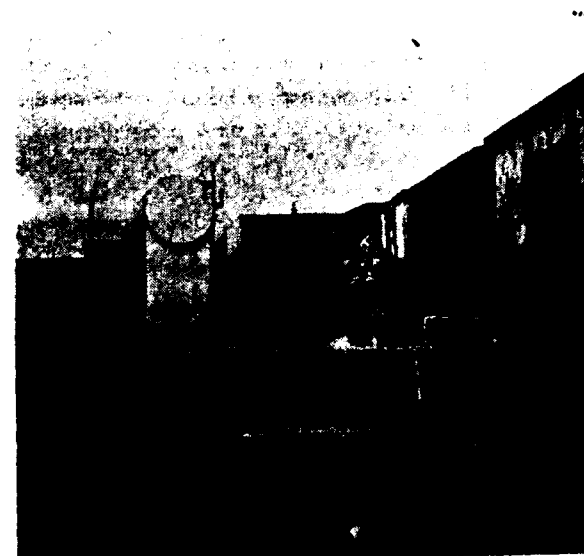
Illustration of Cess Spraying.

With the co-operation of the Railway engineer, the Chemical Manufacturer can illustrate the potentiality of modern chemicals and demonstrate the labour saving possibilities to be derived from a methodical approach to an age-old problem.

"Any weedkiller is only as effective as the way it is applied"—aptly sums up this subject, but undoubtedly chemical weed control can be considered as a modern "tool" in permanent way maintenance.

Too often in the past the question of the correct equipment for the job has been given little consideration, and in many places the secondary method of application viz: domestic watering can, has rendered the job tedious and expensive in both labour and effort.

The initial cost of the organic weedkillers including C.M.U. and D.C.M.U., calls for even and accurate application and the tolerance between successful treatment and poor results is very close at the marginal dosage rates necessitated by railway economics.



320 Gallon Trolley Unit.

Since introducing chemical weed control to British Railways in 1926, Chipman Chemical Company has provided advice and assistance on the construction and operation of spray trains and equipment.

Between 1955 and 1959 three new spray trains have been constructed, two with a tank capacity of 15,000 gallons and the third of 19,000 gallons. This latter equipment can treat 238 acres at one fill (130 miles track miles 15' 0" wide). All three trains normally operate at a speed of 20 m.p.h. and can vary output and width of cover up to a total width of 23'. The complete train comprises a machinery van with a meter-

ing pump driven from the coach axle, booster pumps, speedometer and mileage recorder.

A booster pump is also carried for use when the train is working at very low speeds and for static operation.

Coupled to the machinery van is the living accommodation for the crew. Butane gas supplies the power for lighting, heating, cooking and refrigeration storage capacity for 450 gallons of fresh water is provided. Frequently spraying operations, commenced early in the day, often extending to late at night, give the crew no opportunity to obtain meals from normal sources. An upholstered mess room and sleeping quarters offer a comfortable self-contained unit, in which the crew can live for several days.

For smaller duties, such as marshalling yards and sidings, small trolley-mounted 320 gallon spray units have been produced, capable of spraying a swath of up to 15' 0" at speeds of 5 m. p. h. Such machines can be propelled by a Wickham inspection car or pushed by hand at 2 m. p. h.

On other sites where track possession is difficult smaller equipments are available, ranging from self-contained 160 to 30 gallon capacity tank and pump units mounted on a chassis and four rubber tyred wheels.

Recent development has been concentrated on the handling of granulated weedkillers. Such 'dry' products e. g. "Chlorea Granular", possesses many advantages over liquids; particularly the lack of dependence upon water supplies and the reduction in weight of material required to treat a given area.

Experience has shown that on many sites one man with a spreader can treat a greater area than 2—3 men with a liquid spray equipment. Development of larger spreaders for applying granules over wider areas at speeds of up to 25 m. p. h. are in hand and should be available soon.

From this brief review it is hoped that Overseas Railway Engineers will appreciate the value of the research work regularly undertaken in this field and give consideration to some form of investigation as to how modern chemicals can contribute to the task of efficient track maintenance.

MONORAIL — WHAT IT IS

By A. C. Bhattacharya, A.M.I.Prod.E., A.M.I.Loc.E.

(Exclusively for Indian Railway Engineer)

ONE of the most discussed and at the same time least understood means of transportation is the monorail. In their attempt to find a solution for practical ways to move multitudes of people, transit authorities in many of the world's major cities—San Francisco, Los Angeles, Tokyo—are comparing various rival possibilities: buses, conventional railways, monorails and other exotics.

Monorail systems are still largely theoretical although they have been in existence, at least in experimental forms, since a long time. One monorail line, built in 1901, has carried over 1,000,000,000 passengers and is still a profitable operation. Yet, other than this and some specialised industrial monorails for in-plant mechanical handling, the monorails that have been built for anything more than test purposes, have not met with success for one reason or another.

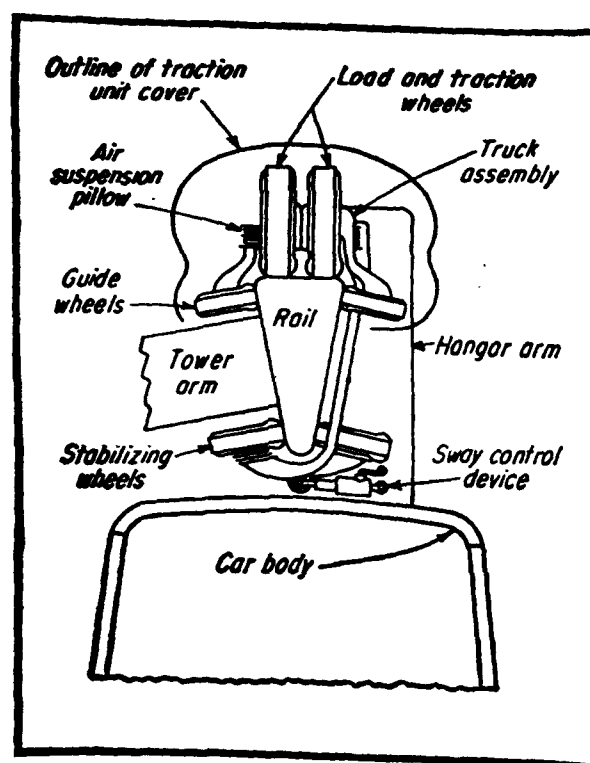


Fig. 1. Conventional Monorail Suspension.

EARLY HISTORY

The concept of a single-track railroad was first proposed in 1896 by an Irishman, Louis Brennan. In 1882 he invented a torpedo that was guided by wires from the shore. Since his torpedo was stabilised by gyros, he believed a monorail car could also be gyro-balanced. A successful working model, which travelled around a circular track at 20 miles per hour, was displayed by him in 1910. In the same year, a similar monorail was demonstrated by a German, August Scherl, in Brooklyn.

At about the same time, in a mountain railway near Salzburg, a railway car was placed on a single track



Fig. 2. Wuppertal Schwebebahn Monorail.

going up a mountain. The car with its 10 passengers was literally floated by means of a balloon attached to it. To get down, a large tank within the car was filled with water. The increased weight took the car back down again.

In U.S.A., Goodell Monorail of Houston has a prototype line running in Dallas. It is developing a new, simplified concept which is claimed to have no apparent moving parts. There is an Alweg monorail at Disneyland. It is closely patterned after an experimental line that Wenner-Gren built near Cologne,



Fig. 3. Undercarriage of Alweg Supported Monorail.

Germany in 1957. Seattle is now considering a monorail system for its ensuing fair.

THREE BASIC TYPES

There are three basic types of monorail: the suspended, in which cars swing from a single overhead rail; the supported, in which saddle bag cars straddle the rail; the split-rail suspended, in which instead of a single overhead rail, dual rails are used, retaining its monorail designation as both the rails are contained in a single girder.

In the suspended type monorail system, the cars are suspended by means of a hook-like construction from a single rail. The one designed by Murel Goodell of Houston—U.S.A., is suspended from a triangular

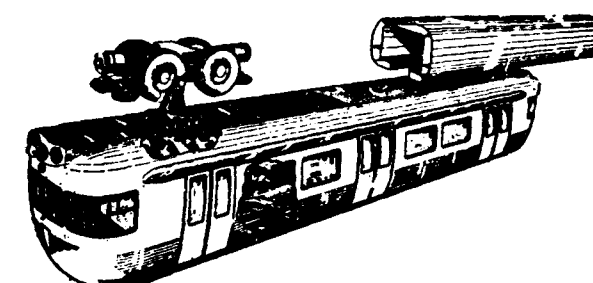


Fig. 4. French Split-Rail Type Monorail.

track, 22-in. wide and 42-in. deep. Each traction unit has four running wheels that run on top of the rail; and six stabilizing wheels—two upper and one lower on each side of the track. Coach suspension is by air springs and torque bars. The air springs also serve to keep coach floor at constant level. The arrangement is depicted in Fig. 1.

The Wuppertal Schwebebahn, illustrated in Fig. 2, was completed and put in service in 1901 over an 8.2 mile route. It is the oldest among suspended trains and the only successful commercial monorail ever built. This German line which carries 86,000 passenger daily, has cat-type bogies composed of running wheel and driven wheel with worm gear. It has an enviable record for safety as well as performance.

The supported type refers to the monorail car supported from below and riding on a beamway. Dr. Wenner-Gren, the leading proponent of supported systems, began operating a full scale prototype near Cologne in 1957. The cars ride over an I-shape reinforced concrete beam which carries five steel tracks on sides and top. The beam is 4 ft. 7 in. high and 2 ft. 8 in. wide, spanning 15 ft. pylons at 40 ft. intervals. Conductor rails run along the indented portion of the support beam.

ALWEG TYPE

The supported Alweg type system has had extensive tests on 1.25 miles of prototype track. Articulated trains of two cars operate successfully over three turns and a 15% grade. Each car is 36 ft. long, 9 ft. 10 in. wide and 13 ft. high. Cars have two bogies, each with one driven supporting axle. The bogie, as shown

in Fig. 3, uses pneumatic tyres on 2 running and 4 guide wheels. The two vertical running wheels ride atop the beam, and the 4 horizontal guide and stabilizing wheels hug sides of the beam. The guide wheels have rubber-steel springs with variable spring rate to enable the resistance to increase non-linearly with deflection. Speed is 50 miles per hour with 150 miles per hour claimed.

SPLIT-BOX GIRDER

The split-rail suspended type in which bogie of the French suspended trains ride, uses split-box girder that allows the car to hang symmetrically below. It is not a true monorail in the sense the other types are and the San Francisco Rapid Transit Authority refers to the car and its beam-riding relatives as "exotics".



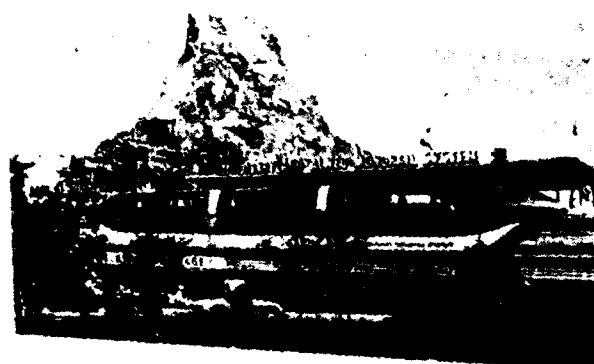
Fig. 5. Suspended Monorail under Trial in Japan.

In this arrangement as illustrated in Fig. 4, two problems, i.e., car sway and elevation at platform, that confound designers of suspended cars, are handled by a double-pendulum suspension system. The car sway is sensed in the primary pendulum and a hydraulic cylinder in the secondary pendulum system rotates the car in the direction of swing to set up a restoring moment that counteracts the sway.

The French-split-rail cars are 56 ft. long, 10 ft. 1 in. wide and 9 ft. 9 in. high. With maximum passenger load, car weigh 22,000 lbs., including 6,300 lbs. of mechanical and electrical equipment and 7,900 lbs. of structure. Cars are driven by 2 bogies with 2 driving axles, both powered by 3,600-rpm., 100-hp, 750-v. traction motors. The population units drive a fully loaded train weighing 29.7 tons at a top speed of 62 mph.

JAPANESE MONORAIL

Tokyo has a 1094-ft. monorail running through the city's Ueno Park. It uses rubber for both running



Supported Alweg type Monorail in use in Disneyland, America.

and guide wheels. It was opened in November, 1957, and has been carrying 7000 passengers daily since then. The line is regarded as an experiment that may serve as the basis for a transit system between Tokyo and its satellite cities.

As may be seen from Fig. 5, the cars are driven by two bogies, each of which has two pneumatic drive wheels and four stabilizing wheels. A train is composed by two such cars. Rubber-and-steel springs control the lateral oscillation. The beam which is square shaped with top indented, has two conducting rails fitted to the bottom and a pair of Z-shape pantographs collect current from the motor.

Driving and control apparatus is provided at the top of the car. The main, 300 volts D. C. motor has an output of 30 kwh. and delivers 1,600 rpm. Current is supplied by a 600-volt distributor at the terminal.

Monorail is a possible solution to the transit problem in all but the most densely populated cities. Recently competition among designers of monorails is becoming intense. In January, 1960, two French companies completed an experimental line near Orleans, France. Heavy initial capital investment required for the introduction of the monorail system is standing on its way of large scale development, but once this is overcome, the advantages offered by single rail systems will put monorail in a more favourable light.

High-speed Hydraulic Presses 5, 10 and 15 Ton Models

An entirely new range of high-speed hydraulic presses, known as R-G, has been designed and built for Dowding & Doll Ltd. by Rhodes, Gill & Co. Ltd., who have earned a high reputation in the field of high-pressure hydraulic engineering.

There are three models—with 5, 10 and 15 ton pressure capacity. They are of streamlined design and entirely self-contained. The hydraulic reservoir, pump, motor, and all pipe work and control rods are fully enclosed within a fabricated steel frame of exceptionally sturdy design.

R-G presses have been developed to simplify and speed up such operations as blanking and piercing, forming and bending, broaching, clipping, marking and assembly. Extended tests have proved their efficiency and reliability.

On all three models, operating pressure and slow ram advance for setting are controlled by a regulator fitted close to the pressure gauge for which an isolating valve is provided. Both the ram nose and the table are designed to accept most existing tooling. Perspex guards provide a clear view of the work while affording complete protection to the operator.

5-TON MODEL

The 5-ton model can be supplied either as a bench press or with a pedestal for floor mounting. Operation is by means of a hand-rail which extends across the front of the press—an arrangement which permits working with either hand. The pedestal model can also be supplied for foot operation.

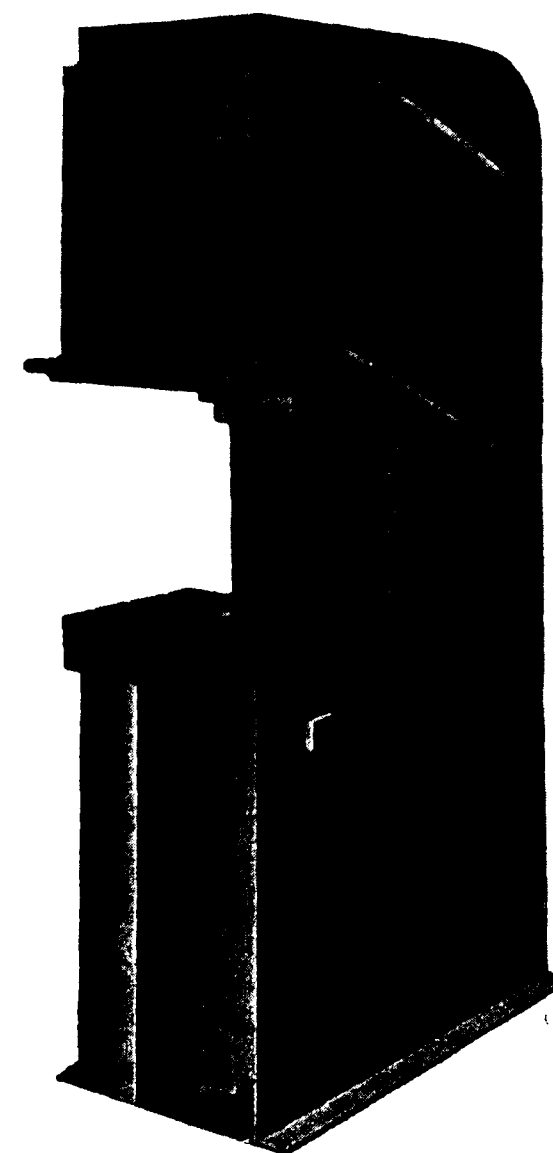
A unique accumulator system provides rapid ram approach with instantaneous speed reduction and the application of full operating pressure immediately the load is applied. The double-acting cylinder and ram provide positive power ram return. The ram is prevented from turning by a spring-loaded plunger housed within the frame. There is no obstruction of the table area and the stroke is readily adjustable.

Pressure can be maintained for normal periods and simple special equipment is available to extend the duration of pressing.

The speed of the ram on the approach, pressing and power return strokes is 1000, 35 and 650 inches per minute respectively.

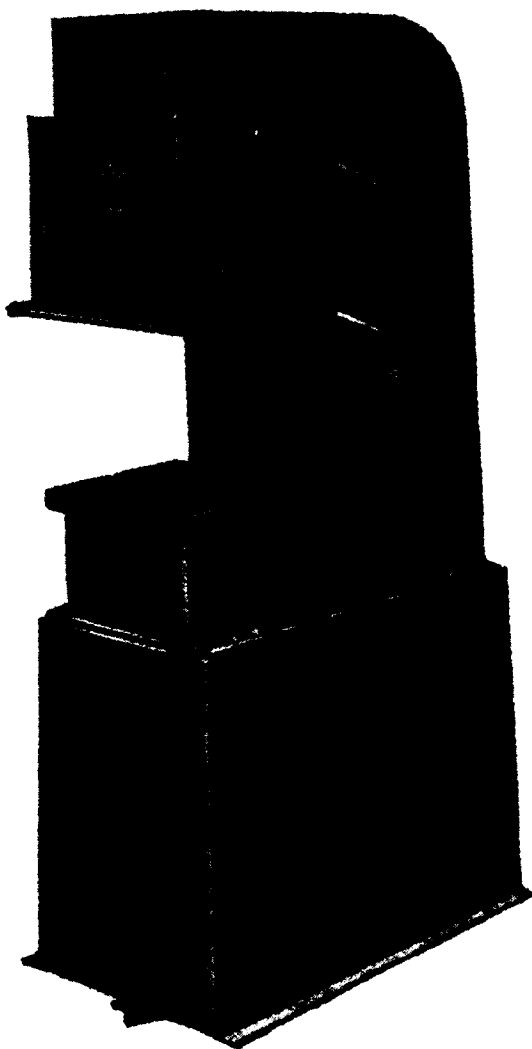
10 and 15-TON MODEL

Both the 10-ton and the 15-ton models operate on the jack-ram prefill system. A robust guide is fitted



to check rotation of the ram. Compactly housed, it permits full use of the table area and does not foul the pillars of the die sets. A device can be fitted to limit the downward stroke which is readily adjustable

by means of a knurled wheel projecting from the side of the press. The device permits extremely accurate inching of the ram.



T-slotted tables are available for either model and a 4 or 8 station automatic rotary indexing table can also be incorporated. Extra high speed models are available.

Speed of the ram on the standard 10-ton model is 390, 35 and 186 inches a minute on the approach, pressing and power return strokes respectively. Speeds for the 15-ton model are 390, 21, and 140 inches per minute.

The R-G range of presses is available from Dowding & Doll Ltd., 346 Kensington High Street, London, W.14.

SPECIFICATIONS

	5-ton	10-ton	15-ton
Stroke	4"	8"	10"
Throat depth	7"	9"	10"
Height (table to ram)	12"	16½"	19½"
Table	14" X 11½"	16" X 14"	18" X 16"
Ram nose	1½" dia.	1½" dia.	2.7/16" dia.
Floor space	2' 7" X 16"	3' 1" X 18"	3' 3" X 20"
Motor	1 HP.	2 HP.	2 HP.

Extra high speed 10 and 15 ton models

Ram speed :—

Approach	630"/min.	630"/min.
Pressing	57"/min.	33"/min.
Power return	300"/min.	225"/min.
Motor	3 HP.	3 HP.

BHILAI PRODUCTION DURING SEPTEMBER 1960

The Bhilai Steel works produced 30,737 tons of steel during September 1960 against 23,824 tons produced during August 1960. The aggregate steel production totalled more than 2,41,000 tons including 1,96,000 tons of billets upto the end of the month.

The pig iron production during September totalled 54,240 tons against 50,512 tons in August 1960. The aggregate pig iron production totalled 7,82,000 tons.

About 5,58,000 tons of pig iron and 1,79,000 tons of steel billets had been despatched from Bhilai upto the end of September 1960, since the beginning.

Teddington Industrial Equipment Production Control Panels and Protecting Instruments for every contingency for complete automatic control of Marine, Rail Traction and Stationary Diesel engines

By An Engineering Correspondent

DURING recent years it has become increasingly evident of the expanding use being made of automatic warning and shut down devices to protect diesel engines from damage. No where is this more noticeable than in the marine and rail traction spheres, where it is felt that a great advantage of remote reading and automatic protection equipment really becomes apparent. In these classes of service of course, there is the added problem, so far as the use of sensitive instruments is concerned, of vibration and shock. It is against this background that a study of the development of engine protection equipment has been most enlightening.

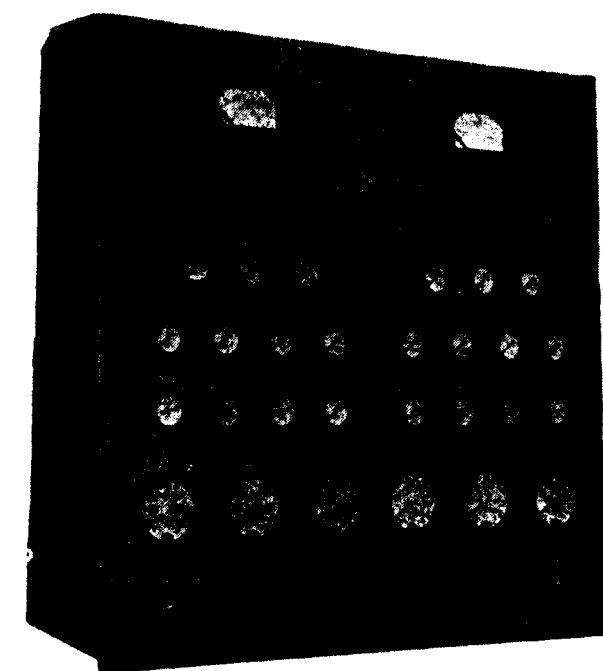
One of the first large scale commercial uses of protection equipment that comes readily to mind is in naval service, where in order to reduce to a minimum engine room staff in such vessels as inshore and coastal mine sweepers, the use of automatic warning systems and shut down systems is very desirable. This process can, of course, be applied to the auxiliary engines of larger vessels such as destroyers, frigates and for many other types of marine applications including small coastal vessels and private yachts.

Since the end of the last war the acute shortage of naval personnel, particularly those with technical training, has necessitated a complete revision of engine room practice in smaller vessels carrying a large amount of technical equipment, and the general policy of leaving such routine tasks as engine watching to automatic devices is becoming more and more widely adopted. Even where trained personnel are available, simple instruments can facilitate the task of supervising an engine by operating audible or visible signals in the event of a fault.

One of the foremost Company's specialising in the design of engine protection equipment is Teddington Industrial Equipment Limited of Sunbury-on-Thames, a visit to whose works vividly illustrates the extent of the business now done in this field. Teddington

Pressure Controllers and Thermostates have been in use for over twenty years to protect all types of engines giving warning signals in the event of failure of oil pressure or excessive cooling water temperature.

Arising from experience gained over the past years, this field has now been widened to include protective instrumentation for all types of temperature and pressure control. It is interesting to note that all the Teddington instruments used for engine protection

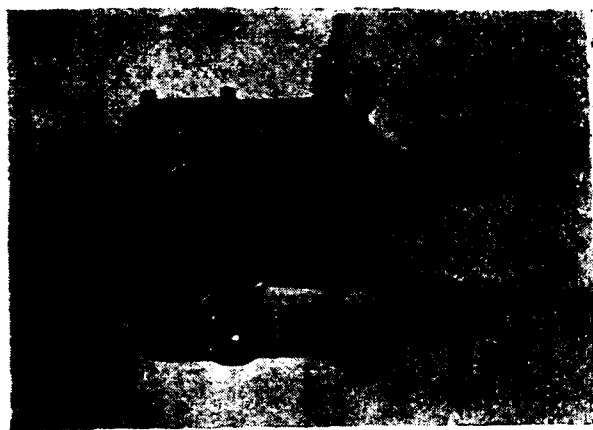
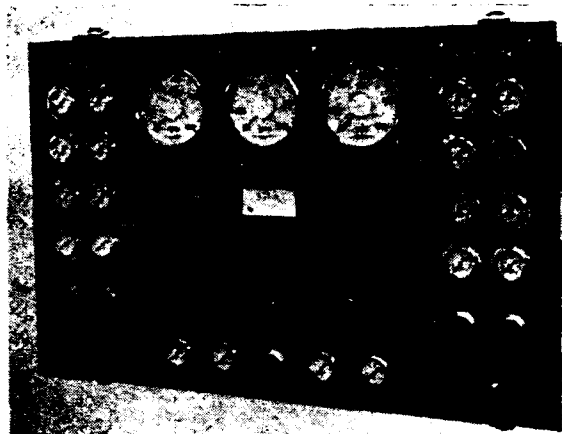


have British Admiralty approval. In addition, it will be appreciated that wherever engine protection is discussed, the question of resistance to shock and vibration has come very much to the fore and it is now regarded as essential that all equipment mounted on engines of every description, no matter what there application is, should be capable of withstanding such shocks without interference to their operation

or suffering any permanent damage. In order to meet the very exacting demands of the Admiralty, much development was necessary and Teddington Designers concluded that small light weight switches and components would give best results under these conditions.

Further, assuming that suitable instruments were made available, they would also be very satisfactory for other applications such as rail traction work and ordinary marine diesel installations and, indeed, all commercial applications.

Arising from this development work, much of which was carried out with the assistance and support of the British Admiralty, Teddington produces a complete range of equipment which has been fully shock tested and found satisfactory under all specified conditions. This range is now available for use with any kind of protection of diesel engines so required by engineers.



The range mentioned comprises of oil and coolant pressure controls; thermostats for oil and coolant temperatures; dial indicating thermometers and gauges; warning lamps; solenoid operated fault

indicators; engine mounted tachometers; transmitters; moving coil relays for over and under speed warning or shut down; secondary relays for use with the above. Solenoid operated engine trips for coupling to the fuel pump levers and solenoid



operated slide valves suitable for use with fuel or lubricating oil.

DESIGN DETAIL

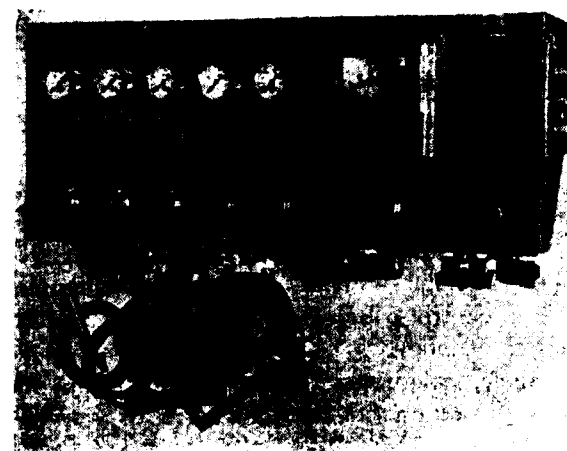
The temperature sensitive equipment developed by Teddington Industrial Equipment Limited for the general range of applications described above, is of the vapour pressure type consisting of an immersion bulb which is inserted into the lubricating oil cooling or other medium, the temperature of which is to be measured and this bulb is connected by a length of fine bore capillary tubing to the instrument proper.

The instrument itself is of the Carcase type specially designed for building into the panel mounted equipment. In the case of pressure sensitive units an identical instrument is used, but in this case the oil or coolant pressure is brought directly to the instrument through small diameter copper tubing, the connection being by threaded union in the panel. All these instruments consist of a seamless metallic bellows opposed by a spring and under the influence of changing pressure in the

bellows unit, an operating member moves and either opens or closes a special type of snap action switch. The pressure oil temperature at which the switch operates can be selected by varying the load of the spring through an adjuster which is normally enclosed within the panel and locked in position. This being assumed that once the desired setting has been selected no further adjustments will be required.

A special feature of Teddington panels is that by use of this compact light switch mechanism it is possible to combine two units on the same temperature bulb and capillary tube. It can be clearly seen that where pre-warning is required, one unit can be set to operate for example, a signal lamp or klaxon for a particular hazard, the second unit operating if the temperature continues to rise or the pressure to fall. This simplifies the application as only one immersion well or pocket is required for each temperature point.

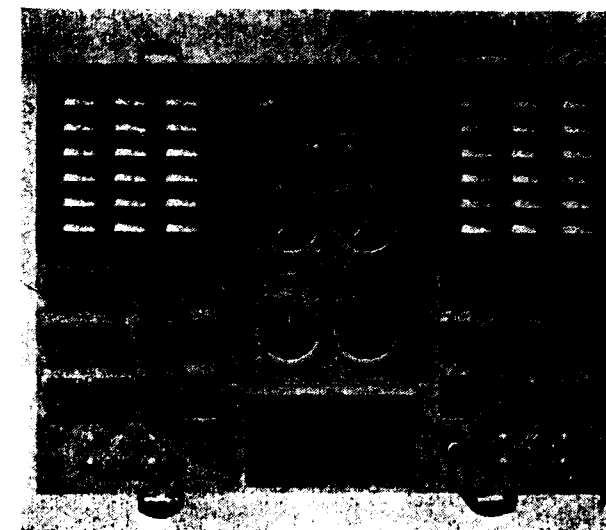
For indication of pressure oil temperatures a small 2" dial gauge unit is available and where protection against failure of oil pressure and indication of pressure is required, this gauge is normally coupled to



a common pressure connection inside the panel, so that only one pipe run from the engine to the panel is required. In the case of temperature indicators, the same system is used as for the protection units, namely immersion bulb and capillary tube transmission. In all cases the capillary tube is suitably armoured stainless steel wire for additional protection.

Certain special instrument combinations are available, it being possible to combine, for example,

one switch and one thermometer on a common bulb if warning and indication is required but in shut down conditions. Alternatively, warning and indication can be combined with an additional bulb for shut down



on an independent switch. These combinations are normally worked out in conjunction with the user so as to ensure maximum coverage of the particular problem associated with the protection of the engine together with the ease of fitting.

INDICATION

Where engines are left unattended and automatic shut down for full protection is provided, it is essential to give some indication as to the cause of trouble. To enumerate this point further it will be appreciated that once an engine has stopped oil pressure returns to zero, and if under speed protection is provided this circuit will obviously be made even though the cause of shut down was something quite different. In order to overcome this difficulty, Teddington Industrial Equipment have developed a special solenoid trigger type indicator unit. This unit is fully shock proofed and once set in the normal position cannot be operated unless a circuit is made to its solenoid, thus freeing the trigger. When the trigger is released up to four independent switches can be operated, one of these is used to isolate immediately the solenoid coil which is heavily over rated. At the same time the unit isolates the coil of all other solenoid indicator units, so that once the panel is

through a fault the engine is stopped and one only fault indicator shows the exact cause of the shut down. It is of course necessary to utilise one fault indicator for every fault for which protection is provided.

The second switch on the fault indicator is parallel to an identical switch on each of the other fault indicators so that any one of these operating passes on a signal to the solenoid engine shut down unit. It therefore can be readily seen that it is impossible to re-start the engine or to leave it operating until the fault has been cleared and the fault indicating unit has been re-set to the normal position. Thus, once again the engine is fully protected.

The above has given a more or less detailed reconnaissance of the products that Teddington Industrial Equipment have available for all general protection of engines. To elaborate further on this point this not only covers diesel engines but steam turbines, gas turbines, gasifiers and, in fact, any control system that the user would require.

Besides the control panel system, Teddington have also covered a range of individual Teddington engine watchers for inclusion on any installation. It can be appreciated that in many engines loss of lubricating oil pressure will result in seized bearings if the engine is not stopped within thirty seconds. To this end crankshaft re-grinding, bearing renewal and the loss of operating time is an expensive business for any diesel user, but the risk can be eliminated completely by the fitting of these Teddington watchers. These are easily connected on the delivery side of the pump and the protection units can either be re-wired to a klaxon to give warning of impending danger, or used with a Teddington shut down unit to stop the engine automatically.

Loss of water arising from high cooling temperature is a menace which is frequently un-detected until the

damage is done. It can occur for a number of reasons which again have nothing to do with the performance of the engine itself, i.e., blocked radiators; fractured hose connections; broken fan belts; water pump failure; failure to top up.

These are all potential dangers which can cause piston seizure and in damaged liners ultimately result in a re-bore and other large repair bills. Agreed, the danger can be avoided by constant attendance, but it is far safer and considerably cheaper to let Teddington engine watchers protect the engine against over-heating.

It will be appreciated from all the above that Teddington Industrial Equipment have a full coverage for all eventualities that can cause damage to engines in general.

To summarize, their coverage besides those mentioned above include tank level watchers; coolant and pressure trip mechanisms and in every indication visual and audible alarm components. It can be seen also that for the larger installations the engine protection panels as described previously can be utilized and will cater for any hazard combination required. All this equipment can be specified as original equipment or can be readily fitted to most existing installations.

The finest engine made will break down unless it is properly maintained and an operator's neglect for the unforeseen trouble can cause not only repair bills and ruinous loss of operating time, but in many cases, particularly in marine and traction installations, can have disastrous consequences. Any type of Teddington engine watcher from an individual instrument to a control panel is always on duty and costs nothing to maintain. The above must be of benefit to every engine, compressor, generator or turbine which requires protection and does not have to rely on the human failing.

Galvanized Iron and Steel Wire for Telegraph and Telephone Purposes

An Indian Standard Specification for Galvanized Iron and Steel Wire for Telegraph and Telephone Purposes (IS: 279—1951) has been published in 1951. Based on the experience gained in the use of this standard and also in view of Government of India's decision to changeover to the metric system of weights and measures, it was decided to revise this standard. The draft revision is expected to be put into wide circulation shortly in draft covers two grades of galvanized steel wire having the required electrical and physical properties. The revised modifications made in the draft revision relate to the reduction of number of sizes of steel wire, deletion of the minimum test length of wire for electrical resistance test and selection of dimensions in metric units.

MIRRLEES IN TRACTION

By An Engineering Correspondent

[A description of this makers well known JT type of rail traction engine with an indication of its performance in line service on British Railways in the successful "Brush" type 2 diesel electric locomotive.]

INITIAL DESIGN CONCEPTION

THE original design parameters for the Mirrlees J and JV range of engines were laid down in 1947, the intention being two fold; to satisfy an immediate British Admiralty requirement and to meet the demand, as then understood, for a robust and reliable rail traction unit in the medium speed category.

At an early stage it was decided to adopt a bore of $9\frac{1}{2}$ " and a stroke of $10\frac{1}{4}$ " and experience having shown that the most reliable traction engines are those that have undergone a lengthy period of continuous design development, the possibility of high pressure turbo charging was envisaged from the outset with the ultimate objective a B. M. E. P. of 200 p. s. i. at 1000 R. P. M.

EARLY APPLICATIONS

The prototype JV, a 16 cylinder engine was built in 1950 after which there followed a period of almost two years continuous development work under the observation of independent engineers during which time the engine achieved outstandingly high performance figures and in 1952 these engines were put into quantity production. At the same time a contract was placed by the Ceylon Government Railways with Brush Electrical Engineering Co. Ltd. for 25 locomotives incorporating the Mirrlees JVST12 engine and the first of these locomotives was commissioned early in 1953.

The three years of arduous operation in Ceylon during the period 1954—1957 yielded valuable service experience and made possible the introduction of many important refinements, the value of which has been borne out by the subsequent service experience obtained with a large fleet of similar locomotives on British Railways.

Among the features built into the rail traction

version of these engines are the efficient locking of all nuts and the clipping of all pipes to withstand the effects of vibration and shock inseparable from this class of duty together with complete and easy access to all parts of the engine.

BRITISH RAILWAYS

The initial contract placed by the British Transport Commission with Brush Electrical Engineering Co. Ltd. in the autumn of 1955 for 20 locomotives powered by the JVST12 engine was completed at the end of 1958 and since that date repeat orders have brought the number of these engines (Fig. 1) supplied or on order for this customer alone to 226.

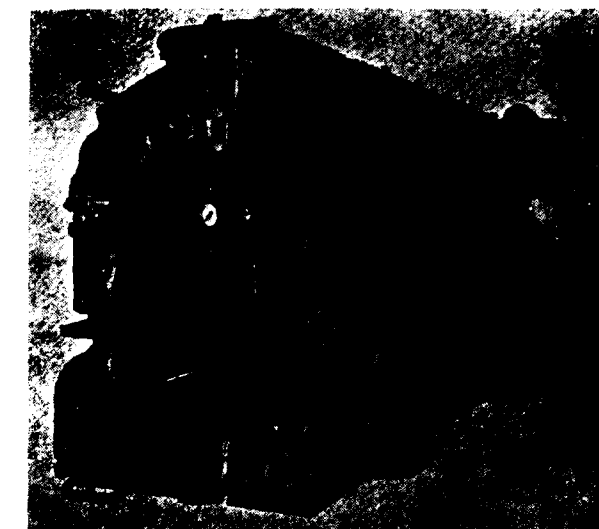


Fig. 1
Mirrlees JVST12 Diesel Rail Traction Engine rated at 1365 H. P. at 900 R.P.M. coupled to a Brush Generator as supplied to Brush Electrical Engineering Co. Ltd., for installation in British Railways Type 11 Main Line Diesel Electric Locomotives.

The development towards higher output and higher speed as originally envisaged and referred to above, has been achieved without any sacrifice of reliability—

the engines built for the Ceylon locomotives were rated at 1254 H. P. at 850 R. P. M. at N. T. P., the built of those supplied in the locomotives for British Railways have a rating of 1365 H. P. at 900 R. P. M. whilst a number have been rated at 1600 H. P. at 950 R. P. M. This steady improvement in specific output has been achieved without recourse to cooling of the charge air on which considerable development work has taken place and which can be employed to further increase the power available always provided that the additional equipment can be accommodated within the limitations imposed by loading gauge and axle weight.

Engine Details

BEDPLATE AND SUSPENSION

The bedplate is an all welded structure (Fig. 2) with cast steel intercostals which embody the main bearing housings. The crankshaft assembly is carried in the bedplate, which is extended to carry the generator, and a wet type sump is incorporated.

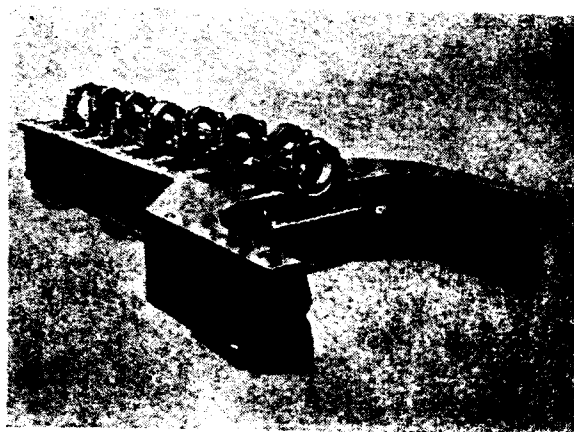


Fig. 2

CRANKSHAFT

The crankshaft (Fig. 3) is a carbon steel forging, machined all over, having hardened journals and pins; it runs in steel backed shell type bearings that are prefinished and require no hand scraping or finishing.

A torsional vibration damper of the viscous type, the accessory drive assembly (for lubricating oil and circulating water pumps) and the camshaft drive gear are all mounted on the crankshaft and an extension shaft drives the radiator fan.



Fig. 3

CYLINDER HOUSING

The cylinder housing (Fig. 4) like the bedplate to which it is secured, is an all welded structure and houses the removable wet type cylinder liners. Quick release hand hole covers are fitted and the camshaft and fuel pump compartments which are separated from the crankshaft by a vapour tight deckplate and to the crank case doors are fitted BICERA type relief valves.

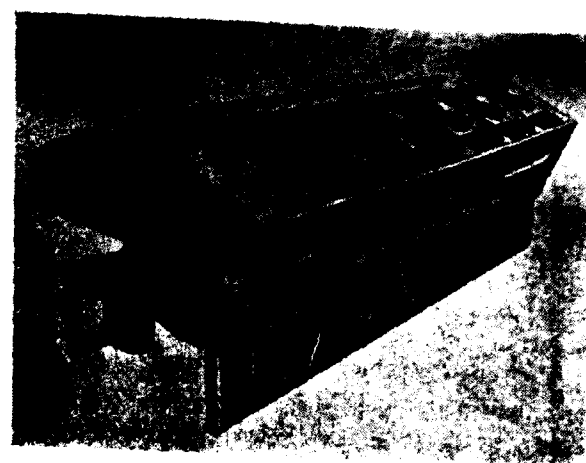


Fig. 4

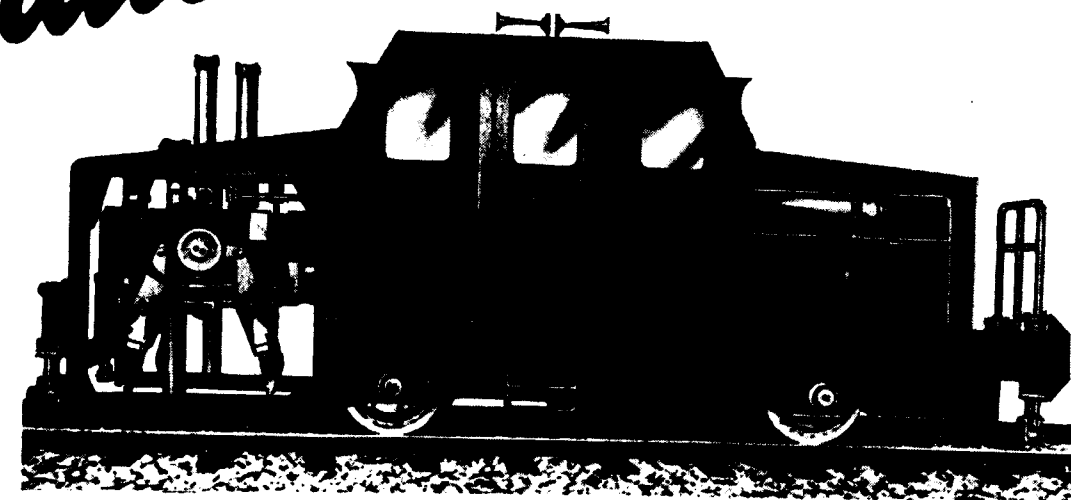
CAMSHAFTS

The camshafts which are gear driven from the engine crankshaft consist of single lengths of carbon steel to which the alloy steel camsleeves are keyed. A bevel gear fitted to 'B' bank camshaft drives the engine governor.

CONNECTING RODS, SMALL AND LARGE END BEARINGS

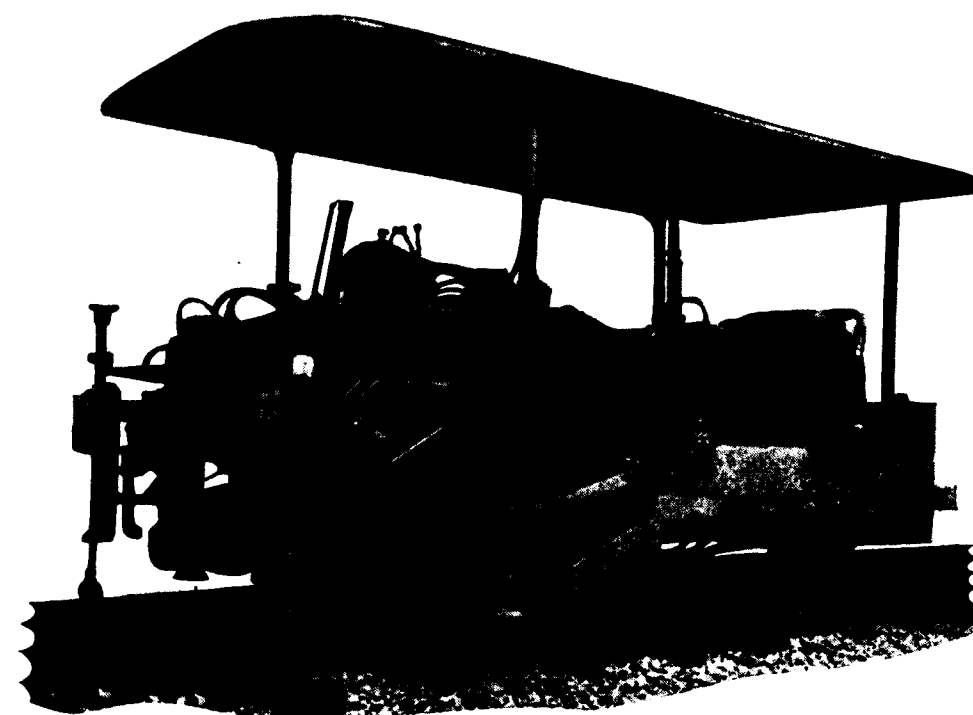
The connecting rods are heat-treated carbon steel

Matisa



MATISA MODEL B60 BALLAST TAMPER

THIS MACHINE CAN BE SUPPLIED WITH MATISA AUTOMATIC LEVELLING EQUIPMENT



← MATISA JAKPAK
FOR TRACK JACKING
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BALLAST TAMPERS
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TRACK JACKS etc. . etc. .

MATISA EQUIPMENT LIMITED

HANWORTH LANE, CHERTSEY, SURREY

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forgings (Fig. 5) and the small end bearings are phosphor bronze bushes pressed into the eye of the rod. The fully floating gudgeon pins are hardened alloy steel and are located endwise by circlips.

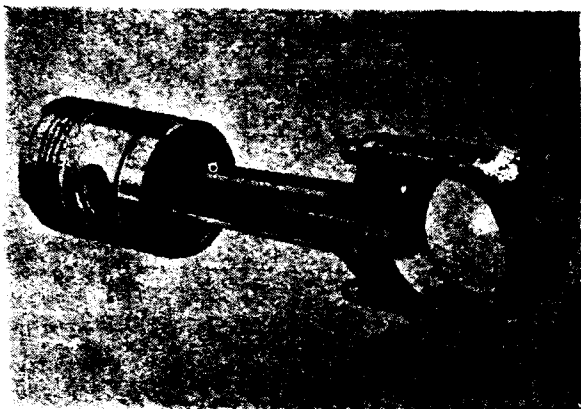


Fig. 5

The large end bearing housings are separate assemblies, which are bolted on to the palm face of the connecting rod; the bearings are steel backed shell type, copper lead lined.

PISTONS

The silicon alloy pistons have four compression rings and two scraper rings arranged one above and one below the gudgeon pin. A 'cocktail-shaker' ensures even distribution of the cooling oil over the inner surface of the piston.

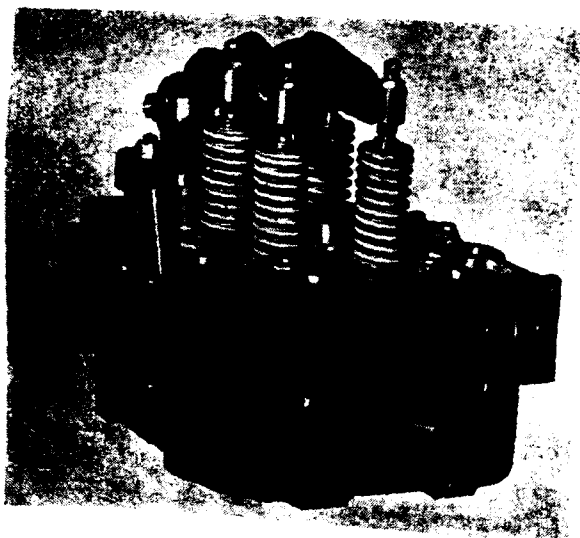


Fig. 6

CYLINDER HEADS

The cast iron 4 valve cylinder heads (Fig. 6) have well proportioned water passages to ensure adequate cooling, the water entering each head from the cylinder housing through two ferrules. Jumper pipes lead the water away from the highest part of the cylinder heads to the twin outlet header pipes.

Light easily detachable cylinder head covers are fitted.

VALVE GEAR

The four valves which are identical have an inner and an outer valve spring and seat on to alloy inserts which are shrunk into the cylinder head; cast iron valve guides are pressed in.

The rocker bracket which is mounted on each head carries the inlet valve rocker shaft in a pressed-in bushing. The inlet valves are operated by two rocker arms, which are secured to the splined ends of the rocker shaft by pinch bolts. One inlet rocker arm has an extension which is connected to the inlet push rod fork.

The exhaust rocker has two arms which operate the exhaust valves, one arm having an extension which is connected to the exhaust push rod fork. The exhaust rocker boss runs on the outside of the rocker shaft bushing.

Lubricating oil is supplied to a fitting on one of the rocker bracket lugs to feed the rocker shaft bushing and the push rod bushings through drilled oilways in the rocker shaft and rocker arms. Pipes brazed to the arms feed oil to the tappets and valve stems.

VALVE TAPPETS

Hardened valve tappets, held in the ends of the rocker arms, bearing direct on to the ends of the valve stems.

CAM FOLLOWERS

The air inlet valves, exhaust valves and fuel pumps are operated by their respective cams, through roller type cam followers, which are held in the fork ends of guide levers that pivot about the cam follower fulcrum shaft.

FUEL PUMP TAPPETS

The fuel pumps are mounted on cast iron brackets bolted on to the cylinder housing. A short adjustable tappet rod, screwed into the cam follower fork end, actuates the fuel pump plunger through a guided plunger carried in the pump bracket.

GOVERNOR

A Woodward P. G. (pressure compensated) governor is fitted which regulates the engine speed at any position of the master controller, limits the torque output at any speed and matches the generator output to the engine output, thereby obviating the possibility of engine overload.

FUEL SYSTEM

A motor driven fuel transfer pump draws fuel from the main tank, through an in-line strainer and delivers it to the fuel service tank from which it is led to a Vokes fuel filter mounted at the control end of the engine. From here the fuel passes to the two injection pump supply manifolds.

Individual Bryce type injection pumps are supplied through flexible hose connections from the main fuel supply manifolds and deliver the fuel through solid drawn steel delivery pipes of equal length to the injector nozzle in each cylinder head.

An edge type filter is embodied in the nozzle holder feed pipe.

LUBRICATING OIL SYSTEM

A positive displacement, self-priming, gear type pump driven from the engine crankshaft draws oil from the sump, passes it through the filters and oil cooler and delivers it to the main lubricating oil gallery. From this gallery the main bearing are fed directly, the oil then passing to the big end bearings, small end bearings and pistons through drilled passages in the crankshaft and the connecting rod. A nozzle at the small end of the connecting rod directs oil on to the underside of the piston crown. Tappings off the main gallery feed oil to the camshafts, their driving gears, the accessory drive gears, the rocker gear and the governor vertical drive shaft bushing.

A flow regulating valve is fitted to limit the quantity of oil entering the cooling system which

thereby controls the pressure drop across the oil cooler; a pressure regulating valve limits the maximum pressure of the oil entering the engine system.

COOLING SYSTEM

The engine-driven circulating water pump draws water from the radiator and delivers it to the inlet manifolds running along each side of the engine. Branch pipes with flexible hose connections feed water into the cylinder jackets.

The heated water discharged from the engine into the two outlet manifolds passes to the top of the radiator via a thermostatically controlled by-pass valve.

ENGINE STARTING

The engine is started by the main generator which acts temporarily as a motor fed from the locomotive battery, an oil pressure switch ensuring that adequate lubricating oil pressure has been built up by the separate motor driven priming pump before the engine can be started.

PROTECTIVE FEATURES

The customary protective features against high water temperature and low lubricating oil pressure are fitted as also is an emergency overspeed shut down device.

SERVICE CONDITIONS

The majority of the locomotives powered by these engines are in service on the Great Eastern lines of British Railways Eastern Region, where 668 steam locomotives are being replaced by 249 main line diesel locomotives based on four depots, a proportion of more than 2½ to 1.

Locomotives operating from the first of these motive power depots to become 100% diesel are accumulating 47,000 miles each week of which 60% is freight, 22% is passenger and 18% is parcel trains, empty stock working etc. The main burden of the train working at this depot, 40,000 miles each week, is carried by 25 Mirrlees engined Brush locomotives which are diagrammed 22 hours a day, six days a week.

A high utilisation factor is made possible by a high availability record to which every component contributes and in this respect the record of the Mirrlees engine has been exemplary.

An Important Announcement

- We have great pleasure in announcing to all our Readers and Advertisers that we are incorporating the following Supplements as usual on various aspects of **RAILROAD ENGINEERING** in our **1961 Annual Number** to be released by the end of August 1961.
- Advertisers desirous of buying advertising space in any one of the Supplements should intimate the fact to the Technical Editor (Advertising Branch) on or before 20th July 1961. We can accept only a limited number of advertisements due to space restrictions.
- Technical articles or write-ups concerning Engineering Products would be published free of charge and twentyfive reprints would also be supplied without any charges. For other details please address your enquiries to the Technical Editor, **INDIAN RAILWAY ENGINEER**, Flats 17 & 18 "Ashoka" (Second Floor) 15, Ghodbunder Road, Santacruz West, Bombay-54 (India)

DETAILS OF VARIOUS ENGINEERING SUPPLEMENTS

- | | |
|--|--|
| 1. Diesel Engines, Steam, Electric, Diesel-Electric, Diesel-Mechanical, Diesel-Hydraulic & Industrial Locomotives Supplement | 8. Air-Compressors & Pneumatic Tools Supplement |
| 2. Railcar, EMU Coach, Carriage & Wagon Supplement | 9. Cranes, Traversers, Hoists, Conveyors and Mechanical Handling Equipments Supplement |
| 3. Buffers, Brakes, Bushes, Couplers & Shock Absorbers Supplement | 10. Railway Track & Permanent Way Engineering Supplement |
| 4. Wheels, Tyres, Axle-boxes, Ball-Bearings & Springs Supplement | 11. Heavy Machineries, and Railway Workshop Machine Tools Supplement |
| 5. Foundry, Castings, Forge, Furnaces & Heat Treatment Supplement | 12. Railway Overhead Electrification Supplement |
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TECHNICAL EDITOR

Construction and Utilization of Modern Transportation Facilities for RR* Service

THE modern RR service is naturally utilizing the rail as general means for transportation purposes. Since nowadays an interacting with other transportation facilities is absolutely necessary, it is the responsibility of RR administrations to deal efficiently with problems surrounding the transshipment of goods between rail and highway. Many RR administrations have solved this problem by acquiring even railless special-purpose vehicles and by utilising them in an economically justified manner at "places of joint" between rail and highway.

The West German Maschinenfabrik Esslingen (Machine Tool Plant in Esslingen), which has been shipping locomotives and RR cars to numerous countries throughout the world for the past 110 and more years, had adjusted itself so as to fully meet the requirements of RR administrations. For scores of decades, this plant also constructs railless transportation facilities such as forklifts, carts and related equipment, developed to a high degree of perfection and capable of meeting all operational requirements by attaching the appropriate accessories.

The Machine Tool Plant in Esslingen has acquired its outstanding reputation mainly by its ingeniously creative achievements in rail vehicle engineering and railless forklifts of all loading capacities.

The following furnishes a brief survey about both special fields:

RAIL VEHICLES

Locomotives of various gauges, designs and capacities, as constructed by the Machine Tool Plant in Esslingen, are in operation throughout nearly all countries in the world. Special locomotive designs, as developed by the Machine Tool Plant in Esslingen, have attracted great attention in foreign countries and worth mentioning is also the vast number of locomotive spare-parts and accessories completed in good craftsmanship. In this connection, mention is made of 40 locomotive replacement (exchange) boilers shipped to the Indian Government Railways in the early fifties.

Very early, the Machine Tool Plant in Esslingen, in the further development process of RR motor cars,

* Railroad

has engaged in technical problems pertaining to the utilization of combustion engines as locomotive and motor-coach traction unit. In this connection, the complex problems arising from power transmission have also been dealt with. The constructive and useful tests go back to the nineties of the past century.

The first Diesel locomotive had been shipped to the Soviet State RR Administration as early as 1924. It was a 2-10-2 125-ton gross weight locomotive, equipped with a 1000/1200 hp. MAN Diesel engine and electric power transmission. This first large-type locomotive has been followed by other Diesel-electric locomotives shipped to Japan, Argentina, and the South-Manchurian Railways.

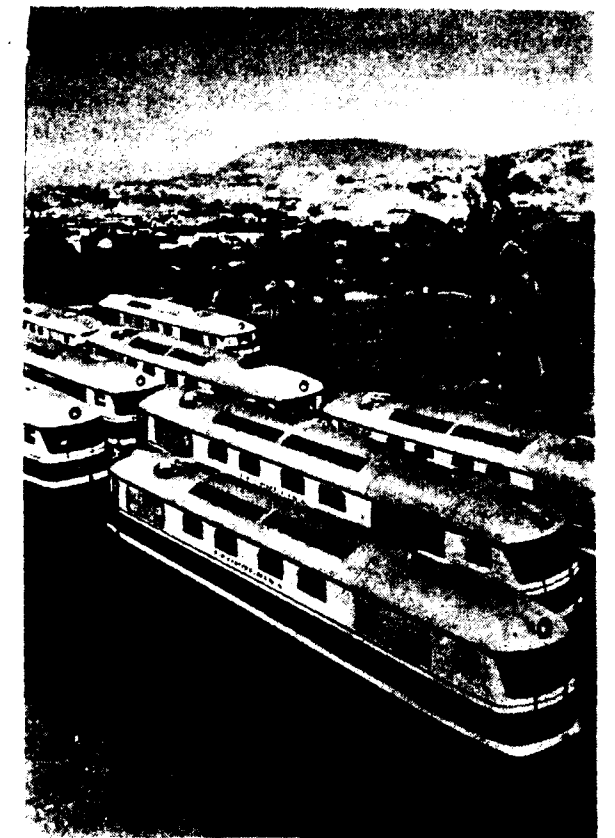


Illustration No. 1. 1900 hp. Diesel locomotives, constructed by the Machine Tool Plant in Esslingen, for Brazil.

A 1000-hp. capacity, pneumatic power-transmission-type Diesel locomotive has been developed and constructed for the German Reich Railways in the period from 1924 to 1929 in order to test another power-transmission method. During the subsequent period, the rapid development of hydraulic drive has resulted in almost exclusive application of this power-transmission type for 170—1900-hp. Diesel locomotives, constructed in remarkably high numbers since 1950, and destined for South America (illustration No. 1), Sweden, Norway, Near East, South Africa, as well as for German industrial installations, secondary railways, and the German Federal Railways.

While under actual operation, certain capacity types of Diesel locomotives have developed and these have been used by the Machine Tool Plant in Esslingen as a basis for a standard production programme of up-to-date and efficient Diesel locomotives to be used by industrial installations and ports. Locomotives of the new type schedule, which included capacities from 150 to 340 hp. have proved efficient and useful under heavy-duty operation. The use of standardized components and drive sub-assemblies contributed to lowering the production costs and it permitted a more efficient maintenance work as well as procurement of spare-parts. The constructive development of vehicles (illustration No. 2), in addition, meets the clients' wishes as to a variety of engine and drive designs.

Another type schedule includes noiseless (laufruhige) bogie-type locomotives (illustration No. 3) ranging from 450 to 800 hp. in capacity. Due to their simple design, easy operation, and negligible axial pressure, these locomotives are suited for shunting and medium-heavy line traffic, primarily and preferably for transportation facilities with light superstructure and with relatively small rail bend radii. The small

and low front structures ensure a full and all-around visibility from the elevated cab. The spring system of the vehicle consists of steel springs or wear-and-tear-resisting metal-rubber components which require no maintenance work.

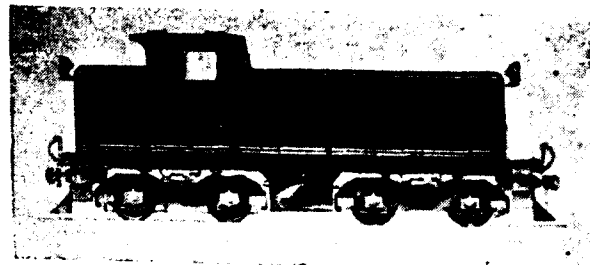


Illustration No. 3. Four-axled bogie-type Diesel locomotive of 450/800 capacity class.

The development of locomotive construction at the Machine Tool Plant in Esslingen has always been handled in conjunction with the construction of RR cars of all types. There was a long but successful way of constructive and ingenious development from the freight cars and coaches of the past century up to the modern motor coach with Diesel-engine or electric motor drive. Some of the last shipments of Diesel-hydraulic motor coaches were for Spain, Near East, Turkey and Greece. Especially the Diesel motor coaches, destined for the Greek Peloponnesian Railways, (illustration No. 4), permitted a considerable improvement of the cruising speed and of travelling comfort as compared to the increased competition in the line traffic on highways.

Conforming to the change of times, the transportation facilities of large cities are also demanding their due share on the modern development. Therefore,

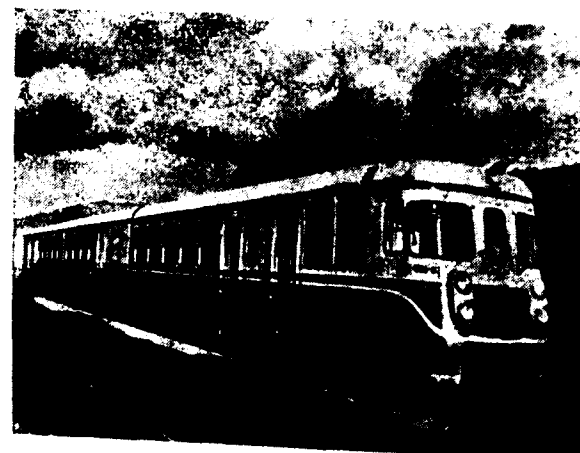


Illustration No. 4. Three-unit motor coach train (1000 hp.) for Greece.

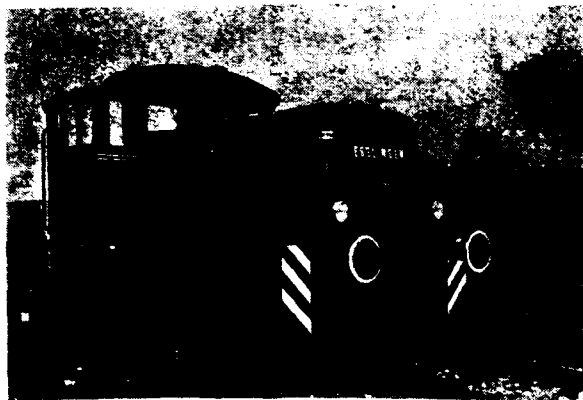


Illustration No. 2. Bi-axial Diesel locomotive of 150/340 hp. capacity class.

the streetcar trains, constructed by the Machine Tool Plant in Esslingen, became not only more efficient but also nicer in shape and more spacious. Only a few screws and rivets are still visible on welded car designs.

The ever increasing requirements for light structure call for a more accurate determination of the stress properties as well as of the dynamic and static strains.

A special department of the Machine Tool Plant in Esslingen is dealing with the computation of these high-grade undetermined systems of RR car and locomotive construction. By the aid of modern procedures—especially at elongation and vibration measurements—complicated designs are subjected on test stands to operation-like stresses in order to be able to check the thus obtained theoretic values also by practical tests.



Illustration No. 5. Tractor, constructed by the Machine Tool Plant in Esslingen, engaged in loading a mail train.

RAILLESS SPECIAL-PURPOSE VEHICLES

The loading of mail and baggage from the platform to the expedition halls is effected smoothly at modern RR station (illustration No. 5). Luggage elevators are superfluous. Electric and Diesel tractors of high-climbing capability, as constructed by the Machine Tool Plant in Esslingen, transport loaded trailers in long trains over ramps and via under-passes.

Since long, the RR administrations are availing themselves of railless transportation facilities. Rather early, the engineers endeavoured to motorize also the vertical lifting on electric carts by means of lifting and crane superstructures. Based upon these beginnings, the forklift was designed. The lifting and stacking carts, designed by the Machine Tool Plant in Esslin-

gen, are being used for various transportation ends at RR installations, e.g. RR repairshops and warehouses, where they are used for interplant transportation and at



Illustration No. 6. Tractor utilized for shunting.

freight yards for the transshipment of various goods between RR cars and road vehicles. In addition, tractors may also be used, to a certain degree, for shunting (illustration No. 6). Consequently, in many instances heavy-duty shunting locomotives may be dispensed with and are thus made available for other duties. The possibility of achieving the nowadays strived for smooth transportation flow by one (1) man without loading ramps, also in the transshipment of goods on freight yards, will result in substantial operational advantages. (Illustration No. 7). The versatility in the expedition of transported goods accounts for the fact that at many transshipment yards certain transportation tasks, previously



Illustration No. 7. Forklift utilized for loading freight cars.

handled by cranes and winches, are now performed by stacking trucks from the Machine Tool Plant in Esslingen. The re-arrangement of loads, as called for by the utilization of cranes on extended transportation routes, is no longer necessary.

Experience yields quality. The quality of construction and of manufacture, as a tradition, is the primary principle also in the designing of new vehicle types. The vehicles from the Machine Tool Plant in Esslingen are, on purpose, constructed of a sturdy and rigid structure, thus ensuring a long serviceability and usefulness undermost heavy-duty conditions. The high efficiency is the result of perfected designs and of the exclusive application of high-grade drive sub-assemblies. Diesel-powered stackers, constructed by the Machine Tool Plant in Esslingen, and fitted with motors of world-known makes, smooth operating hydraulic clutch, full synchronized reverse gear, and

mechanic differential, belong to those stackers which are in greatest demand. Trained transportation engineers and a widely extended servicing system are always available to clients for possible assistance and advice. Under consideration of existing operational conditions there are being developed appropriate attachments by which an additional increase in the efficiency of individual vehicle types is attained. Most of these attachments may be exchanged within a few minutes. They include e.g., tilting scoops, crane jibs, grabs, and forks.

The Machine Tool Plant in Esslingen, which is one of the oldest and largest installations in Europe manufacturing numerous transportation equipment such as forklifts, carts, etc. is, due to its many-year experience, capable of furnishing appropriate railless transportation facilities of varied driving types for any and all loads up to 50 tons to be incurred by way of necessary organising conversions.

(By Courtesy of Maschinenfabrik, Esslingen)

U. S. Company Honors Indian Businessman

Indian business executive Mohan T. Advani, Chairman of the Blue Star Engineering group of companies, was honored by Worthington Corporation, major U. S. manufacturer of air conditioning and refrigeration equipment.

Mr. Advani was presented with a plaque marking his firm's long and loyal service as Worthington distributor in India. The presentation was made by N. A. Gardner, head of Worthington's international air conditioning and refrigeration division.

Mr. Advani is in the U. S. on an extended business trip during which he apprised Worthington officials of the air conditioning and refrigeration market situation in India. He stated that the market for air conditioning and refrigeration is expanding very rapidly, with industrial refrigeration equipment having the most promise.

The demand for this kind of equipment stems from the need for increased development of basic industries in India. Advani said that India hopes to become an exporting nation of "non-traditional" products to Southeast Asia, the Middle East and East Africa. Small diesel engines, sewing machines, fans, batteries and lamps were among the products cited by the Blue Star executive as already being manufactured in India and exported.

Industrial refrigeration will play an important role in this development because it will enable the manufacturing of several products that cannot be made without proper humidity and temperature

control, according to Advani. The synthetic fiber, drug and chemical industries were mentioned as three specific industries requiring refrigeration.

India, Advani confirmed, welcomes U. S. technical know-how and investment capital. "We want U. S. companies to come into India and build plants. Our home markets for many basic products are expanding and the government puts no restrictions on the transfer of profits back to the U. S.

"What we are looking for are arrangements through which foreign investment is attracted into India at least to the extent of the value of capital goods to be imported for our local production. We simply do not have the foreign exchange ourselves for this".

Investments and technical know-how from other highly industrialized countries will be looked on with favor also, Advani added.

Among India's most pressing needs affecting industrial expansion is the need for qualified, independent consulting engineers who can work with contractors, Advani asserted. Independent consultants are today all but non-existent, he said.

The design of refrigeration and air conditioning systems is too often a matter of the sales aims of the contractors and not of the most efficient design. Independent consultants, Advani declared, could establish the most beneficial design specifications and it would then become the business of contractors to meet those specifications.

FRICTIONALLY CONTROLLED BUFFER STOPS

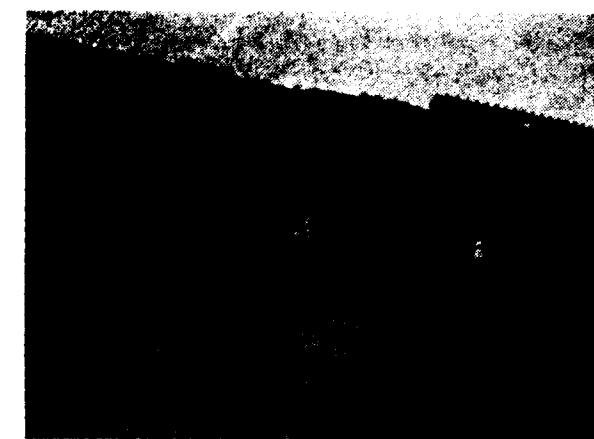
By An Engineering Correspondent

EARLY in 1959, Godwin Warren (Engineering) Ltd., Bristol, commenced manufacturing, under licence, frictionally controlled buffer stops and rail brake shoes which have been used on the Continent for many years. Since the introduction of these buffers into their country the demand has been remarkable, and many large steel works and the British Railways have installed these units as the latest means of preventing the many accidents caused by trains and goods wagons hitting fixed buffer stops at a speed they cannot withstand.

Trains and engines approaching buffer stops are very rarely out of control, but there is always the possibility of an error of judgment in applying the brakes, or some local circumstance, such as unusually greasy rails, resulting in the striking of the stops. Even if the speed is low the kinetic energy involved in a heavy train is considerable.

Collisions can result in the immobilisation of badly needed stock and react most unfavourably on the traffic working. In some termini in Great Britain special buffer stops of the hydraulic or other type, and

On the Continent, however, especially in Central Europe, much thought has been given to this subject and what have become known as braking type buffer stops, making use of friction to provide a retarding effect, have become widely installed. On some



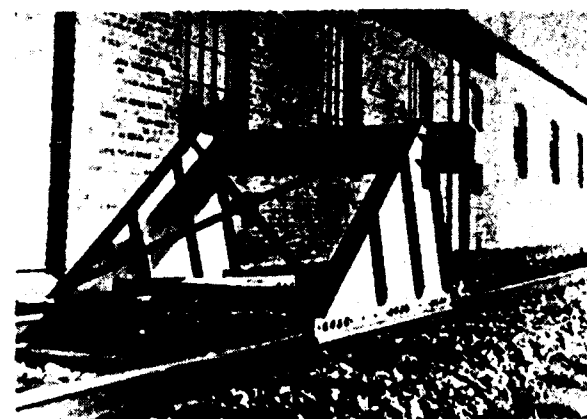
Frictionally Controlled Buffer Stop.

systems such as the German Federal Railway, simple fixed stops have long been prohibited except in unimportant sidings where only a few vehicles are placed. Everywhere else the braking type has become the rule, as elimination of damage to stock and contents and harm to people are considered to justify this.

The first suggestions for a retarding type buffer stop using the frictional principle were advanced over 50 years ago by Franz Rawie, whose family had founded the firm of A. Rawie, of Osnabruck, Germany, in 1855, for general forging and engineering work.

OPERATION OF FRICTIONAL ELEMENTS

The fundamental principle has remained throughout the same: to make use of a frictional hold of some kind, either constant, or made to vary, should circumstances necessitate, as a function of the weight of the front part of the train—as, for example, where a locomotive is used—or by causing the frictional elements themselves to come into operation succes-



Goods Type Frictionally Controlled Buffer Stop.

sand drags, have been provided to bring an over-running to rest with the minimum of shock, but little attention has been paid as a rule to other locations, while even in stations fixed types of stop are frequently to be seen.

sively. A combination of both these methods also can be used.

There are two principal types of these Buffer Stops in use at the present time. One is for Goods Yards and industrial yards and the other is the Passenger type for terminal stations. Each can be modified or supplemented by altering or adding components as conditions may render advisable.

The Goods type is the simplest and is called the rail brake design. In this type, friction grips or shoes, provided with bronze inserts, are bolted to the rail head in such a manner as to give the desired brake power in tons. When the stop is driven forward they bring the train or vehicle to rest under a safe rate of retardation.

The whole assembly, after slackening off the bolts is then pulled back to its original position, when the shoes are re-tightened. If required, additional shoes can be fitted to the rails behind the Buffer Stop at definite intervals. They are linked so that at first only one pair is functioning, then they pick up the second pair and so on, thus progressively increasing the retarding action.

The Buffers can only be used on Flat Bottom rail and it means that a length of this type of rail has to be laid for the distance over which the stop may be required to travel. The reason for this is because the shoes would foul the chairs used with Bull-Head rails. New shoes have been designed for use with Bull-Head rails, but have not been tried to see how successful they would be in practice.

RESULTS OF TESTS

The following figures give the results of tests made with this type of stop:—

Test No.	Weight of Train	Impact Speed	Travel of Stop	Average Stopping Resistance	Retardation	Work done by stop
			ft.	tons	ft/sec ²	ft/tons.
1	400 tons.	5 mph.	6.92	48.3	3.89	334.0
2	705 tons.	6 mph.	12.08	70.3	3.21	850.0

The Passenger type consists of the Buffer Stop being mounted on a wooden raft which is situated under the

running rails, so that the weight of the locomotive helps to increase the retarding effect. Additional retarding shoes are fitted behind the Buffer Stop to assist the braking effect and are the same as those used on the Goods type Buffer Stop. Sliding sleepers are fitted to the front end of the Buffer to take the weight of the train when the Buffer has been moved back



Fixed Rail Brake Shoe.

after being struck by the locomotive. The bolts on the retarders have to be loosened to allow the whole unit to be pulled back to original position. Twelve of this type of Buffer Stop are being installed at London Road Station, Manchester, which is being re-built in accordance with the British Railways modernisation scheme.

RESULTS OF MANCHESTER TESTS

Weight of Train	Impact Speed	Travel of Stop	Average Stopping Resistance	Retardation Rate	Average.
tons.	m.p.h.	ft.	tons.	ft/sec ²	
285	7.3	15' 5"	32.8	3.7	
565½	4.75	6' 5"	66.7	3.8	
565½	6.0	10' 7½"	64.1	3.65	

The last two tests were with Loco and 15 coaches.

The Buffer Stops used in the above tests are the Passenger type 5004/2 and are designed to absorb impacts of 100 tons to 1,200 tons.



Passenger Type Buffer Stop in Main Terminal Station.

RAIL BRAKE SHOES

A modification of this form of stop is seen in the rail brake shoe. This, in its ordinary form, requires a flat-bottom rail, but the hinged design can be used with bull-head track, as it is carried on a separate piece of flat-bottom rail laid parallel with the running rails and hinged to come over the latter only when required. With this device the leading pair of wheels of a vehicle bear on the shoe itself, so increasing the frictional effect proportionally. It is intended for use in certain siding and similar tracks and is valuable where it is desired to prevent collisions with vehicles on which staff may be at work, or to protect men engaged on the permanent way.

A trial made at Port Talbot with this brake shoe gave the following result:—

Weight of Train	Impact Speed	Travel of Brake Shoe
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100 tons. 3 m.p.h. 2 ft. 5 ins.

Frictionally Controlled Buffer Stops are designed to

cope with speeds of 10 m.p.h. for main terminals and about 6 m.p.h. for shunting in goods yards. The situation is simpler where trains arrive with locomotives in front, as their weight helps to increase the retarding effect.

Where, however, lightweight trains and railcars also are used, it becomes preferable to have less braking effect to begin with and use supplementary rail brake shoes to build up the retarding action progressively. An adequate braking distance must always be allowed, though this may sometimes mean increasing the length of the platforms and adding to the distance passengers have to walk. It becomes a matter of reconciling all the known requirements to the best advantage, having regard to local conditions. There are designs for all known requirements.

These various types of braking stops are in use throughout Great Britain, Germany and in terminal stations in Austria, Switzerland, Holland, Belgium, Luxembourg, Italy, Spain, Portugal, Finland, Russia, Denmark, Poland, Serbia, Roumania, Turkey, Persia and Israel.

TEST PARTICULARS

In order to determine the speed of the train impact the train was timed over a distance of 88' immediately in front of the Buffer Stop. The velocity calculated by the following:— $\text{Velocity (M. P. H.)} = \frac{60}{\text{time (secs.)}}$

THE 285 tons TEST

10 coaches were used, total weight 285 tons, the leading coach 28½ tons. This was to simulate the effect of an electric multiple unit fully laden and it came in at 7.3 m.p.h., moved stop 15' 5" and gave a retardation rate of 3.7 ft/sec².

Then 2 tests were made with a 2—8—0 class 8 F steam locomotive weighing 125½ tons hauling a train made up of 15 coaches (439½ ton weight) making a total weight of 565½ tons. The train ran freely into the buffer stop—no brakes being applied.

So we had:—

- (1) 565½ tons travelling at 4.75 m.p.h. moved stop 6' 5" giving a retardation rate of 3.8 ft./sec²
- (2) 565½ tons travelling at 6.0 m.p.h. moved stop 10' 7½" giving a retardation rate of 3.65 ft/sec².

TESTS — GOODS TYPE

	Weight of Train.	Impact Speed.	Travel of Stop.	Retardation Rate.
(No. 10 at Dorman Long, Ltd., Middlesbrough)	150 tons.	8 m.p.h.	5' 6"	—
(No. 12 at Richard Thomas & Baldwins, Ltd., Ebbs Vale.)	150 tons.	20 m.p.h.	9' 0"	—
(No. 12/4 at Steel Company of				

	Weight of Train.	Impact Speed.	Travel of Stop.	Retardation Rate.
Wales Ltd. Port Talbot.)	400. tons.	5 m.p.h.	6.92 ft.	3.89 ft./sec ²
	705 tons.	6 m.p.h.	12.08 ft.	3.21 ft./sec ²

RAIL BRAKE SHOES

100 tons.	4 m.p.h.	2' 0"
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LONDON ROAD — MANCHESTER — PASSENGER TYPE

285 tons.	7.3 m.p.h.	15' 5"	3.7 ft./sec ²
566 tons.	4.75 m.p.h.	6' 5"	3.8 ft./sec ²
566 tons.	6.0 m.p.h.	10' 7½"	3.65 ft./sec ²

India on the threshold of Steel Revolution

India's determination to achieve a production target of 6 million tons of steel ingots by the end of 1961 was described as 'courageous' by some pessimists at home and abroad. But the determination has been crowned with success belying all echoes of alarms. All the three new steel plants were commissioned during 1959 and it can be safely predicted that a capacity of 6 million tons of ingots would have been created by the end of the Second Five-Year Plan in 1961. Considerable expansion programme of the existing steel plants at Jamshedpur, Burnpur and Bhadravati was also completed in 1959.

A large reserve of trained personnel is being created to man the plants. The expansion of the steel processing industry is receiving due attention. India is also adopting recently developed techniques such as high top pressure operation in blast furnaces and sintering for increasing production.

A new plant to manufacture tool and alloy steels will also be set up at an early date.

The Government of India have taken steps to encourage the development of small iron, steel and re-rolling units in the country simultaneously with the establishment of large integrated steel works. More than 20 scrap-based electric furnaces were working so

far. A solid foundation has thus been laid for rapid industrial advancement in the country.

The blast furnaces that started production in 1959 produced 1.5 million tons of pig iron upto October 1960. More than 100,000 tons of pig iron has already been exported.

Eight firms have been licensed for setting up small pig iron plants. Of these, two—one at Coimbatore in Madras State and the other at Barbil in Orissa State—have gone into production.

In view of the necessity to plan for a further capacity of 200,000 tons to 500,000 tons of pig iron to be able to meet the requirements by the end of the Third Five-Year Plan, Government has decided to revise its earlier decision and to license pig iron plants to a capacity of about 100,000 tons a year each.

As a result of increased production, larger supplies of billets were available to the re-rolling industry, which stepped up production from about 680,000 tons in 1959 to 572,000 tons (upto August) in 1960.

A still higher target of 10 million tons of steel ingots has been envisaged in 1965 by the expansion programmes of the existing steel works and by setting up a new steel plant at Bokaro in Bihar.

Manufacture of Reinforced Cement Concrete Sleepers for Northern Railway

By

S. D. Pathak K. G. Salvi
General Manager Design Engineer

The authors in this article describe in detail the various types of sleepers used in foreign railways and they stress the need for switch over to concrete sleepers in Indian Railways and thus save steel and wood which can be utilised for better purposes—Editor

INTRODUCTORY

THE Indian Railways require millions of sleepers annually for replacement as well as for other new developments. In the past sleepers required for Railway tracks were obtained from various sources. The types of sleepers in usual practice with the Indian Railways are :—

1. Wooden sleepers
2. Steel trough type sleepers
3. Cast iron type sleepers

The wooden sleepers were generally procured from the Himalayan Forests. However, due to heavy construction programme as well as expansion schemes in post independent India, the requirement of wood from the Indian forests has considerably increased. As a result of this it has become extensively difficult to get enough quantity of required type of wooden sleepers. The other two types are generally imported and due to policy of the Government to preserve the Foreign Exchange it has become unadvisable to go to steel or cast iron sleepers. With this in view the Indian Railways have been considering introduction of concrete sleepers.



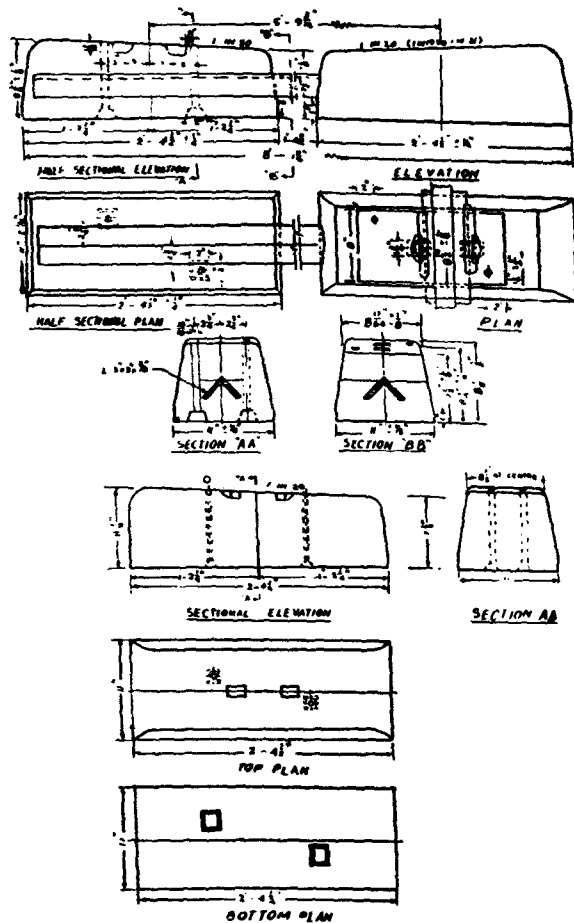
Reinforced concrete sleepers stacked in yards.

TYPE OF CONCRETE SLEEPERS

The concrete sleepers can be divided into two main types :

1. Reinforced cement concrete.
2. Prestressed concrete.

There are many types of reinforced cement concrete sleepers prevalent on the continent. Out of this the Sonvil type of Reinforced cement concrete sleepers are most widely used in France.

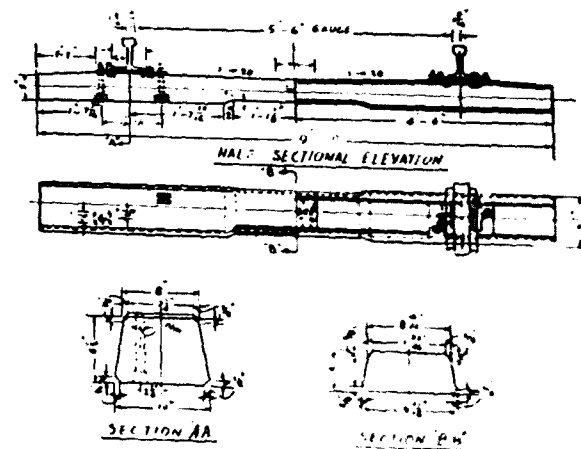


Prestressed concrete sleepers are also being used in many European Countries especially in Germany and Hungary.

The prestressed sleepers have a certain amount of resilience, require less steel than R.C.C sleepers but do not have resistance under differential loading conditions.

DESIGN ADOPTED BY THE RAILWAYS

The Indian Railways after due consideration have



adopted the design for R.C.C. sleepers shown in the illustration for the Broad Gauge and for the Yards. The main line design is also being worked out.

SPECIFICATION FOR CONCRETE SLEEPERS

The concrete strength required was 5600 lbs. per square inch at 28 days. The mild steel required was of tested quality. Tolerance in various dimensions were as follows :—

Width of concrete block	$\pm 1/8"$
Height of blocks	$\pm 1/8"$
Length of concrete block	$\pm 1/4"$
Slope in block for rail seat	1 in 19 to 1 in 21
Centres of bolt holes with respect to their correct position	$\pm 1/32"$
Diameter of bolt holes	$\pm 1/16"$
Distance between centre lines of block and centre line of recess for loose jaw	$\pm 1/32"$
Radius of the loose jaw recess	$\pm 1/16"$
Length of loose jaw recess	0
Width and depth of loose jaw recess	$\pm 1/16"$
Recess for bolt head — all dimensions	0

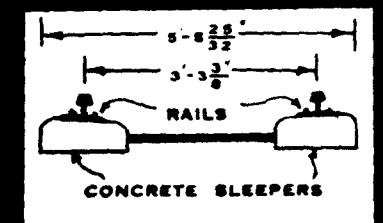
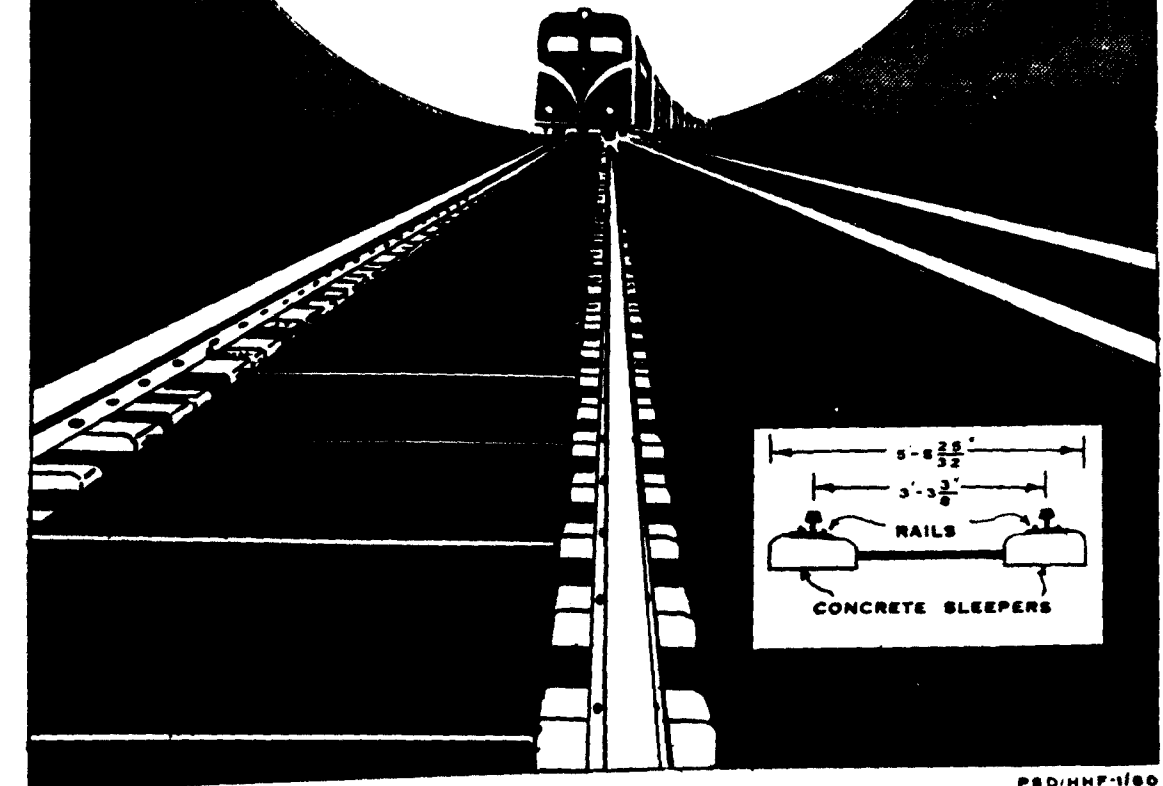
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rapidly expanding railways
we are proud to be Pioneers in manufacturing...

Concrete RAILWAY SLEEPERS

- DURABLE • ECONOMICAL
- SAVING OF WOOD & STEEL

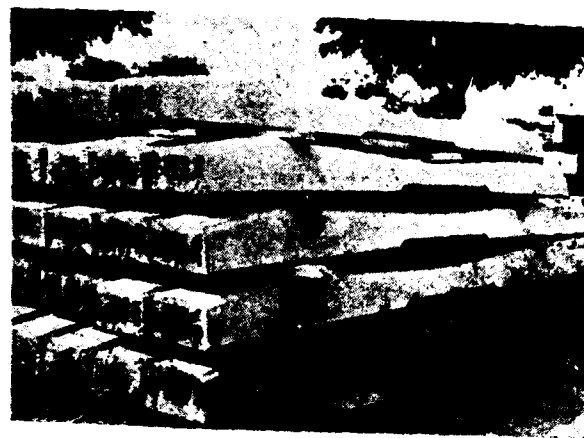
HINDUSTAN HOUSING FACTORY LTD.

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JANGPURA-NEW DELHI



PSD/HMF-1/60

The initial test load under 3 point loading area was 6.7 tons to be taken without appearance of hair crack and 20 tons to be taken without complete failure.



Prestressed concrete sleepers for broad gauge.

MANUFACTURE OF SLEEPERS

The Northern Railway placed an experimental order of 50,000 sleepers on the Hindustan Housing Factory on the above specifications and the design.

The actual testing of these sleepers manufactured by this factory showed that where as the sleepers were supposed to take a test load of 6.7 tons without cracking they actually took an average of about 15 tons before a hair crack could appear, and sleepers did not show complete failure at 30 tons which was the limit of the load apparatus. The accuracy of gauge was so nicely maintained that no single sleeper was rejected. The entire production of the sleepers has been done so nicely that no rejection was found although the specifications were very severe as can be seen from above.

TYPE TESTING OF INTERNAL COMBUSTION ENGINES

The Indian standard Code for Type Testing of Constant Speed Internal Combustion Engines for General Purposes (IS: 1600—1960), published recently by ISI is another addition to the series of Indian Standards on testing of internal combustion engines. This code applies to type testing of constant speed reciprocating internal combustion engines of the following types used for general purposes:

- (a) Compression ignition engines,
- (b) Carburettor type engines, and
- (c) Gas engines.

USE AND TRANSPORT OF THESE SLEEPERS

Reinforced cement concrete sleepers are heavy and to a certain extent less adaptable to indiscriminate manual handling. The Railway Officials were, however, aware of this and issued detailed instructions to their staff for careful handling of these sleepers. The sleepers were loaded in railway wagons and dispatched to various places of destination, where they were laid in tracks without much of trouble. Illustration shows sleepers laid in track at Tughlaka-bad.

CONCLUSION

The concrete sleepers, either of reinforced or of prestressed type are necessary to overcome acute shortage of essential materials. The wood and the steel available in the country can be used for much better purposes than utilizing them in the sleepers, where concrete can do the job.

It has been also proved now that we can produce the quality sleepers in prestressed and reinforced concrete more than satisfactory from the specifications laid down by the Railways.

At present the only difficulty in use of these sleepers is manual handling. This is not such a serious set back. It is a matter of getting used to handling these sleepers. Some kind of mechanical handling devices can also be easily evolved to overcome this difficulty.

In foreign countries concrete sleepers have already passed the stage of experimentation and have come to be used extensively. It is, therefore, hoped that we are used to these sleepers in this country the Railways will go in for more and more for the concrete sleepers.

The code is not applicable to pressure-charged engines for road or rail traction, engines for ships propulsion or for marine auxiliaries, and engines for aircraft propulsion or aircraft auxiliaries.

When major modifications are made in the design or materials or both of an existing type of engine, or when an entirely new design is evolved and is to be introduced in the market, it is necessary to type test the new or modified design under rigorous operating conditions in order to prove its reliability.

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ARE ADOPTING

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THE WORLD OVER growing interest is being taken in the rapid development, backed by excellent performance, of diesel-hydraulic locomotives.

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TOMORROW the demand will be even greater, as more railway administrations realise the advantages of this type of motive power.

BRITISH RAILWAYS, under their Modernisation Scheme, are utilising diesel-hydraulic locomotives in the Western Region and 95 locomotives of this type have been ordered from Beyer Peacock (Hymek) Ltd.

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The Development of Roller Bearing Axleboxes for Railway Vehicles

At a conference dealing with roller bearing axleboxes held on 4th and 5th March 1959 at SKF Gothenburg and SKF Katrineholm, and attended by railway engineers from Finland, Norway and Sweden, Mr. Viktor Synek gave a short lecture with the above title. This article is an English translation of a more detailed version of this lecture.

IN 1918 SKF started an investigation into bearing applications which were subjected to heavy shock loads, and a detailed study of the problems involved led to the design of the spherical roller bearing—a type which has subsequently become of outstanding importance to machines in general and to railway vehicles in particular. A great deal has been published about spherical roller bearing axleboxes, but a summary of their development may nevertheless be of interest. Spherical roller bearing axleboxes have also had a decisive influence on the development of other types of roller bearing axlebox, particularly cylindrical roller bearing axleboxes, and these are also discussed in this article.

Two designs of spherical roller bearing axlebox, which differ considerably in design and principle of operation, have undergone parallel development—axleboxes with two spherical roller bearings (twin bearing design) and axleboxes with one spherical roller bearing (self-aligning axleboxes).

The twin bearing design of axlebox can support a bending moment in any plane passing through the centre-line of the axle, and in this respect there is basically no difference between its properties and those of roller bearing axleboxes of alternative design or of plain bearing axleboxes.

The self-aligning axlebox with one spherical roller bearing has special properties. With this design the angular freedom of movement of the spherical roller bearing is deliberately utilized either to prevent cornering of the box in the guides or to promote smooth running of the vehicle.

The differences in characteristics and design of these two types of axlebox make it necessary to deal separately with their development. It is natural that individual stages of development should overlap, and some simplification of the presentation is necessary in order to give emphasis to essential features. In the

following pages, therefore, only axleboxes for passenger coaches with axle loads of 15 tons and goods wagons with axle loads of up to 20 tons are dealt with.

AXLEBOXES WITH TWO SPHERICAL ROLLER BEARINGS

The axlebox shown in Fig. 1, with one spherical roller bearing at the outer position and one cylindrical roller bearing at the inner position, may be regarded as the predecessor of axleboxes with two spherical roller bearings. It was very widely used and therefore occupies an important place in the development of roller bearing axleboxes. The cylindrical roller bearing only carried radial load, whilst the spherical roller bearing carried both radial and thrust loads.

Axleboxes of this design were first fitted to bogie wagons on the Swedish State Railways in 1922, and in the following years came to be used in relatively large numbers in many countries, especially for express passenger coaches.

Both bearing inner rings had an interference fit on the journal and some difficulties were experienced in machining the journals within the specified tolerances,

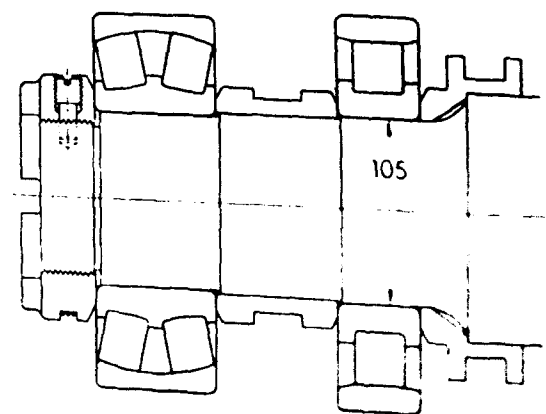
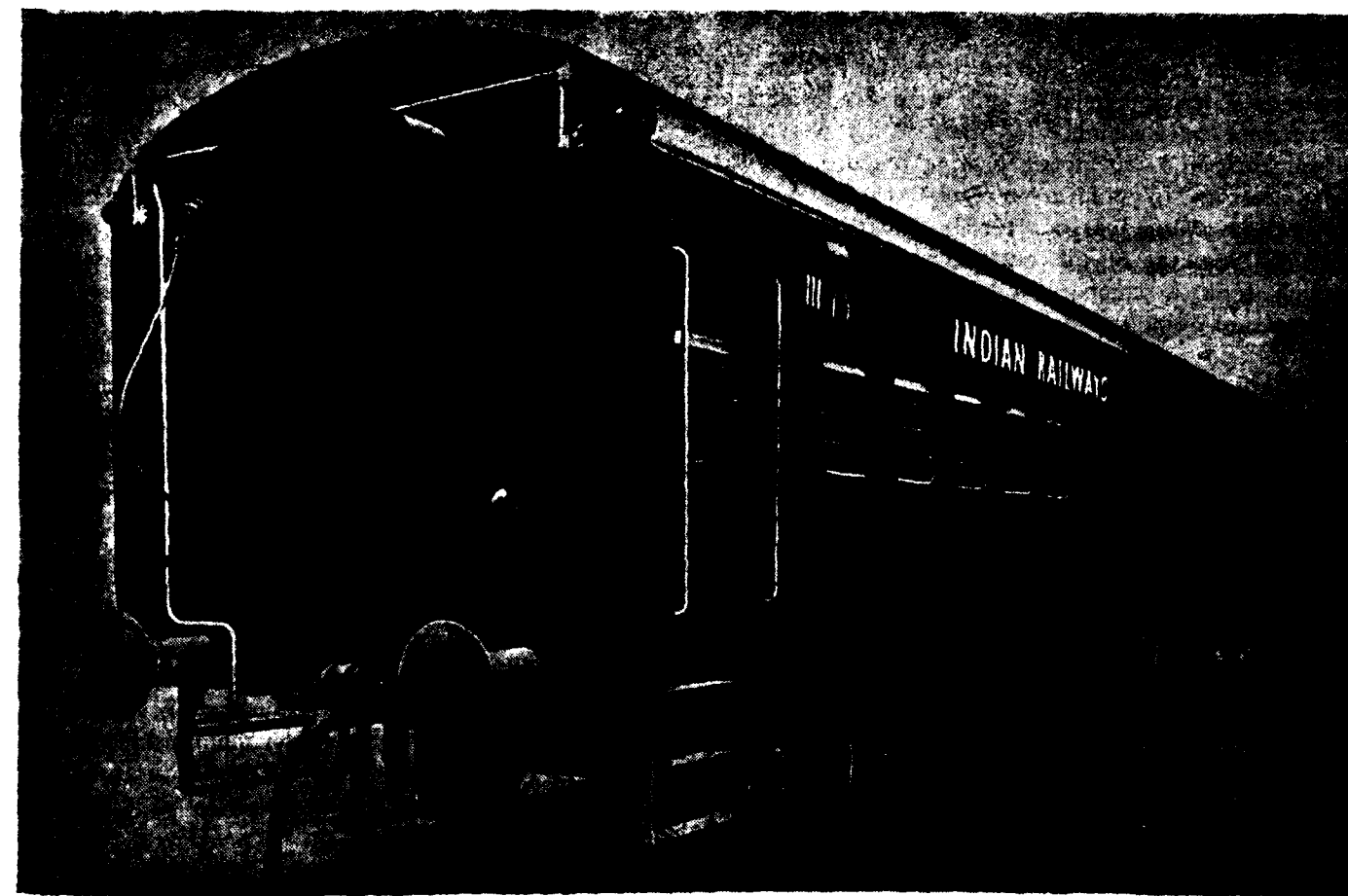


Fig. 1. Axle bearing arrangement in 1922.



Utmost reliability on

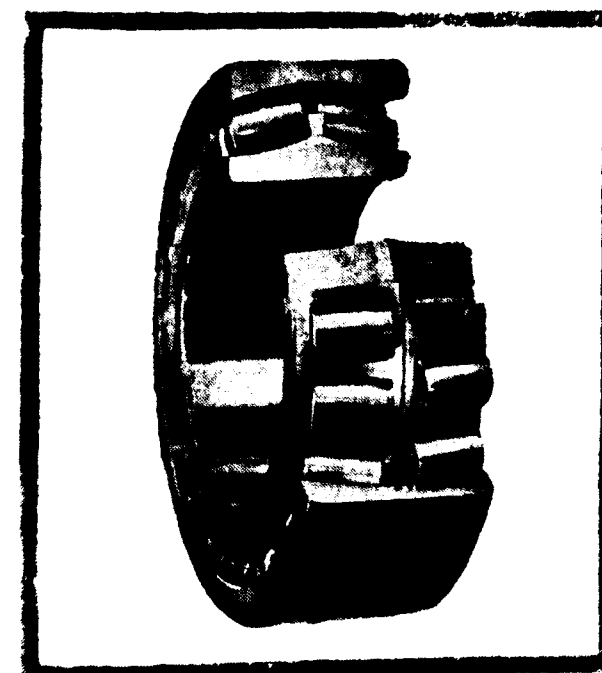
SKF bearings

SKF Bearings are used in the axleboxes fitted on the passenger coaches manufactured by ICF Madras.

Designed for underslung spring suspension each axlebox is fitted with one SKF Self-aligning spherical bearing as shown in the photograph on the left.

SKF bearings have been ordered for more than 2000 such coaches on Indian Railways.

The rolling stock is running smoothly and with the utmost reliability on SKF.



THE SKF BALL BEARING CO. PRIVATE LIMITED

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especially in countries where facilities for grinding the journals were not available and there was insufficient experience in machining to limits which were very close compared with plain bearing practice. It was also necessary to conform to regulations for periodic inspection of the journals for fatigue cracks. This entailed removal of the bearings at each inspection, which took a comparatively long time with the methods of dismounting then in use.

Withdrawal sleeves had come into use as far back as 1920 and good results had already been obtained with them in axleboxes with one spherical roller bearing. The advantages that these sleeves offered were that they permitted wider limits for the journal diameter and they facilitated the dismounting of the bearing. It

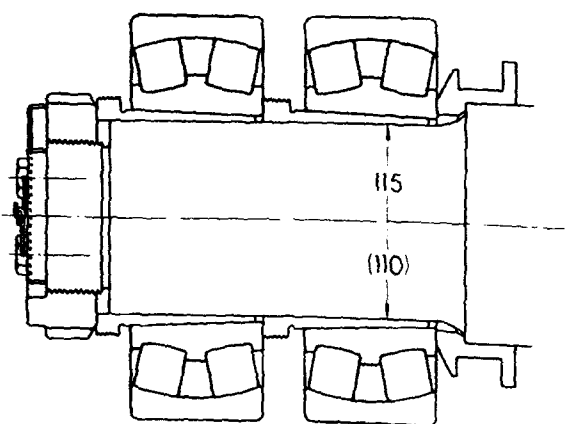


Fig. 2. Axle bearing arrangement in 1926.
Bearing dimensions: $120 \times 240 \times 80$ mm.

was therefore a logical step to use these sleeves in conjunction with two spherical roller bearings of the same size in twin bearing boxes. Some railway administrations were reluctant however, to change from the design with one spherical roller bearing and one cylindrical roller bearing because this type of axlebox had proved very reliable. Certain types of vehicle were being fitted with this type of axlebox in the 1930's and many of them are still in service today.

When the design incorporating two spherical roller bearings mounted on withdrawal sleeves was first introduced only bearings of medium series were available. The dimensions of the bearing considered suitable for standard vehicles in high speed traffic was $110 \times 240 \times 80$ mm and the withdrawal sleeve had a bore of 100 mm. It soon became obvious however, that the carrying capacity of the bearings could not be fully utilized, the deciding factor being the carrying capacity of the journal, and as far back as 1926 a

special "railway bearing" was designed having dimensions of $120 \times 240 \times 80$ mm and approximately the same carrying capacity. The withdrawal sleeve for this bearing had a bore of 110 mm. This bearing has been widely used not only for express passenger coaches but also for special goods wagons; in Germany it has been used even for large goods wagons with an axle load of 20 tons. These axleboxes were not really intended for such heavy axle loads, nevertheless the bearings proved extremely reliable even under these conditions giving convincing proof of the high carrying capacity of spherical roller bearings. In 1931 however, there were a number of cases of fractured journals, especially on the large goods wagons just mentioned, and it became necessary to use a more robust journal. Investigations showed that after a period fatigue fractures developed due to grooving of the journal, at the end of the inner withdrawal sleeve. In Germany the withdrawal sleeve for the inner bearing was dropped and the bearing mounted direct on a tapered seating, whilst in Sweden, the difficulty was overcome by the introduction by SKF of a thin-section withdrawal sleeve with a bore of 115 mm, which reduced the stresses in the journal by 12%, Fig. 2. This design proved satisfactory, at least as far as bogie passenger vehicles were concerned, and no more fractured journals occurred. It was realized however, that the journals still prevented the carrying capacity of the bearings from being used to the full. Experience with the spherical roller bearing in other industries had, meantime, shown that the bearing rings could be of thinner section (especially the outer ring) without adversely affecting the reliability of the bearing. These considerations led to the introduction in 1934 of a spherical roller bearing with dimensions of $130 \times 240 \times 80$ mm for axleboxes. Although the section height was reduced below that of the bearing with the

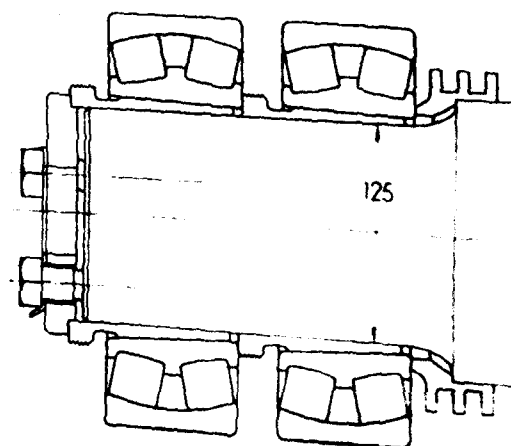


Fig. 3. Axle bearing arrangement in 1934.
Bearing dimensions: $130 \times 240 \times 80$ mm.

same outside diameter which it superseded, a somewhat higher carrying capacity was obtained by better utilization of the available section height. The withdrawal sleeve for this bearing initially had a bore of 120 mm which was later increased to 125 mm. This diameter of journal was suitable for all loads for which the bearings themselves could be used, Fig. 3.

During the first 30 years of their existence no essential changes took place in the internal design of spherical roller bearings, because they fulfilled all

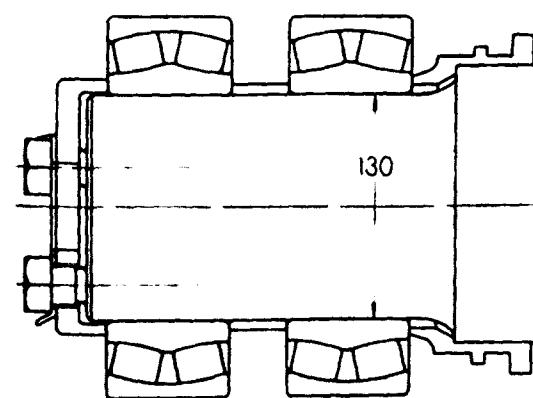


Fig. 4. Axle bearing arrangement incorporating spherical roller bearings. U.I.C. 130 mm journal.
Bearing dimensions: $130 \times 220 \times 73$ mm.

requirements made of them. It was not until the years 1948—1950 that SKF began to consider the possibility of redesigning the bearings to increase their carrying capacity. One of the reasons for starting these investigations was a general desire to reduce the dimensions of roller bearings for axleboxes, although not at the expense of reliability or life. During the second World War work was started on roller bearing axleboxes for standard 4-wheel goods wagons and for these comparatively low-priced vehicles it is important to design inexpensive axleboxes. The investigations led to the design of a spherical roller bearing which differs essentially in internal construction from that originally introduced in 1920.*

For goods wagons with axle loads of up to 20 tons and passenger coaches with axle loads of up to 15 tons, spherical roller bearings with dimensions $135 \times 220 \times 73$ mm were developed, Fig. 4. Despite the reduction in section height to only 45 mm a bearing of this type has a higher carrying capacity than the larger bearing previously used for the same axle loads. The axle

* See Ball Bearing Journal No. 4/1957.

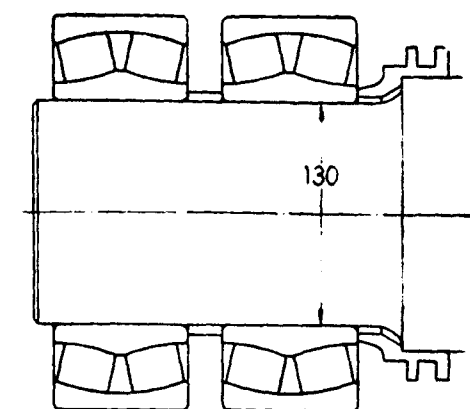


Fig. 5. Axle bearing arrangement incorporating spherical roller bearings. U.I.C. 130 mm journal.
Bearing dimensions: $130 \times 230 \times 80$ mm.

journal shown in Fig. 4 has been standardized by U.I.C.

The reasons which led in the initial stages of development to the use of bearings mounted on withdrawal sleeves did not apply to the same extent after the War. There is no longer any uncertainty regarding the correct fit to be used for inner rings mounted direct on the journal and manufacturers have no difficulty in keeping to the close tolerances required on journal diameters. The proved reliability of the bearings and the robust journals have made frequent inspection unnecessary; also facilities are now available in many railway workshops for supersonic crack detection without removal of the bearings. As a result a less expensive design with direct mounted bearings is more widely used. Improved methods of mounting (for example by heating the bearings electrically) and of

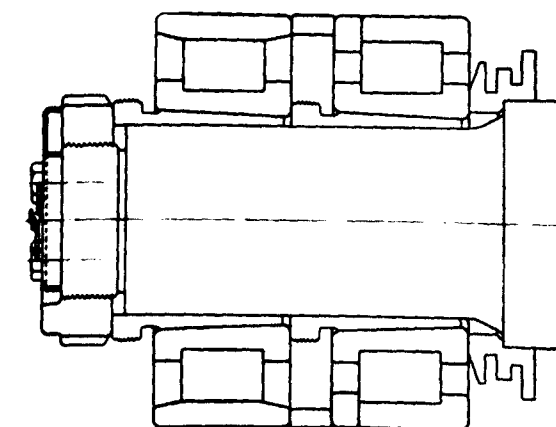


Fig. 6. Axle bearing arrangement incorporating cylindrical roller bearings. Used from 1927.
Bearing dimensions: $120 \times 240 \times 80$ mm.

dismounting (by means of oil injection) have also contributed to this change.

Certain railway administrations, however, are already committed to the use of bearings on withdrawal sleeves and prefer to continue with this practice, with its well-established advantages. SKF therefore manufacture bearings which only differ from that shown in Fig. 4 in that the inner ring is of thinner section and has a taper bore. Bearings of this type with withdrawal sleeves can be fitted on the same 130 mm. diameter journal.

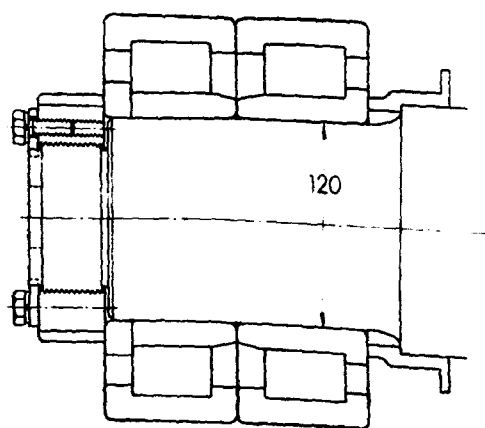


Fig. 7. Axle bearing arrangement incorporating cylindrical roller bearings. U.I.C. 120 mm journal. Bearing dimensions: $120 \times 240 \times 80$ mm.

From Fig. 4 it will be seen that the bearing span is comparatively large, which is advantageous to the load distribution on the two bearings. When deciding the length dimension for this U. I. C. journal it was intended that it should also be used for particularly heavy vehicles, for example, certain types of motor coach which require bearings of higher carrying capacity. Standardized spherical roller bearings with dimensions of $130 \times 240 \times 80$ mm. may be selected in such cases. They are shown in Fig. 5.

AXLEBOXES WITH CYLINDRICAL ROLLER BEARINGS

In parallel with the development of twin spherical roller bearing axleboxes, cylindrical roller bearing axleboxes have also been developed in a number of countries. Early tests showed that cylindrical roller bearings were suitable for railway applications and this was also proved by the results obtained with axleboxes of the type shown in Fig. 1.

In the United Kingdom these boxes have been established for suburban electric multiple unit stock, but only radial loads are carried by cylindrical roller bearings—a ball bearing or a thrust pad being used for carrying the thrust loads; in other countries, particularly Germany, designs have been developed where the radial and thrust loads are carried by the cylindrical roller bearings. The thrust loads are taken on the flanges of the bearing against which the end faces of the rollers slide and it has been shown in practice that the thrust loads which occur when negotiating bends etc. can be carried by the cylindrical roller bearing without any damage due to sliding friction, provided that the side faces of the rollers are executed with great care and a first class lubricant is used. The working conditions of railway rolling stock are favourable to the bearings since the thrust loads are usually of short duration and under no thrust load, or fluctuating thrust load, the lubricant is able to get between the flange and the roller ends. On the other hand, cylindrical roller bearings are sensitive to continuous thrust loads which may occur, for example, if the bearings are mounted in vehicles where the axleboxes can be cross-located.

As mentioned earlier, after 1926 spherical roller bearings with dimensions $120 \times 240 \times 80$ mm. came to be used in all types of railway rolling stock and these bearings gave very satisfactory results. Their performance in Germany was also very good if the subsequent journal breakages experienced on large goods wagons are disregarded. Because of the structure of the German rolling bearing industry however, trials had been carried out at quite an early stage with cylindrical roller bearings having the same boundary dimensions as the spherical roller bearings and using the same method of securing them on the journal, see Fig. 6.

The cylindrical roller bearings shown in Fig. 6 did not fulfil expectations for various reasons, including the fact that securing the inner rings by means of withdrawal sleeves was not suitable for this type of bearing. The design shown is, however, the predecessor of the axlebox used in Germany today, see Fig. 7. The boundary dimensions laid down for spherical roller bearings in 1926 were retained, but the bore is cylindrical. The bearings are mounted side by side on a 120 mm. journal, partly to reduce costs by dispensing with the distance collar and partly to obtain a short axle journal which, according to the U.I.C. specification, must be suitable for an axle load of 20 tons. The end of the journal is threaded and the nut and method of locking is similar to that previously

used for spherical roller bearings. In addition to the 130 mm journal, the journal shown in Fig. 7 has also been standardized by the U.I.C.

It might perhaps be thought that the 130 mm journal would be better for spherical roller bearings and that the 120 mm journal would be better for cylindrical roller bearings, but this is not so. The 130 mm journal is a general purpose journal on which all types of roller bearing can be mounted without difficulty. Fig. 8 shows cylindrical roller bearings on the 130 mm journal. Their outside diameter and width are the same as for the bearings in Fig. 7. Their carrying capacity is also the same, the reduction in the section height from 60 mm to 55 mm being obtained solely at the expense of the ring thickness.

Fig. 9 shows spherical roller bearings mounted on the U.I.C. 120 mm journal. Despite the smaller size of these bearings, their carrying capacity is only about 10% less than that of the spherical roller bearings shown in Fig. 4 and they conform to U.I.C. requirements in respect of carrying capacity and life.

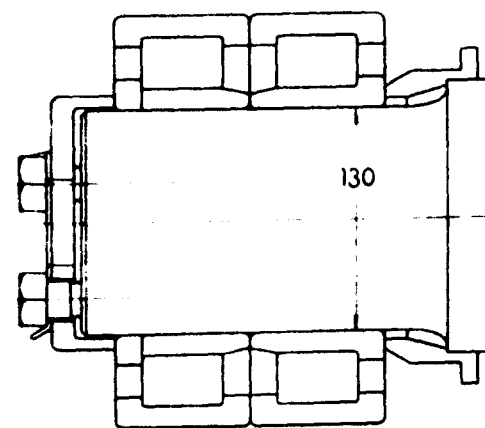


Fig. 8. Axle bearing arrangement incorporating cylindrical roller bearings. U.I.C. 130 mm journal. Bearing dimensions: $130 \times 240 \times 80$ mm.

DEVELOPMENT OF AXLE JOURNALS

A glance at the axle journals illustrated shows that not only has the diameter increased to 130 mm over the years but that the method of securing the bearings on the journal has also undergone development.

Figs. 1 and 2 show that initially the end of the journal was threaded and a robust nut used to locate the bearings. To begin with, as shown in Fig. 1, the

nut was locked by means of a set screw, but this method was soon discarded because frequent inspection of the journal and remounting of the bearings often made it necessary to drill new holes for the screw. The use of a key secured to the journal end by two set screws as shown in Fig. 2 was then introduced. Although the nut used with this method of locking is expensive, the method has given good results and is still being used today.

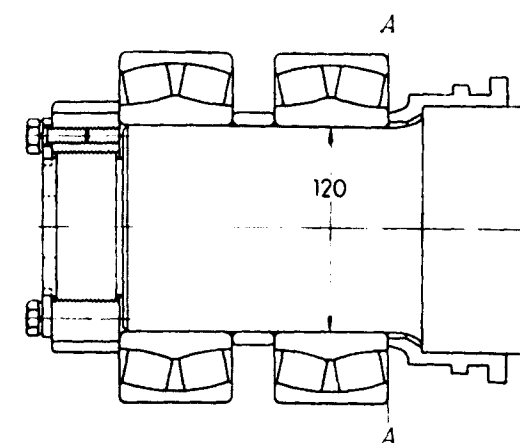


Fig. 9. Axle bearing arrangement incorporating spherical roller bearings. U.I.C. 120 mm journal. Bearing dimensions: $120 \times 205 \times 68$ mm.

In cases where roller bearing axleboxes were used to modernize old vehicles it was often found that the axle journals were too short to be threaded on an end plate was then used secured to the journal with three screws, Fig. 3. This method of securing the bearings proved to be advantageous and it came to be adopted in increasing numbers as far back as the 1930's, largely because it was cheaper than using a threaded journal and nut. The axle journal shown in Figs. 4 and 8, which has been standardized by U. I. C. is fitted with an end plate.

At this point it may be appropriate to consider in greater detail some of the requirements made of nuts and end plates. In spherical roller bearing axleboxes, because of the tight fit of the inner rings, the thrust shock loads occurring during operation are transmitted from the bearings direct to the journal. These loads are not such as to cause displacement of the bearing inner rings, even if there is no nut or end plate. As the thrust loads from the axlebox body are usually transmitted to the inner bearing, the fit of both bearings would have to be overcome to achieve displacement of the inner rings, and experience shows that this does not occur. In recent years there has been a

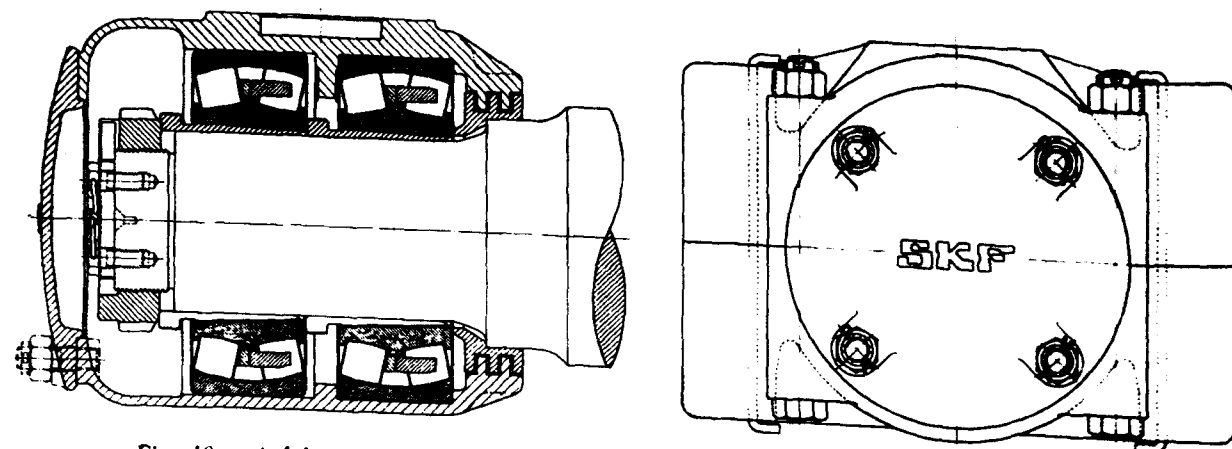


Fig. 10. Axlebox with spherical roller bearings of type shown in Fig. 3. Split box.

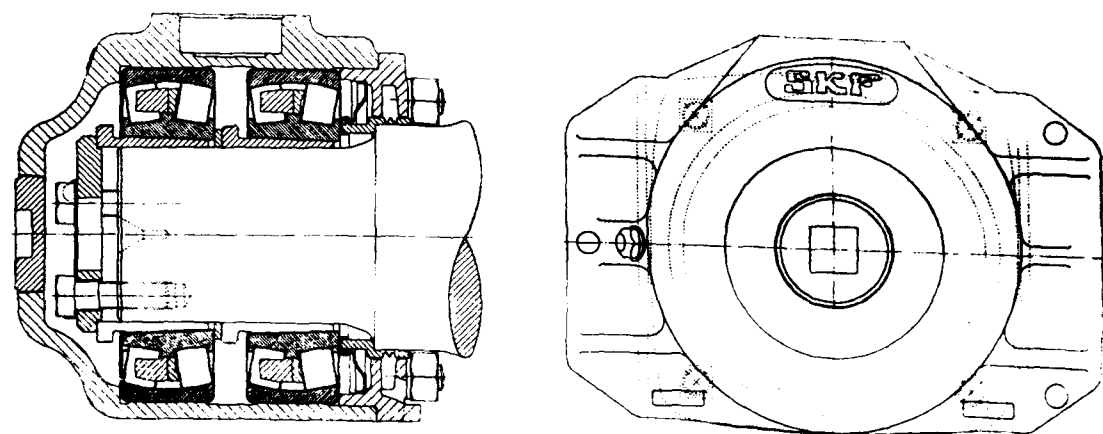


Fig. 11. Spherical roller bearing axlebox for goods wagons. Solid box.

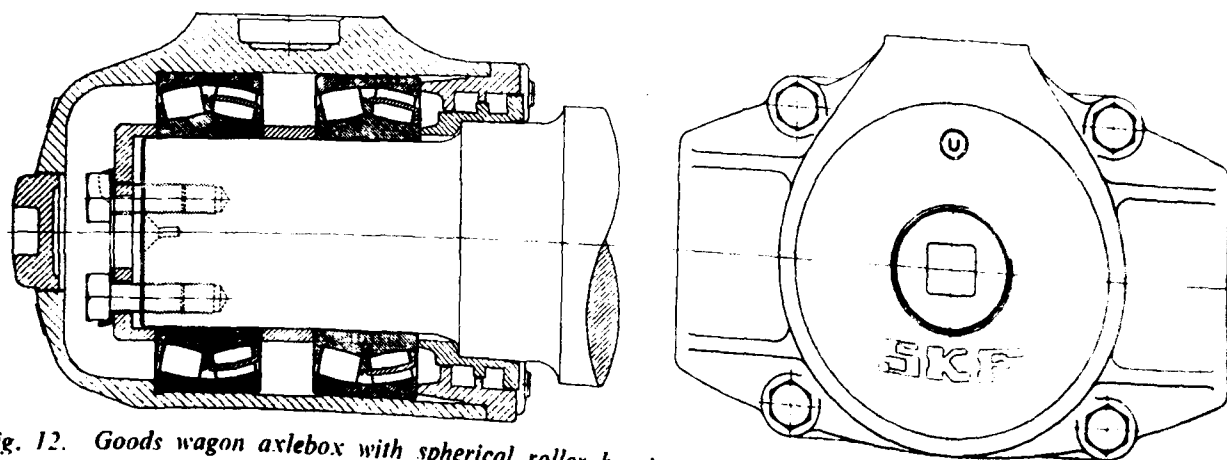


Fig. 12. Goods wagon axlebox with spherical roller bearings of type shown in Fig. 4. U.I.C. 130 mm. journal.

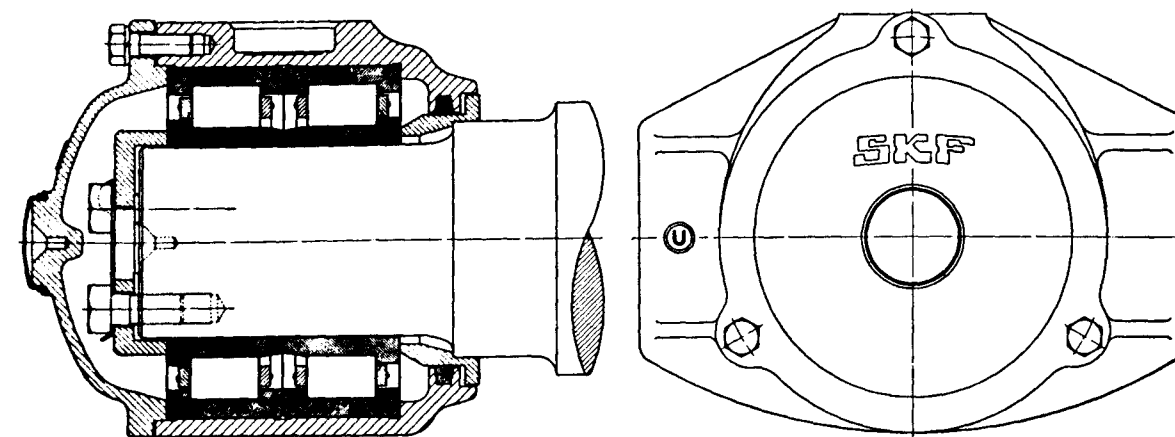


Fig. 13. Goods wagon axlebox with cylindrical roller bearings. U.I.C. 130 mm journal.

move towards dispensing completely with the axial securing of spherical roller bearings with cylindrical bore, Fig. 5, although so far only in cases where the axlebox is guided by flanges in both directions or at the inner flange only. A factor which has contributed to this arrangement is that even in the very unlikely case where the inner rings of both bearings have loosened on the journal—either due to bearing damage or to unsatisfactory machining of the journal which has been overlooked during inspection—the axlebox will remain in position on the journal because the box is suitably checked in the frame. The use of a securing device on the journal end would serve no useful purpose in such circumstances.

It is obvious that dispensing with nuts and end plates not only reduces initial costs but that work in connection with mounting and dismantling of bearings is also considerably reduced.

In the case of spherical roller bearings on withdrawal sleeves, the securing device at the end of the journal should never be dispensed with.

In axleboxes with cylindrical roller bearings of the usual design, Figs. 7 and 8, the outwardly directed thrust loads act undiminished on the securing components at the end of the journal, and these are therefore not only necessary—they must be of appropriate strength.

The U.I.C. 130 mm journal, Figs. 4 and 8, has an end plate secured by three robust screws (7/8"). Although this journal was developed in connection with spherical roller bearings, the robust end securing device was selected so that the journal could be used

generally, especially also for cylindrical roller bearings.

DEVELOPMENT OF AXLEBOX BODIES

During the first twenty years or so after the introduction of spherical roller bearings for railway vehicles the axleboxes were of twin bearing design, and, with few exceptions, of split type. This design was selected not only because it was absolutely necessary for spherical roller bearings, but also because it offered great advantages during the development period, some of which are still applicable today.

Fig. 10 shows an example of an axlebox of this type with spherical roller bearings. The box is split horizontally and the two halves held together by four bolts.

As mentioned earlier frequent inspection of the bearings and the journal used to be necessary. The dismantling and removal of the split box could be done more rapidly and with less effort than in the case of a one-piece casting, since removing and mounting the axlebox only entailed lifting each half separately and not the whole box. This latter factor still retains its importance, and split boxes are still often preferred, especially for large bearings, because they are easier to handle—despite the fact that they are more expensive.

The experience gained in the course of time has shown the superiority of roller bearing axleboxes over plain bearing axleboxes. One of the results of this was that shortly before the outbreak of the Second World War various railway administrations began to take an interest in these axleboxes for standard goods wagons.

Increased demands were being made on goods wagon stock, especially as records running speeds, and the time was therefore opportune for the design of a suitable goods wagon axlebox.

Frequent inspection of the roller bearings could not be entertained for this type of wagon and experience showed that in any case it was no longer necessary. As, in addition, the cost of the bearings for these relatively low-priced wagons had to be as low as possible, the use of solid axleboxes was obvious. Fig. 11 shows the axlebox designed at that time for a 125 mm. diameter journal. It will be seen that the box has a solid back cover, and after the bearings are mounted on the journal the box body is pushed over the bearings and the cover bolted up. These axleboxes came into use about 1940 and a very large number of them were fitted during the ensuing years.

Fig. 12 shows a more recent goods wagon axlebox having a solid body conforming to dimensions laid down by U.I.C. The roller bearings are shown in Fig. 4. To facilitate mounting and dismantling the back cover is secured to the body by four bolts which are accessible from the front of the box.

Split axleboxes have only rarely been used for cylindrical roller bearings, the usual design of box being shown in Fig. 13. The axlebox is to U.I.C. dimensions and fitted with the bearings shown in Fig. 8. The method of securing cylindrical roller bearings makes it necessary to have a box with a front cover.

The development of axlebox bodies has not been limited to design only; very important developments have taken place as regards material.

Cast steel was originally considered the only material suitable for axlebox bodies, and in cases where it was possible to give the box a simple form, and where the boxes were mass produced, steel forgings started to be used. Steel castings and forgings are still used today for many boxes.

At about the same time as the introduction of roller bearing axleboxes for two-axle goods wagons, types of alloyed cast iron with good strength properties were introduced. It was soon recognised that these cast irons offered an excellent and inexpensive material for axleboxes which, because of their shape and application, are subjected to normal stresses. In the last 20 years a very large number of goods wagon axleboxes—and to a lesser extent passenger coach

axleboxes—with high tensile, copper alloy cast-iron bodies have been supplied and have given satisfactory service.

For axlebox castings, which, due to their shape and the loads they have to carry, are subjected to heavy tensile and bending stresses, or which have to meet special safety requirements, spheroidal graphite cast iron has become a serious competitor of cast steel in recent years.

Spheroidal graphite cast iron cannot be regarded as cast iron or as a kind of steel, although its mechanical properties are very similar to those of steel. In many respects spheroidal graphite cast iron is even superior to cast steel as a material for axlebox bodies. It is tough, corrosion resistant, wear resistant and easy to machine.

The strict specifications laid down by railway administrations in regard to the selection of materials for mechanical components, where great reliability is an obvious requirement, do, of course, make it difficult to change over from a well-known material to a new one whose properties differ from those specified. Despite this, spheroidal graphite cast iron will undoubtedly be used more and more for axlebox bodies on passenger coaches, motor coaches and locomotives as it not only fulfils the technical requirements but also shows advantages from the point of view of manufacturing costs.

COMPARISON OF TWIN SPHERICAL ROLLER BEARING AXLEBOXES AND CYLINDRICAL ROLLER BEARING AXLEBOXES

When comparing axleboxes of different design the life and running properties of the bearings are of major importance, but certain other factors such as the method of mounting and dismantling the bearings, the work involved during bearing inspection, etc. must also be taken into consideration. Some of these latter factors will be considered first.

In a spherical roller bearing axlebox both bearings are identical; they are self-contained, i. e. each bearing forms a unit. In the case of cylindrical roller bearing axleboxes the inner rings of both bearings are different and the bearings are not self-contained units.

Mounting of the two types of bearing is carried out differently. With a spherical roller bearing axlebox the bearings are mounted on the journal, the end plate (where required) is fitted and the bearings

lubricated and then the axlebox body pushed over the bearings. With a cylindrical roller bearing axlebox the loose inner rings are first mounted on the journal in the correct order; the outer rings and roller sets are then fitted in the box body, the free space

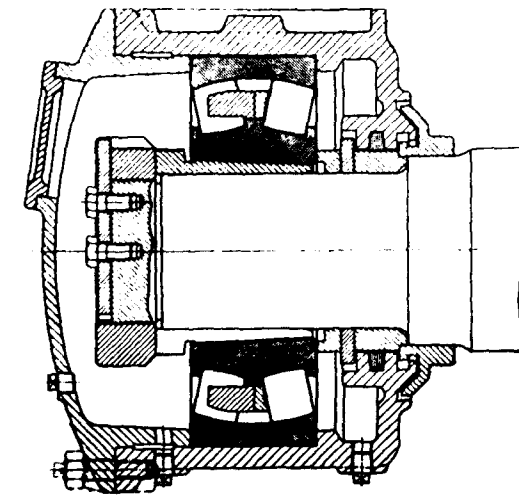


Fig. 14. Self-aligning axlebox dated 1921.

between the rollers filled with the grease and the box then pushed over the inner rings. The weight which has to be lifted in this case is greater than for a spherical roller bearing axlebox because, with the exception of the inner rings, the two bearings are in the box body, whereas with the spherical roller bearing box the bearings are on the journal. Fitting of the box body must be carried out more carefully

with cylindrical roller bearings as otherwise the rollers may easily score the inner rings if the axlebox is not lined up properly. Damage of this kind is not possible with spherical roller bearings.

Another essential difference is that in the case of cylindrical roller bearings the nut or end plate must be removed in order to withdraw the axlebox for inspection of the bearings. With spherical roller bearings this is not necessary.

It is easier to inspect the inner rings of cylindrical roller bearings, since with spherical roller bearings it is necessary to remove some of the rollers before the inner ring tracks are visible. On the other hand, the outer ring track of the spherical roller bearing can be inspected quite easily by swivelling the outer ring.

Both spherical roller bearings and cylindrical roller bearings meet the requirements of the railways with regard to long lubricating intervals and low working temperatures. In the case of very high train speeds it is theoretically possible that cylindrical roller bearings are slightly better in this respect, but as the matter appears to have no practical significance actual temperature recordings in service with a view to confirming the theory or otherwise, have not been carried out.

Care must be taken in the selection of lubricants for both types of bearing, and greases are available which will give good performance over long periods of service.

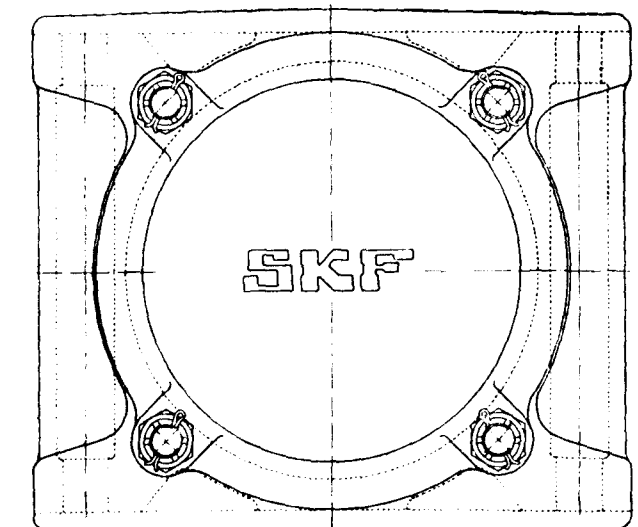
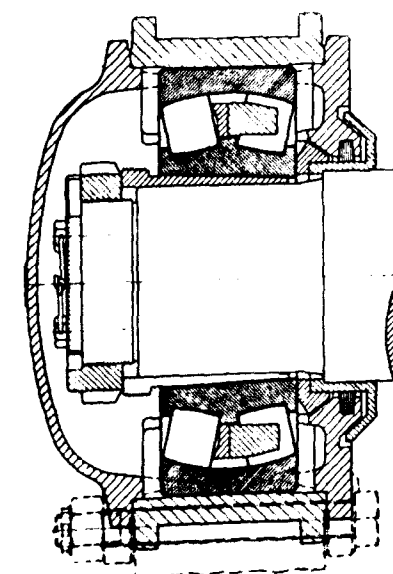


Fig. 15. Axlebox for diamond bogies. Old design.

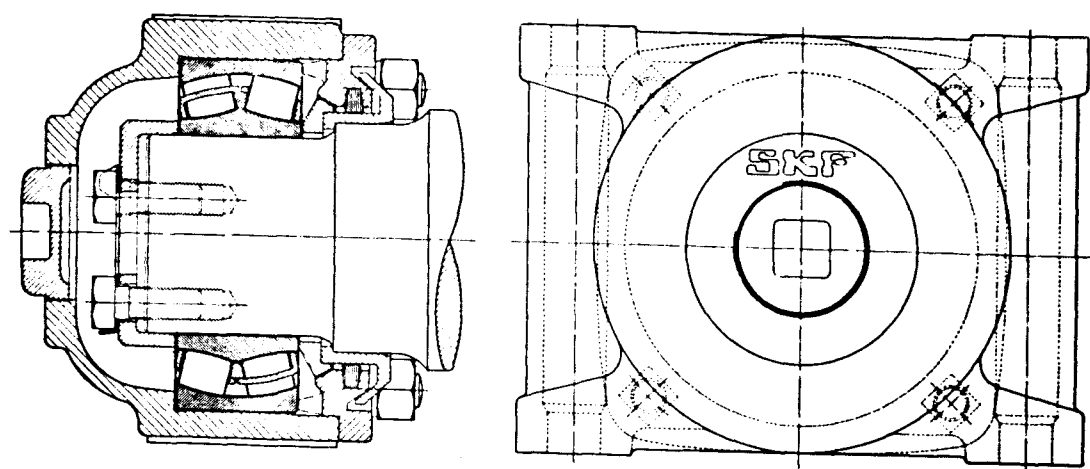


Fig. 16. Axlebox for diamond bogies. Modern design.

SELF-ALIGNING AXLEBOXES

The first roller bearing axleboxes to be widely used on railway rolling stock had only one spherical roller bearing per box, the design being shown in Fig. 14. This box was introduced in 1921 with bearing 22332 K with a modified, extra thick inner ring. This was the first occasion on which withdrawal sleeves were used. The vehicles were bogie wagons with an axle load of 15 tons, which were run at speeds of up to 75 m. p. h. These axleboxes gave satisfaction until, about 25 years after the roller bearings had been fitted, the wagons were scrapped. This alone gave ample proof of the importance of self-aligning

axleboxes.—In the case of self-aligning axleboxes the axle journal is short and no problems are encountered with regard to journal diameter comparable with those which have been met with twin bearing designs.

In vehicles with diamond bogies the body of the axlebox is rigidly bolted to the bogie frame. Deflection of the frame must be taken into account and it cannot be assumed that the boxes on the same axle have the same centre-line. The self-aligning feature of spherical roller bearings was therefore regarded as an important advantage for this type of bogie right from the outset. Figs. 15 and 16 show two stages of the development of this type of box.

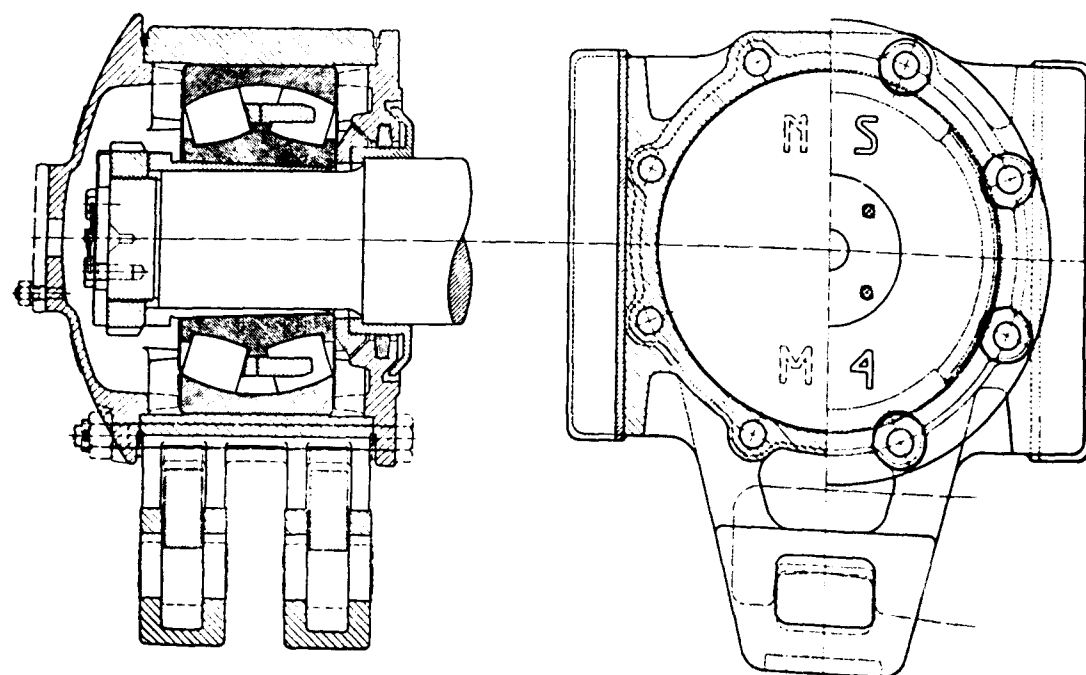


Fig. 17. Axlebox used on multiple unit stock of Netherlands State Railways.

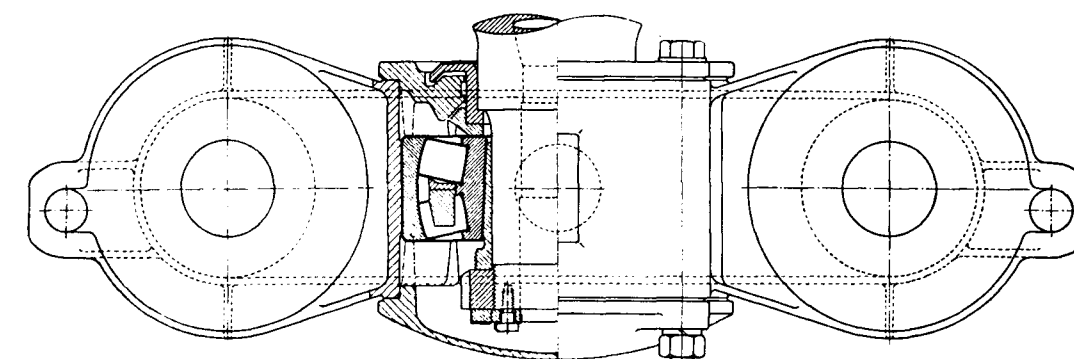
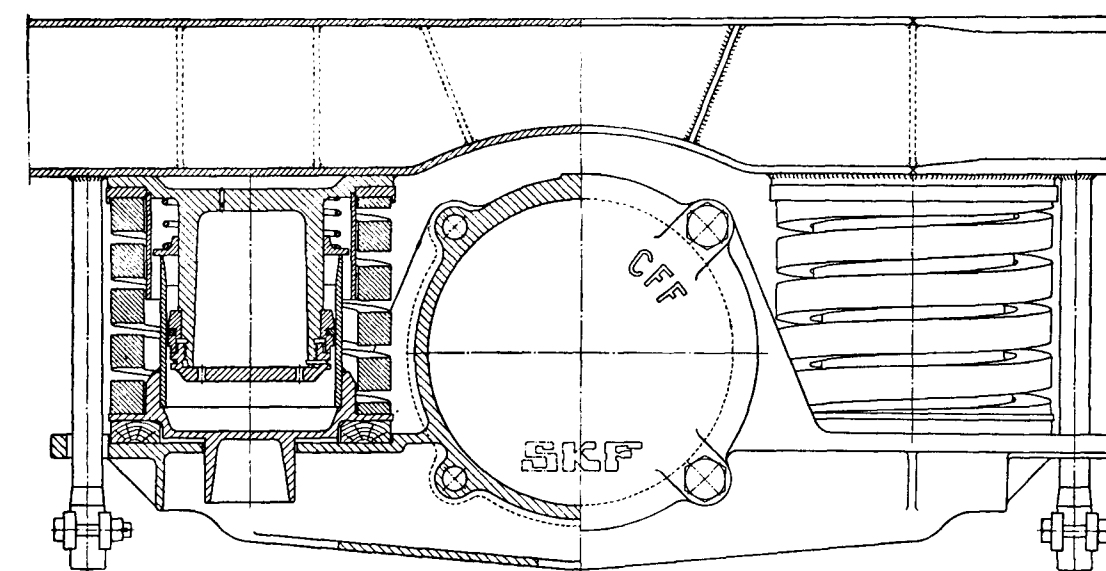


Fig. 18. Schlieren bogie axlebox.

In the initial designs bearings mounted on withdrawal sleeves were used almost exclusively, Fig. 15, but in recent years development has taken place along similar lines to that of twin bearing boxes and there is a preference for bearings with cylindrical bore as shown in Fig. 16.

It was general practice for a long time to secure the bearing on the journal by means of a nut and locking key, but this method is gradually being superseded by the simpler end plate. With the direct mounted design of the type shown in Fig. 16 it has been possible in some cases to dispense with the locking device entirely, as with the twin bearing design of box, since the thrust loads arising during operation are not sufficient to displace the bearing inner ring on the journal. Since the box itself is rigidly bolted in the frame the question of lateral location of the box body does not arise.

It has been mentioned earlier in this article that the new design of spherical roller bearing has made it possible to reduce the overall dimensions of axleboxes, and this important feature has resulted in an increase in the use of self-aligning axleboxes.

The special properties of axleboxes having only one spherical roller bearing have encouraged rolling stock designers to produce bogie designs in which these properties can be utilized to the full. Two examples are shown here. Fig. 17 shows the axlebox used for electric multiple unit stock of the Netherlands State Railways. This design was introduced during the 1930's and a very large number of these axleboxes are in service. Fig. 18 shows the axlebox for Schlieren bogies which are being widely used nowadays because of their excellent running characteristics.

Both these axleboxes are designed for underslung

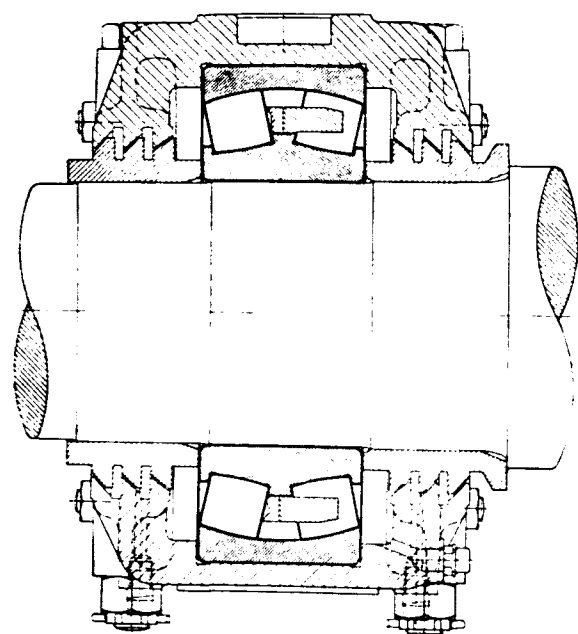


Fig. 19. Trailing truck axlebox for inside journal.
Horizontally split box.

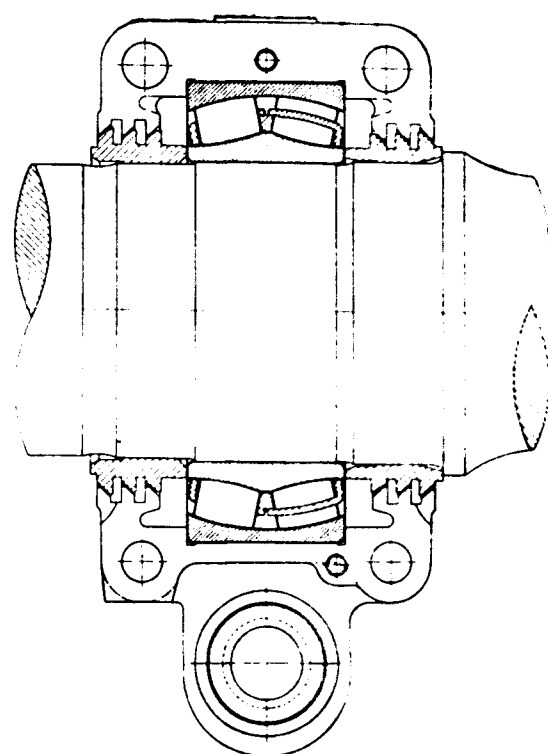


Fig. 20. Axlebox for the driving and coupled axles
of steam locomotives. Vertically split box.

spring suspension and the axlebox therefore remains in stable equilibrium even if the guidance of the box in the frame is disregarded.

Self-aligning axleboxes are also often used with top spring loading. In these designs, however, good lateral guidance of the box in the frame is necessary.

All the examples mentioned so far deal with axleboxes fitted outside the wheels, but special mention should be made of inside boxes which are commonly used on locomotives. Whilst the static

axle load in the case of a locomotive is much the same as for any other railway vehicle, for technical reasons the axle diameter at the bearing seating is considerably larger than the journal diameter for an axlebox fitted outside the wheel. Because of this one spherical roller bearing per journal, often from a light series, is sufficient, and axleboxes with only one spherical roller bearing for fitting to inside journals have therefore generally been selected.

Bearings mounted on withdrawal sleeves have only been used very occasionally for inside journal

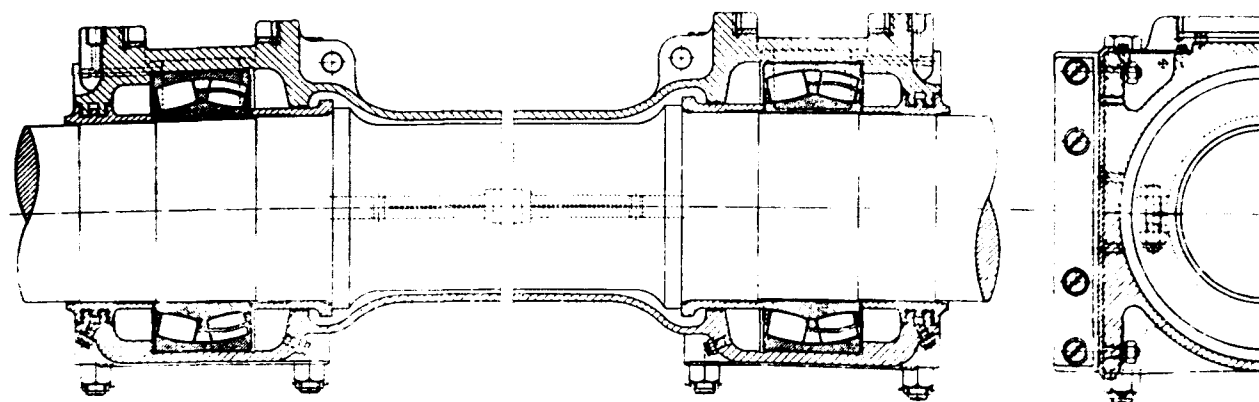


Fig. 21. Cannon type axlebox for coupled axles of steam locomotives.

axleboxes. The reason for this is that the main advantage of the withdrawal sleeve—ease of dismantling of the bearing—cannot be utilised because it is necessary to press off the wheel before removing the bearing.

Figs. 19 and 20 show two typical designs of axlebox for inside journals. Fig. 19 shows a box which was developed many years ago for the trailing axles of steam locomotives, whilst Fig. 20 shows a more modern design for the driving and coupled axles of steam locomotives.

Although self-aligning axleboxes for outside journals are always of solid type, axleboxes on inside journals are usually of split design to simplify bearing inspection. The trailing truck box shown in Fig. 19 is split horizontally and the two halves are held together by bolts. The driving and coupled-axle box in Fig. 20, on the other hand, is split vertically. Compared with the horizontally split box this latter design has a number of advantages. It is comparatively narrow, which has a favourable effect on the required width of

frame gap; the bolts which hold the two halves of the box together are not subjected to any undue stresses even in applications designed for underslung spring suspensions; finally, when the box is dismantled it is not necessary to remove the liners.

It has already been mentioned that self-aligning axleboxes intended for top spring loading require good lateral guidance in the frame. This arrangement is therefore not suitable for coupled axles which must have a certain amount of axial float. In these cases cannon type axleboxes are used, Fig. 21, which also incorporate only one spherical roller bearing per journal. The use of cannon type axleboxes is not confined to floating coupled axles however, and they are also often used on non-floating axles.

Self-aligning boxes with underslung springs are characterized by their self-righting properties, and if lateral freedom of the axle is necessary in relation to the frame the self-aligning feature of the spherical roller bearing can be utilized.

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Dragonair Diesel Railcar Heater

By An Engineering Correspondent

THE Dragonair DVLA. 80 Diesel Railcar Heater is specifically designed for, and supplied to, British Railways for heating and ventilating diesel railcars. The units can be used for ventilation only in hot weather by operating the fan only.

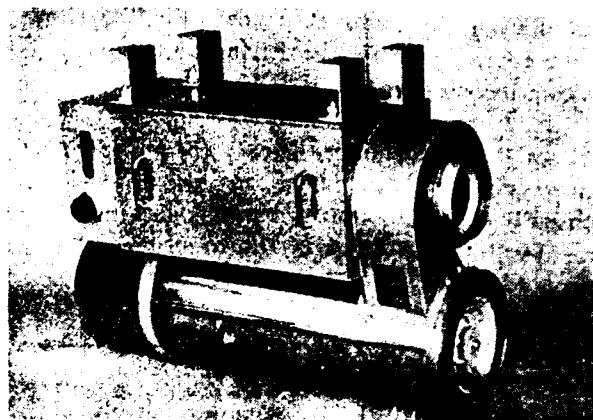
The heater is an oil-fired air heater working on the direct-to-air heat exchange principle with an efficiency of 85%, and eliminates the wasteful heat-transference of other methods such as hot water and steam heating by taking the heated air direct to desired points through a system of ducting.

The Dragonair automatic air heating and ventilating unit consists basically of a heat exchanger, an oil burner and a fan. Air drawn in by the fan is forced over the exterior of the heat exchanger, which is heated from the inside by the burner, thus keeping the heated air separate from combustion gases and ensuring that only clean fumeless air enters the coaches.

The unit is strongly constructed of the highest quality materials and is designed for the minimum of easy servicing and incorporates automatic safety devices against flame failure and overheating. Both heat exchanger and burner are made of heavy gauge, heat resisting, stainless steel and their high efficiency is the result of long development and experience in air heating applications. The centrifugal fan incorporated in the DVLA. 80 is electrically driven and has a forward curved multi-vane impeller to combine quietness with optimum performance. Fuel ignition is by high voltage spark from a booster coil and the fuel system is complete with pump, fuel filter and solenoid valve. An orifice is also fitted, integral with the pump, which varies the fuel flow to the burner at different pump speeds. As both pump and fan impeller are directly driven from the motor, the air/fuel ratio for combustion is maintained (within the required range) for varying motor speeds between 20 and 31 volts D.C.

The automatic control system incorporates switching to provide "HEAT-OFF-VENT". When switched to "VENT" only the fan operates and unheated fresh air is supplied through the ducting. When the heat position is selected fuel is supplied to the heater, it

ignites, and warm air is supplied immediately. Heat control is then automatic as dictated by the thermostat fitted in the saloon.



A control box is fitted to each heater unit and a Local Control Panel is supplied for mounting in each coach. A Guards' Control Panel is also available for "through-train control" for each train set.

Through-train control enables any number of heaters to be operated simultaneously from one control point (i.e. Guards' Control Panel). The heater units can be operated for either heating or ventilating only by this method.

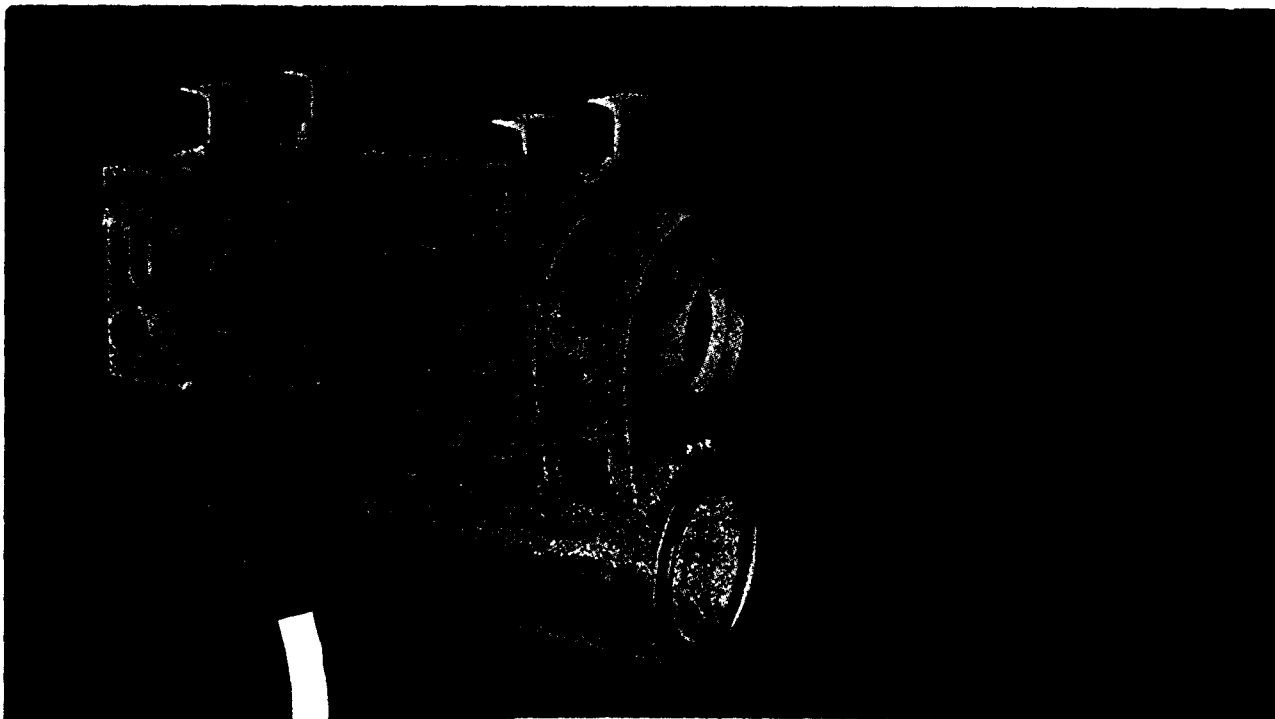
If required, individual heaters may be operated from their local Control Panels.

In the unlikely even of "flame failure" or "overheating" conditions occurring the appropriate warning lights will come on and the heater(s) will switch off to relight automatically when normal temperature conditions are restored.

SPECIFICATION

Heater Output	Maximum 100,000 B.T.U./Hr.
	Rated 80,000 B.T.U./Hr.
	Minimum 35,000 B.T.U./Hr.
Fuel Consumption	0.65 galls/hr. @ rated output
Heated Air Temperature Rise	120°F @ rated output

(Continued on page 58)



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PAXMAN ZH ENGINE

By An Engineering Correspondent

ALMOST 100 years of engineering experience lies behind the Paxman ZH horizontal diesel engine. In 1865 the Company was founded to carry on the business of general engineers, Boiler Makers and builders of steam engines and plant.

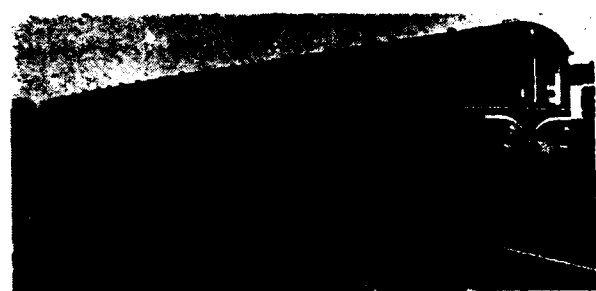
Since the beginning of this century, spark and Compression ignition engines have been manufactured. The Company now produces diesel engines, boilers and industrial products, and before the war was one of the pioneers of the now popular high speed compact vee engines of medium and high power.

All Paxman diesel engines are characterised by compact dimensions and light weight in relationship to the horsepower produced. This has been achieved by over 20 years of continuous development of the same basic engine to secure complete reliability and progres-

sive time, several hundreds of these engines designated YH have been supplied to the British and Commonwealth Governments for marine propulsion and generating duty. Commercial versions employing both aluminium alloy and cast iron castings have been supplied for all applications, in particular to British Railways for their Type 1 locomotives as well as other traction applications.

The Company's experience in the use of light alloy for engine frames prompted them to design a water cooled horizontal 6 cylinder engine based on the YH. This engine, designated the ZH, is probably the only one of its type directly descended from a heavy duty rail traction engine in the 800/1000 H. P. range. As a result it produces its traction rating of 450 B. H. P. at a speed of 1500 R.P.M. which permits extremely long periods between overhauls as stated above. Despite this, its special alloy construction makes it light enough for underfloor mounting in railcars or above the frames of conventional shunters or mainline locomotives, where low bonnet height for all round visibility is essential.

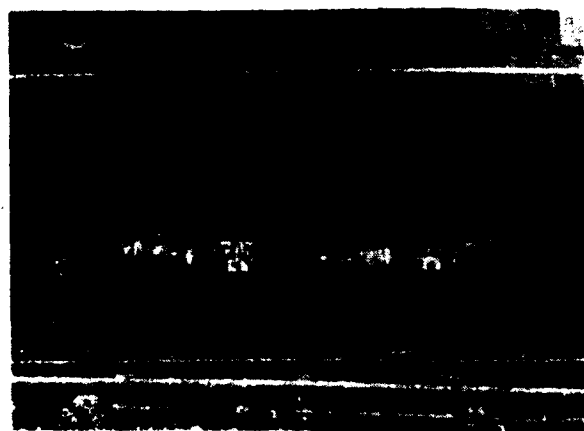
The ZH engine combines the best features of the Paxman YH and RPH engines in particular in the use of cast aluminium alloy for the one piece crankcase/



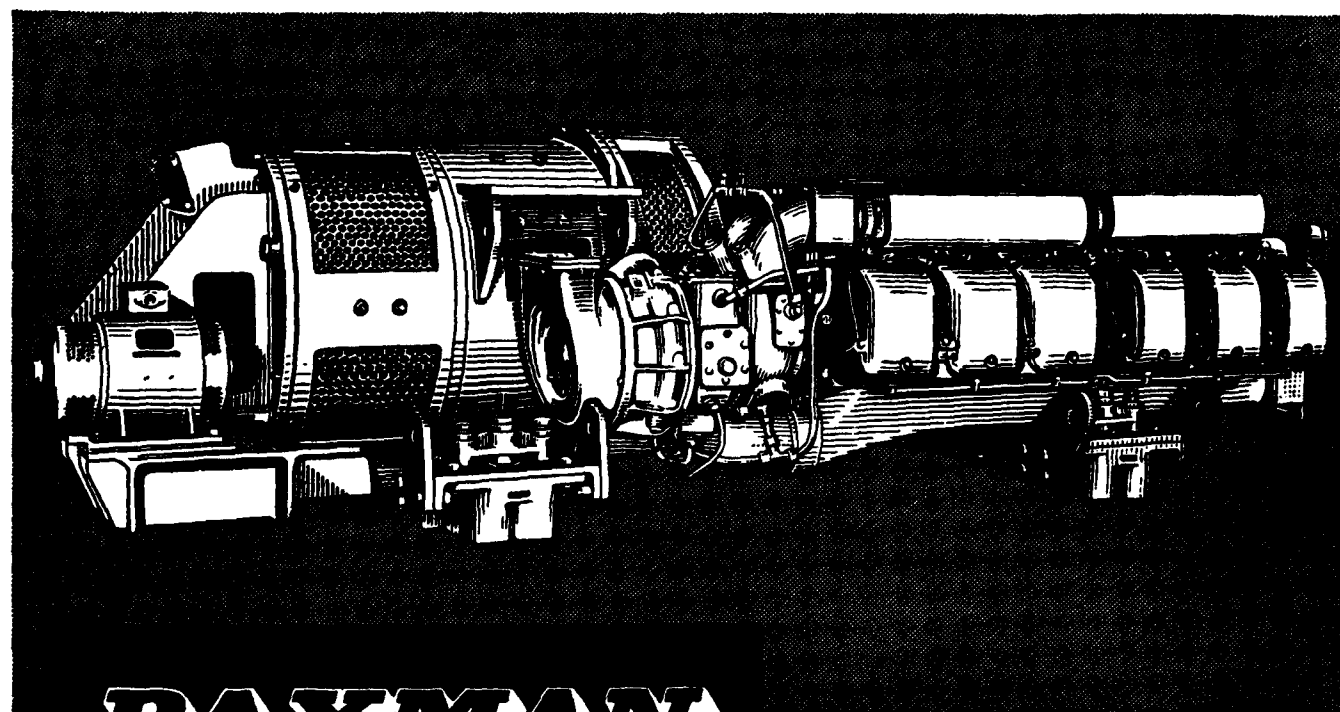
Paxman 6 ZHX horizontal engines installed in railcars. Speeds of up to 90 m.p.h. were attained during trials.

sively longer periods between major overhauls. The Company's recommended period is now 18,000 hours for traction applications but in many instances overhauls have been extended up to 40,000 hours on shunting locomotives working under arduous conditions in steel works.

During these 20 years over 3,000,000 H.P. of Paxman engines employing the Ricardo Comet Mark 3 combustion system have been built. In 1950 the British Government called for an engine similar in size and power to the RPH but with all main castings in aluminium alloy and employing direct injection of fuel into open type combustion chambers. Since that



Close up view of the 6 ZHX engine installation showing the resilient mountings and the accessibility of governor, filtering equipment, fuel injection and priming pumps.

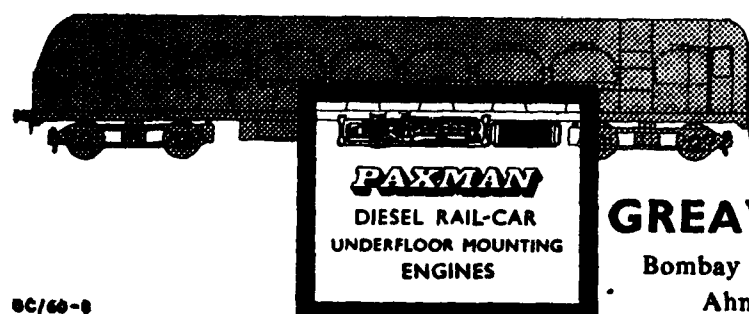


PAXMAN

DIESEL RAIL-CAR UNDERFLOOR MOUNTING ENGINES

The Paxman ZHL range of Underfloor Mounting Engines for Diesel Rail-car applications are Horizontal Engines developing from 200 to 450 b.h.p. at 1500 r.p.m.

After successful completion of severe endurance tests under the most arduous operating conditions in actual service, Paxman offer these engines, fully confident of their proven reliability and suitability for Rail-car applications.



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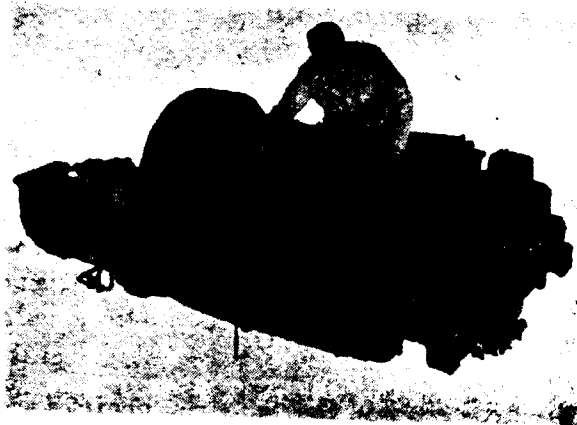


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cylinder block structure, for the cylinder heads, sump and covers.

After extensive test bed running, two diesel/electric units were installed in railcars by British Railways so that high speed trial runs could test the reliability and practicability of using high power underfloor engines. The two cars were first run in September 1956 and after preliminary trials, embarked on a programme of testing which covered most of England. It is only possible to record some of the highlights of this programme, but over a period of about 17 months of continuous service, defects were negligible. The total mileage covered during the period was 43,267 miles. After the completion of the test runs each power unit was thoroughly examined and found to be without



Overhead view of the Paxman 450 h.p. 6 ZHX engine showing position of oil and water pumps and crankshaft drive, manifolds and cylinder heads. An air cooled turbo-blower is now fitted.

significant wear, giving a prospect of 500,000 miles of revenue earning service between overhauls. Some interesting runs performed were:—

1. Two high speed trips from Derby to St. Pancras and back. Distance 129 miles, schedule 120 min. This schedule was met with about 5 min. to spare.
2. A run from Euston to Rugby, 82 miles in 78 min. This schedule was met with 2 min. to spare in spite of permanent way slacks accounting for at least 2 min.
3. Two runs from Derby to Gloucester and back including one of the steepest climbs in the

country—the 1 in 37 Lickey Bank. From a standing start the railcars accelerated to 36 m. p. h. at the end of the two mile climb.



Underside of 6 ZHX engine. Starter motors can be fitted above engine crankcase.

4. High speed runs from Sheffield to Kings Cross on the Eastern Region, a distance of 161 miles, in 161 min.
5. Continuous running over a fast schedule covering a daily round trip from Derby to Carlisle and back. This daily run of 377 miles was maintained for several months.
6. Runs from Liverpool to Bradford and back to a greatly accelerated schedule.

The conclusions drawn from the tests proved the feasibility of mounting 450 h.p. engines coupled to a generator underneath a railcar. There is no doubt

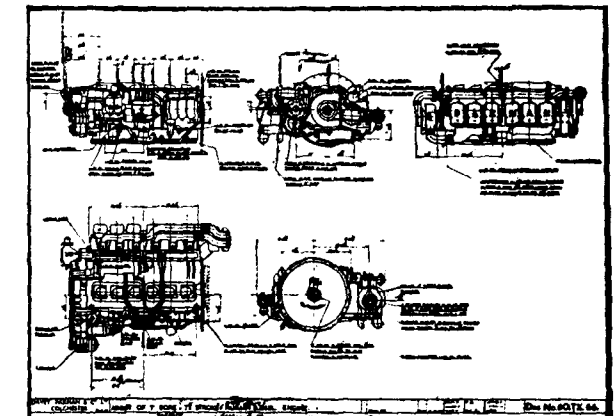
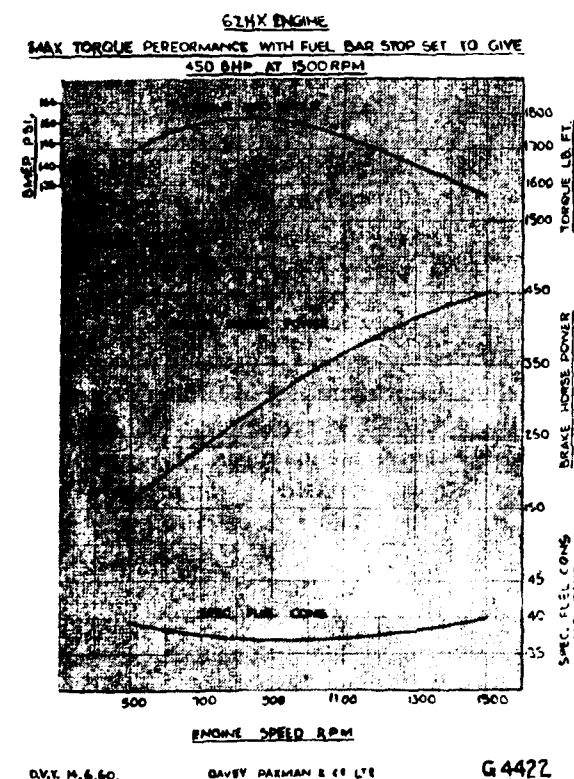


Paxman horizontal engine showing accessibility of governor, filters and fuel pumps. A central through bearer can be fitted when diesel/electric sets are supplied.

that a railcar having no passenger space occupied by engines or equipment and with a high power-to-weight ratio can be a versatile and valuable revenue earning vehicle.

A Holset air cooled turbo-blower is now used as the result of recent developments. This turbo-blower has the advantage of simplified installation and servicing and is one quarter of the weight of a water cooled equivalent. Holset turbo-blowers built under licence from the Schwitzer Corporation of America, employ plain bearings positively lubricated from the engine pressure system. This blower is extensively used for all diesel engine applications in the United States of America. In addition, Paxman have tested these blowers in their Research laboratory on YHX and RPHX engines and in the power house which supplies a large proportion of the Company's electrical power requirements. A large order for engines of this type with air cooled turbo-blowers was recently secured from the British Air Ministry. Additional orders for engines with air cooled blowers include 4, 6, 8 & 12 cylinder units for traction, marine and industrial duty.

Tests have been undertaken with the engine at 500 b.h.p. at 1500 r.p.m. so that the present rating can be considered conservative.



ENGINE DATA

Engine designation	ZH (normally aspirated) ZHX (pressure charged)
No. of cylinders	6
Bore	7 in. (177.8 mm)
Stroke	7.75 in. (196.8 mm)
Swept Volume cylinder	298 cu. in. (4880 c. c.)
Compression ratio	14.25 to 1
Full load speed range	600—1500 r. p. m.
Mean piston speed at 1500 r.p.m.	1940 ft./min. (9.8 m/sec.)
Direction of rotation	Anti-clockwise looking on flywheel end
Weight	ZH 4820 lb. (2190. kg.) ZHX 4920 lb. 2230. kg.)
Output at 1500 r.p.m.	ZH 330 b.h.p. ZHX 450 b.h.p.
Rating at 1500 r.p.m.	ZH 96 lb/sq. in. (6.75 kg/cm ²) ZHX 121 lb/sq. in. (8.5 kg/cm ²)

ENGINE SPECIFICATION

The single-piece crankcase/cylinder block is cast of high-strength corrosion-resisting aluminium alloy with strong cross pieces carrying the seven main bearings.

To take side thrust away from the studs the deep-forged aluminium-alloy bearing caps are closely fitted into the frame structure. A large-capacity finned sump in the form of an aluminium-alloy casting closes the bottom of the structure; over the top surface there are two large pressed aluminium covers.

Easily-replaceable hardened and tempered cast-iron liners are inserted in the cylinder bores; they are surrounded by ample water space. Cast aluminium-alloy pistons with iron insert for the top chrome faced pressure ring, have a centrally-disposed combustion chamber machined out of the crown. There are three compression rings and two stepped oil-control rings, one above and one below the gudgeon pin. The case-hardened fully-floating pin is of nickel case hardening steel and runs in a silicon bronze bush in the small end of the rod.

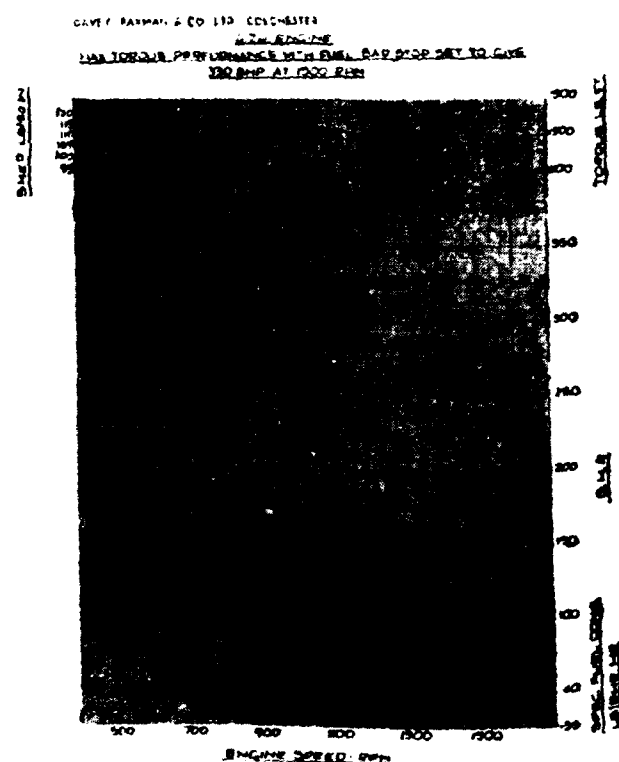
Following established Paxman practice, four valves per head are used. They bear on renewable aluminium bronze seats; ample cooling is provided at these points to reduce to a minimum the need for regrinding and general attention. Valve diameters are large and the ports are shaped and proportioned to give smooth air and exhaust flows without throttling or eddy. All valves are operated by a single gear-driven camshaft located beneath the cylinders. The integral cams run in an oil bath and operate roller-type cam followers which transmit the motion to push rods resting in spherical seatings in the cam followers.

The valve rocker gear, pressure-lubricated from the main engine system, is carried on the cylinder heads which are cast in single units to facilitate handling. The rocker arms pivot on spindles carried in cast aluminium brackets. Tappet clearance is controlled by means of screw-type adjusters in the valve actuating rockers and bridges; the valve gear covers are easily removable sideways for this purpose.

Heat-treated carbon steel I-section stampings are used for the connecting rods, the big-end being split at an angle to facilitate removal of cap, bearing and rod through the cylinder bore. The mating faces of cap and rod foot are serrated. Big-end bearings are steel shells lined with copper-lead and given a lead flash. Bearing replacement is simple and does not involve scraping or fitting. The main bearings are also copper-lead-lined steel shells, but the conservative design ensures low specific bearing pressures. The crank shaft itself, of normalised, oil-hardened and tempered EN26U steel, follows established Paxman practice in having a journal diameter about 70% that

of the cylinder bore. A vibration damper on the free-end of the shaft inside the crankcase enables the engine to be run without adverse effect at any speed within the running range.

Fuel injection is from a C. A. V. monobloc pump with a totally-enclosed camshaft. It is driven by gears



on the free-end of the main shaft and then through a cardan shaft. A plunger-type boost pump ensures an adequate supply of fuel under pressure to the fuel pump gallery. A Vokes filter is installed in the fuel system.

For the lubrication system a pressure pump supplies oil via a full-flow felt-element Vokes filter protected by a safety valve set to 80 lb. per sq. in. All oil is thus filtered before entering the main gallery. A centrifugal type by-pass filter is also fitted in the pressure circuit. A second pump passes low-pressure oil through the tubular oil cooler mounted on the engine. The use of dual pumps protects the oil cooler from high internal oil pressure associated with single-pump circulation, and allows flow through the cooler to be regulated by an independent relief valve. High-pressure filtered oil is led direct to the main gallery, which has a 50 lb. pressure release valve. The camshaft is provided with a constant flow of oil; the

rocker gear receives an intermittent full-pressure supply via the camshaft.

A centrifugal water pump is gear driven from the free-end of the main shaft; it has a cast-iron casing which houses a bronze impeller on a stainless-steel shaft running in plain bush journal bearings. Pump water delivery is led direct to the tubular oil cooler. From the cooler the water is piped to the underside of the engine water manifold. The water manifold is integral with the main crankcase casting. A thermostatically-controlled by-pass valve which normally provides a range of control from 160° to 180°F is

incorporated in the water system and thus controls the temperature of both oil and water.

6" or 7" electrical starter motors can be fitted. A standard 7" dynamo is mounted and driven by vee belts at the free-end of the engine.

An 'Ardleigh' servo governor is fitted for remote operation to give eight engine speeds, with torque control. A suitable overspeed trip mechanism which functions in the event of over speeding can be fitted. One air cooled exhaust driven turbo-blower is fitted to ZHX engines.

CAST IRON AND MILD STEEL FLAT PULLEYS

The Indian Standards Institution has just published IS : 1691-1960 Specification for Cast Iron and Mild Steel Flat Pulleys.

Pulleys of various types are in use for different power transmission systems. This standard covers the requirements only for mild steel and cast iron flat and crowned pulleys of the very commonly used types. It does not include dynamo pulleys and other special types of pulleys.

PLAIN WASHERS

The Indian Standards Institution has prepared draft specification for Plain Washers [Doc : EDC 27 (566)].

This standard gives the dimensions of four types of plain washers used for hexagonal and other heads of bolts. The washers conforming to this standard will be suitable for both metric and BSW threaded fasteners.

SPRING BALANCES

The Indian Standard Specification for Spring Balances (IS : 1702-1960) belongs to a series of Indian Standards on commercial weighing machines, being prepared by ISI at the instance of the Standing Metric Committee, Government of India, in connection with the introduction of metric system of weights and measures in the country. Other standards in the series cover general requirements for weighing instruments and specifications for beam scales, counter

machines, platform weighing machines, weigh-bridges, crane weighing machines and steel-yards.

GALVANIZED STEEL WIRES

The Indian Standards Institution has prepared the following five draft Indian Standard Specifications:

- Galvanized Steel Barbed Wire for Fencing [Doc : EDC 32(486)] (Draft Revision of IS : 278—1951);
- Galvanized Steel Wire. Chain Link Fencing [Doc : EDC 32 (519)];
- Standard Galvanized Steel Wire For Fencing [Doc : EDC 32 (520)];
- Galvanized Stay Strand for Telegraph and Telephone Purposes, Signal Posts and Suspension Strand [Doc : EDC 32 (521)]; and
- Galvanized Steel Wire Strand for Signalling Purposes [Doc : EDC 32 (522)].

The first, namely Doc : EDC 32(486) contains the draft revision of IS : 278—1951 Specification for Galvanized Steel Barbed Wire for Fencing (Tentative). The main modifications made in this revision are :

- basing the sizes of wire on metric system.
- increasing the minimum length of barbs, and
- provision of coiling on metallic or wooden reels.

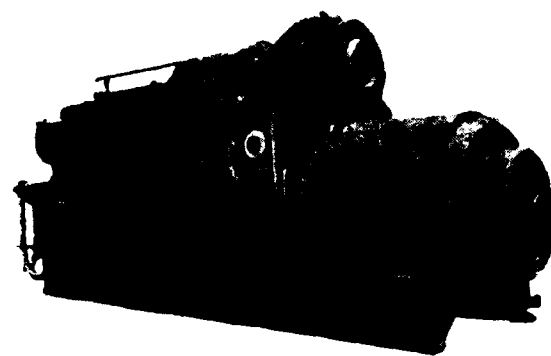
All the five drafts, mentioned above, relate to a series of Indian Standards for Galvanized steel wires used for different purposes.

Crompton Parkinson Main and Auxiliary Generator For Type 4 Diesel Electric Locomotives

THE largest traction generators so far constructed in Europe are being installed in the 137 type '4' diesel electric locomotives for British Railways. These locomotives have Sulzer 12LDA28 diesel engines and Crompton electrical equipment, and are being erected at the British Railways Derby Locomotive Works. They are numbered D1 to D137. The first ten are rated at 2300 h. p. and the remainder at 2500 h. p. As there is an adequate margin of capacity inherent in the original design, the generator is the same for both locomotives.

The main outline dimensions contain two machines which are combined to save space and to economise in weight. The main generator section is a ten-pole machine with a continuous rating in accordance with BS 173/1941 of 1531 kW 580 V, 2640 A at 1080 rev/min. The auxiliary generator is an eight-pole machine with a continuous rating to BS 173 of 90 kW, 220 V 410 A at any speed from 650 to 1080 rev/min.

The generator set is coupled to the synchronising pinion of a Sulzer Bros. (London) Ltd. 12LDA28 double bank diesel engine and runs at 1080 rev/min.—the engine crankshaft speed being 750 rev/min. The engine frame is extended to support the generator set which has a single bearing, the main and auxiliary armatures being mounted on a hollow 'bottle' shaped cast steel rotor bolted directly to the synchronising gear 'take-off' shaft which is rigidly mounted in a supporting bearing. The single roller bearing at the end of the generator set is easily accessible and, if necessary, can be replaced without disturbing any other part of the machines. The whole rotor arrangement has exceptional mechanical

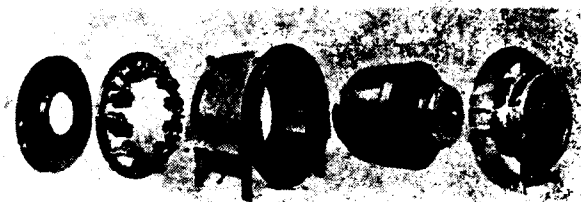


British Railway Type '4' Locomotive,
Sulzer Engine and Crompton Parkinson Generator.

strength to enable it to act as a fly-wheel for the diesel engine and to withstand the inherent cyclic variations of torque. The combination of the main and auxiliary sections into a single rotor provides the attributes of minimum length and maximum strength whilst avoiding excessive weight.

In this machine the main generator commutator is at the driving end. The auxiliary generator is partly accommodated within the field system of the main generator without increase to the overall length. The main generator is fitted with compensating windings of special design and patent by Crompton Parkinson. Normally these windings, which are necessary on large traction generators, make it impossible to change a field or interpole coil without disturbing the compensating winding. With the C. P. design however each field coil, i. e. self field coil, separate field coil and decompounding and starting coil can be removed and replaced with the compensating winding in position. This greatly facilitates maintenance operations if any part of the field system becomes damaged in any way.

High temperature glass insulation is used throughout the generator set and consists of a glass and mica combination without any Class A reinforcement. This type of insulation is eminently suitable for high temperature operation and has the advantage in the diesel electric application of withstanding considerable overloads without damage. The brushgear



British Railways Type '4' Locomotive
Exploded Section of Main and Auxiliary Generator.



British Railway Type '4' Locomotive,
C.171 Traction Motor.

of the main generator is carried on a ring which may be completely rotated by a crank handle and pinion drive engaging with teeth cut in the outer periphery of the ring. With this arrangement it is possible to gain access to all the brush arms for inspection purposes from a working position inside the locomotive engine room. To release the ring for rotation, it is only necessary to remove two flexible connections and a dowel and slacken four nuts, the replacement of the dowel ensuring that the brushgear is correctly



British Railway Type '4' Locomotive
Main and Auxiliary Generators.

set. Wherever possible the brushes and brushgear elements are standardised for both the main and auxiliary generator and are interchangeable between locomotive types.

A special barring gear is incorporated to enable the engine to be turned during maintenance operations. This consists of a toothed ring manufactured integrally with the generator fan, and a detachable barring lever which when engaged with the teeth enables the armature to be rotated.



British Railways Type '4' Diesel Electric Locomotive.

The commutator of the main generator is of overhung construction and has a maximum wearing depth of $\frac{1}{2}$ ". The auxiliary generator commutator is of bolted construction similar to traction motor commutators and also has a wearing depth of $\frac{1}{2}$ ".

The design of this largest traction generator has included techniques developed on the smaller machines for the Type '2' and Type '3' locomotives and includes the provision of field coils bakelised and hot-pressed to precise dimensions, while the armature coils which have insulation along their whole conductor length are finished with the usual hot varnish dip and baking treatment.

[Photographs by courtesy: CROMPTON PARKINSON LTD.]

PERSON WEIGHING MACHINES

The ISI has prepared a draft Indian Standard Specification for Person Weighing Machines [Doc: EDC 41 (528)]. This standard covers the requirements for steel yard type weighing machines, machines fitted with dial type indicator and machines fitted with ticket issuing device.

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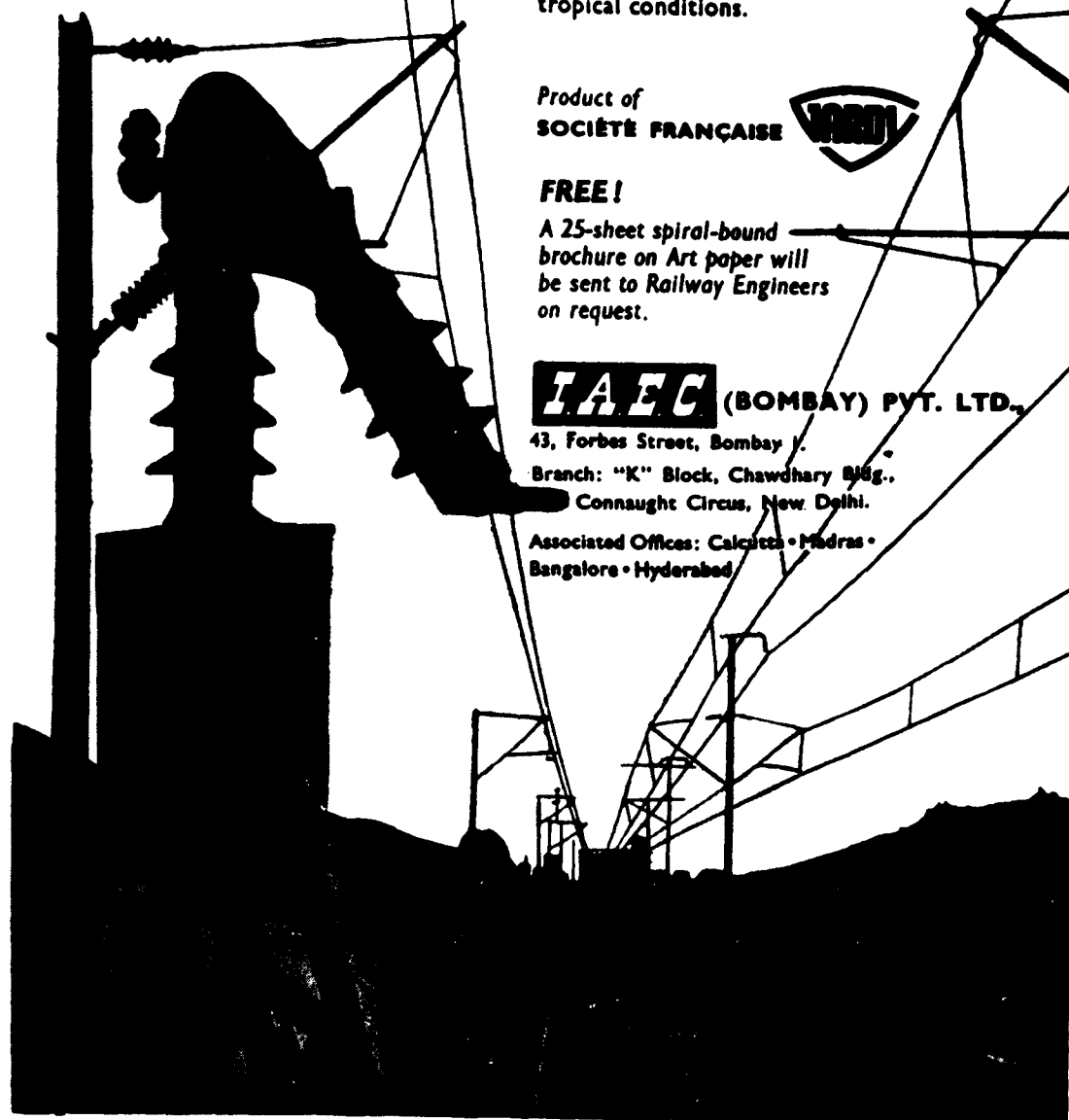
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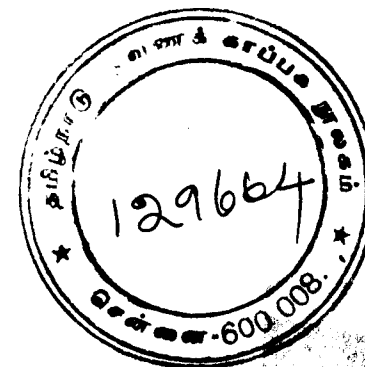
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FREIGHT CAR ROLLER BEARINGS

By Mark S. Downes

General Sales Manager, Railway Division
The Timken Roller Bearing Company, Canton 6, Ohio, U.S.A.

THE freight car roller bearing is one of the most important subjects before the North American railroads today. The degree of this importance is illustrated by the fact that within a period of a few years, their use has increased so that about 45 per cent of all new freight cars ordered in 1959 were equipped with roller bearings.

The great interest in roller bearings for freight cars has been stimulated by the troubles that result from the conventional friction, plain or solid journal bearing; whichever name you choose to call it. These troubles have produced the most important operating problem facing the North American railroads today.

During the past few years, all railroad executives, almost without exception, who have addressed remarks to meetings of railroad people, particularly meetings of Mechanical Division groups, have stressed the importance of the hot box problem and the necessity for solving this problem if the railroads are to perform as an efficient transportation business.

The Association of American Railroads, in an attempt to improve the friction bearing, sponsored a research program which resulted in the development of the lubricating pad to eliminate waste packing, as the solution to difficulties experienced with the conventional friction bearing. The conventional friction bearing had really had no fundamental changes or improvements since the railroads began operating more than a hundred years ago.

The extent of this problem is illustrated by the fact that in the calendar year of 1959, there were a total of 157,471 freight cars set out between terminals because of hot boxes by the U. S. and Canadian railroads. This means that train operation was interfered with to this extent because of the failure of the journal bearings to operate properly. Actually, this is an understatement of the problem because there are about three additional overheated bearings¹ for each car set out. These other overheated bearings

can cause train delays; but if the train crew can get the train into a terminal before the car is set out, the incident is not reportable to the A. A. R. Therefore, the actual number of hot boxes occurring in 1959 was probably between 500,000 and 600,000.

The direct costs that result from each of these failures of the journal bearing to operate properly can be just the cost of a train delay or it can amount to a million or more dollars if the hot box should develop into a burnt-off or wrung journal, with a train wreck resulting. The indirect costs may be many times greater because of the interruption in service and from lost traffic because of dissatisfaction resulting from delays in shipments.

However, from the large number of hot boxes that occur during a year's time, the overall cost must be a very large figure.

The average freight car mileage per car set out between terminals in 1959 due to hot boxes was 202,000 or about 50,000 miles per actual hot box using the ratio of 4 to 1 for total hot boxes to actual cars set out between terminals.

As a result of the research program of the A. A. R., the railroads established a program on the elimination of loose waste packing and substituting a lubrication pad. This program has been in effect for several years; and as of the end of the year 1959, 48.6 per cent of the entire freight car fleet², including cars owned by private car owners, had been converted to pads from waste packing. It has been claimed by some that hot boxes are reduced to only one-third by the use of pads. It is claimed by others that lubricating pads are not effective in reducing hot boxes. It would seem that those who claim pads do not reduce hot boxes have the better argument, as A. A. R.

¹University of Illinois Engineering Experiment Station Bulletin No.406 "An Economic Investigation of Solid Journal Bearing Operation in Freight Service on Two Large Class 1 Railways."

²March 28, 1960, issue of Railway Age.

These bearings put new life in the rails

When on freight car axles, the bearings shown above help freight cars do things you wouldn't think possible. For instance, in high-speed piggy-back service, Timken bearing-equipped cars roll 1,000 miles a day without overheating—have already rolled over 400,000 miles on their original bearings. To date, Timken bearings on railroads have gone more than a hundred million car-miles between car set-outs caused by over-heated bearings.

High-speed, high-mileage service is what Timken heavy-duty railroad bearings are designed for. They solve the problem of over-heated bearings, because they roll the loads.

Timken bearings save time in terminals, too—take just a glance for inspection. And they require additional lubrication only once in four years. That's why more and more railroads are switching to Timken heavy-duty bearings—to give shippers better service while cutting maintenance and operating costs to a minimum. The Timken Roller Bearing Company, Canton, Ohio, U.S.A. Cable: "TIMROSCO".

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car set out records for the year 1959 do not show any marked improvement, when 48.6 per cent of the cars were equipped with pads, over earlier years when none of the cars were pad lubricated; all cars being waste packed.

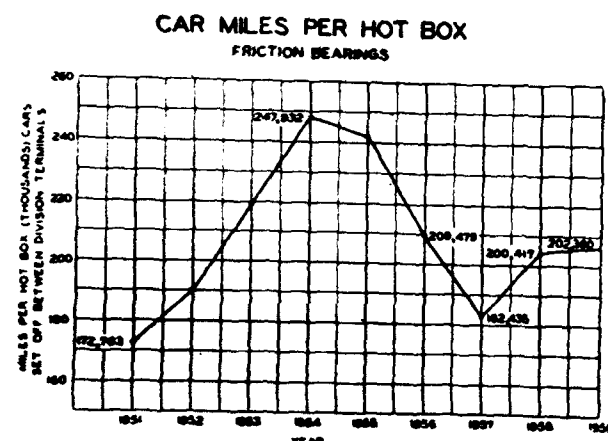


Fig. 1

Fig. 1 shows the car miles per car set out between terminals because of hot boxes each year since 1951, and the average of this nine-year period is 207,484 miles, which is slightly better than the figure for 1959.

If the pads were really effective in reducing hot boxes, it is reasonable to believe that their use on nearly 50 per cent of the car fleet would have produced a clear indication by a significantly improved hot box record.

In any event, many railroad officials feel that the lubricating pads will not give them the performance they want and that the roller bearing is the only answer. The officials of several prominent railroads have stated in public speeches that their railroad will use roller bearings on all newly built freight cars; and a number of other railroads, while not publicly saying so, are following this practice and are putting roller bearings on all of their new cars.

Because of the interest that several railroads had shown in roller bearings for freight cars, the Association of American Railroads created a standing committee about 10 years ago to establish standards and to control approval of roller bearing applications for cars in interchange service. This committee is designated as "Committee on Journal Roller Bearings".

At the same time, the roller bearing manufacturers who were interested in this field were invited to form

an engineers group who would work in close coordination with the A. A. R. committee to establish suitable standards and the rules of approval and any other problems that were encountered at that time and that might develop in the future.

These two groups worked out a set of standard specifications which were formally adopted by the A. A. R. in 1956, and are now a part of the A. A. R. manual and are covered by plates D-39-1957 to D-42-1957 inclusive and plates D-43-1958 and D-44-1958. There are three basic provisions in the standard specifications, which are as follows:

1. The bearings must be designed to have minimum life expectancy of 500,000 miles with full load for half the mileage and empty car the other half. The committee defined "life expectancy" as the life at which 10 per cent of the bearings may have been replaced due to fatigue of the bearing surfaces.
The mileage of 500,000 was chosen as that was considered to represent the life of the average freight car. The life of a freight car, in terms of time, was generally set at 30 years; and with the A. A. R. average of about 17,000 miles per year per freight car, a total of about 500,000 miles is attained by the average car during its life.
2. The design of the application is to be such that it will operate satisfactorily with periodic grease lubrication periods of three years.
The specification was set so that relubrication of the bearings could be done when the cars are on the repair track for periodic air brake inspection. The air brake inspection was on a three-year basis when the roller bearing specifications were drawn up. This inspection period has since been changed to four years, and while the A. A. R. roller bearing specification has not been changed, the roller bearing manufacturers are working toward the four-year period. It is recognized that for economic reasons, it is desirable to have those two jobs done at the same time.
3. The seals of the roller bearing application are to be designed to have a minimum life of nine years.
Nine years was considered to be the average life of a one wear steel wheel or the average time at which the first turning of a multiple

wear wheel would occur. This specification was set up to avoid having to bring wheels and axles into the shop especially just to renew seals.

The balance of the A. A. R. specifications relates to the procedure that is to be followed in obtaining approval of bearings submitted for consideration and procedure that is to be followed in making change to an approved bearing.

These specifications do not cover actual physical dimensions, but since standard freight car axle for roller bearings had been adopted in 1953 by the A. A. R., it is, therefore, required that any suitable bearing must fit on the standard axle.

In addition, the A. A. R. had established standard truck side frames suitable for roller bearings. In fact, there are two standards for roller bearings; one having a narrow jaw opening and the second a wide jaw opening.

The Roller Bearing Manufacturers Engineers Committee established a common outside diameter and a common length of the outer race of the bearing applications for the various types of roller bearings, so that the adapter for the narrow side frame is a standard part used with all types of bearing applications. In addition, other application parts, insofar as it was possible to do so, were made standard for all types and makes of roller bearings.

These same bearing applications can be used in the wide pedestal side frame, but require a heavier and, therefore, more expensive adapter. One of the bearing manufacturers is advocating the use of a different bearing application in the wide frame for a so-called high mileage car.

Grease is used exclusively as a lubricant for freight car roller bearings, and the A. A. R. has set up Specification M-917-56 to cover greases which may be used for lubricating cars in interchange service, both freight and passenger.

This specification covers a grease which has approximately a zero (0) consistency. An oxidation inhibitor is required and the grease must maintain a stable consistency after working. All greases approved must be compatible when mixed.

These A. A. R. specifications have recently been amended to include a corrosion inhibitor and approved

greases must meet the requirement as covered by Coordinating Research Council Method L-41-957, which is the accepted method of evaluating corrosion inhibitors.

Copies of the grease specification and a list of approved greases may be obtained from the A. A. R.

This paper will deal largely with the figures and records established by the applications offered by The Timken Roller Bearing Company, as this data is readily available. But in order to give a clear picture of the position that roller bearings occupy with the U. S. and Canadian railroads, the totals used later on in this paper will include all roller bearings insofar as these figures are available.

As of April, 1960, more than 85,000 freight cars on U. S. and Canadian railroads are in service or on order equipped with roller bearings of all types. The progress that roller bearings are making is illustrated by the following table:

Percentage of All New Freight Cars Purchased which were Equipped With Roller Bearings of all Types	
Year	
1957	10%
1958	25%
1959	45%

It is estimated that by 1965, all new freight cars will be equipped with roller bearings when built. The North American railroads are behind European railroads in this respect as it has been the general practice in Europe, and even in Russia, for some years to put roller bearings on new freight cars.

The primary factor which has delayed the adoption of roller bearings for universal use on freight cars here has been the first cost of the roller bearing and parts in relation to the total cost of the car; or in other words, the economic factor.

A great deal of progress has been made in this respect. Ten or twelve years ago the cost of a new freight car was increased by 25 per cent or more when roller bearings were used, whereas today this corresponding increase has dropped to 5 to 10 per cent, depending on the type of car. The price of a car set of bearings, in terms of dollars, is less today than 10 years ago, while the cost of cars has been greatly increased during this period.

The price of a car set of roller bearings, in terms of dollars, has been decreased during the past ten years by improvement in design and by improvements in production methods and technique. The Timken Roller Bearing Company designed and built a production line for the production of freight car bearings utilizing the latest known methods and techniques in mechanization. This production line involved an expenditure of \$7,500,000 and has a capacity of 20,000 car sets (160,000 bearing assemblies) per year, and was completed in 1958. The demand for freight car roller bearings has grown to the extent that The Timken Company has decided to establish a second line with a similar capacity. This will be completed by the end of the year, giving the Timken Company a capacity of 40,000 car sets per year.

This mechanization has enabled The Timken Company to overcome, to some extent, the great increase in costs of manufacturing that has taken place since the war.

The improvements in bearing application design have had a great deal to do with the lowering of costs. Ten years ago the conventional application design consisted of a two-row bearing mounted in a journal box, with the cost of the journal box being as much or more than the cost of bearings. This is illustrated by the application as shown by Fig. 2.

In 1954, the Timken Company engineers developed an application design in which the two outer races of the bearing are made in one piece with counterbores in the two ends of the outer race, into which are fitted rubbing type seals. This one piece outer race with the seals in place, together with the internal parts of the

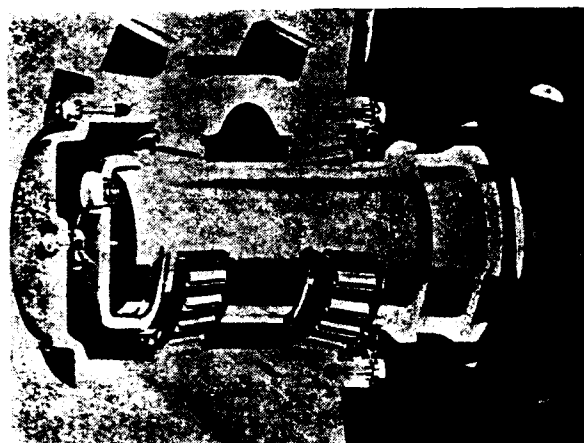


Fig. 2. First Design of Heavy-Duty Application using two Single-Row Bearings in a Journal Box.

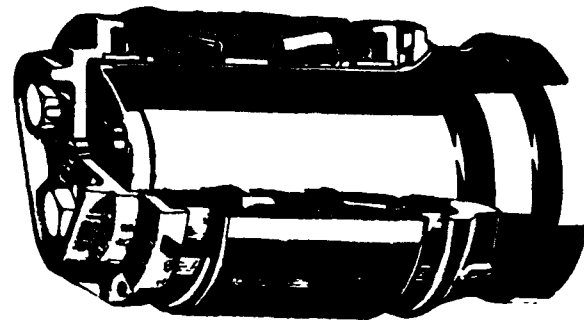


Fig. 3. Timken AP Heavy-Duty Application Eliminating the Journal Box.

bearing and the rings and spacers upon which the seals operate, constitute a self-contained bearing application, eliminating the necessity of a journal box as such. This application is illustrated by Fig. 3.

The bearing application requires only an adapter to fit the bearing to the truck side frame and an end cap to hold the assembly together and secure it to the axle. The bearing, adapter and pedestal type side frame are shown in Fig. 4. This design reduces the total weight of the bearing application and, therefore,



Fig. 4. The Timken AP Type Heavy-Duty Bearing, the Narrow Frame Adapter and the Narrow Pedestal Side Frame.

provides for more efficient utilization of weight without any material sacrifice in bearing load carrying capacity. The following table shows the relative weights of the two types of bearing applications for 50- and 70-ton cars:

Car Capacity	Axle Size	Weight of Conventional Bearing Application-Fig. 2	Weight of New Design Bearing Application and Adapter-Fig. 4
50-Ton	5½" × 10"	160 lbs. per journal	83 lbs. per journal
		1280 lbs. per car set	664 lbs. per car set
70-Ton	6" × 11"	175 lbs. per journal	103 lbs. per journal
		1400 lbs. per car set	824 lbs. per car set

This reduction in weight has not only the effect of making lower prices possible, but has had the further advantage of reducing the space occupied by the bearing application so that the pedestal opening in truck side frame can be reduced. This has the effect of reducing the weight of the side frame, which should result in lower costs of the frame and reduce the dead weight and unsprung weight of the car. For the 50-ton car, the saving in side frame weight is 85 pounds per car set and for the 70-ton car, the saving is 108 pounds per car set. The two pedestal conditions are shown by Fig. 5.

The total saving in weight from the new design is shown in the following table:

TOTAL SAVING IN WEIGHT PER CAR				
Car Capacity	Axle Size	Savings From Bearing Application	Savings In Side Frame	Per Car
50-Ton	5½" × 10"	616 lbs.	84 lbs.	700 lbs.
70-Ton	6" × 11"	576 lbs.	108 lbs.	684 lbs.

It was pointed out in the fore part of this paper that the great interest in roller bearings on the part of the railroad management is to solve the hot box problem. However, roller bearings offer even a larger potential saving than from solving the hot box problem, and that is the savings that will come from the reduction in maintenance expense.



Fig. 5. The Wide Pedestal Frame Above and The Narrow Pedestal Frame Below.

The friction bearing requires a great deal of attention in terminals and shops to make the bearing function even as poorly as it does. This attention means labor, as well as materials. It is well known that the cost of both labor and materials have greatly increased each year since the war, brought about by the yearly increase in labor rates; and it, therefore, becomes increasingly important to reduce the amount of labor and material required.

The roller bearing application offers the opportunity of very large savings on the cost of both hot boxes and labor and materials.

Periodically a report is made to the A. A. R. on the performance of the Timken AP type freight car bearing, and the last report shows a car mileage of 214,429,000 per car set out between terminals because of an overheated bearing or 116,961,000 car miles per overheated bearing including those found in terminals.

The 1959 figures on friction bearing hot box performance were cited previously, and in order to show

clearly the improvement that the Timken Roller Bearings offer, the following tabulation is shown:

	Friction Bearing Equipped Cars	Timken Roller Bearing Equipped Cars
Car miles per car set out between terminals	202,000	214,429,000
Car miles per hot box	50,000	116,961,000

While an occasional overheated bearing will develop with roller bearings, it is clearly shown from the table above that it will happen so infrequently that the problem has been eliminated. If the rate of 116,961,000 miles per overheated Timken Roller Bearing were applied to the nearly 32 billion car miles operated by the U. S. and Canadian railroads in 1959, there would have been 272 overheated bearings instead of 500,000 to 600,000 hot boxes previously estimated. There would have been only 150 cars set out between terminals instead of 157,000.

The performance given by roller bearings on the Quebec, North Shore and Labrador is another example of what may be expected. This railroad hauls iron ore from the mines in Labrador to the St. Lawrence River, a distance of about 360 miles. They have about 3,000 95-ton gondola type roller bearing equipped cars for hauling the ore and these cars are unloaded in a rotary dump. The railroad has operated through seven seasons, during which, they have accumulated 500,000,000 car miles. There have been two overheated bearings in this mileage, giving a figure of 250,000,000 miles per overheated bearing.

The potentialities of the saving in inspection and lubrication is illustrated by the relatively little attention required by the roller bearing. The only attention required by the Timken AP bearing application, other than visual check for any signs of lubricant loss or other abnormal conditions as the cars or trains go through the terminals, is for relubrication of the bearings every four years.

It is customary for freight trains to be checked at terminals for truck defects such as side frame, wheel or brake parts, and the same inspector can give the AP bearing a visual check at that time. Nothing else is required.

At the present time, the A. A. R. rules applying to roller bearing equipped cars in interchange service

provides for the addition of four ounces of grease per bearing at 18-month intervals. It has been recommended to the A. A. R. by the Timken Company that the lubrication interval be extended for the AP bearing to 48 months, at which time eight ounces of grease be added to each bearing. This relubrication period would coincide with air brake inspection and the two maintenance operations could be done at the same time.

The A. A. R. Committee on Lubrication of Cars and Locomotives has considered this recommendation and have recommended its adoption, except that the period be 36 months instead of the 48 months proposed by The Timken Company.

The Timken Company recommendation to the A. A. R. was based on actual operating tests as follows:

The Southern Pacific equipped ten 70-ton existing flat cars with Timken AP bearings to be used in high mileage piggy-back service. The cars were placed in service in March 1955, and each year thereafter a few bearings were disassembled and examined for the amount and condition of the lubricant remaining in the bearing, and for the condition of the bearing parts including the seals.

At the last examination made in March 1959, four years after the start of the test, the bearings, seals and grease were in good condition and there was sufficient grease remaining in the bearings examined to have continued the test for at least another year. However, the test was discontinued as the object of the test had been accomplished, which was to determine if a four-year relubrication period was feasible.

It was estimated the cars operated 288,000 miles during the four-year test in the piggy-back service. It would take the average freight car 20 years to attain this mileage.

The Atlantic Coast Line ran a four-year lubrication test on a group of 766 fifty-ton open top hopper cars equipped with AP bearings and used in wet rock phosphate service. The first of these cars went in service in January 1955. No examinations were made the first year, but a number of bearings were removed and examined as to condition of bearing seals and grease at the end of the second, third and fourth years of operation.

In all cases, the examination showed the bearings

and seals and grease to be in good condition. There was still adequate grease in the bearings for continued operation at the fourth year examination.

The Union Pacific ran a similar test on 100 seventy-ton tank cars equipped with AP bearings and placed in service in December 1954. Yearly examinations were made on a few bearings and at the end of the four-year period, the application was considered to have successfully passed the requirements.

The Gulf, Mobile and Ohio Railroad equipped ten existing 50-ton bulkhead flat cars used in pulpwood service with AP bearings in February of 1955. Each year for a four-year period, a few bearings which previously had not been touched, were taken apart and examined.

In every case, the bearings, seals and lubricant were in good condition and there was sufficient grease for continued operation.

These tests, together with our experiences in observing the operation of many thousands of other freight cars over the past six years, demonstrate the adequacy of the AP bearing to be placed on a four-year lubrication schedule.

Not requiring lubricant attention except at four-year intervals and with bearing maintenance required only at wheel work periods, it will be apparent to every railroad mechanical and operating man the tremendous savings in labor and material that can be made when all the nation's freight cars are on roller bearings.

In addition to the virtual elimination of hot boxes and the great reduction in labor for inspections at terminals, the roller bearing will offer many other advantages. Among these are increased car availability. It was pointed out previously that on new cars, roller bearings increase the cost about 5 to 10 per cent; say 7.5 per cent on the average. Therefore, car availability has to be increased only 7.5 per cent for the car owner to have no net increase in capital cost. This can be taken advantage by either decreasing the car fleet by a like per cent or doing more ton miles with the same fleet.

The question of car utilization is very complex, but we feel certain the railroads will find it possible to get better utilization with roller bearing equipped cars.

Another advantage that will come from the

universal use of roller bearings on freight cars is a great reduction in the wheel slip problem on locomotives. A large part of this problem is the result of journal lubricating oil getting on the rail after leaking out of the friction bearing boxes. No oil or grease would get on the rail if cars are equipped with roller bearings.

This problem is so severe on some railroads in reducing effective tractive effort of their diesels and also in increasing tracting motor maintenance from high speed wheel slips, that the railroad is required periodically to clean the rail in certain locations.

Also, it is thought that roller bearings will allow higher speed schedules to be maintained by reducing the time spent in terminals for journal inspections. While there has been a tendency to reduce time in terminals during recent years by cutting down on inspections with present equipment, this terminal time is saved at the hazard of having delays between terminals due to journal bearing troubles which may result in an actual loss of time overall.

In addition, the roller bearing application and the side frame suitable for roller bearings being lighter in weight than the conventional friction bearing and side frame, there is a decrease in dead weight of the freight car.

Some years ago, the Timken Company prepared an economic study in an attempt to evaluate, in terms of dollars, as many of the advantages to be expected from the use of roller bearings on freight cars as could be evaluated. A number of these advantages can be evaluated into dollars, but a large number, while real, defy placing a dollar value upon them.

In addition, the Timken Company engineers who prepared this study, had to determine condition which could be considered as normal or average for all the railroads in the United States and Canada, because it was desirable to have the study cover the entire railroad operation that is under the A. A. R. interchange system.

This economic study¹ was completed in 1956, and indicated that when all cars were on roller bearings, the railroads would receive an economic return of nearly 20 per cent on the investment for roller

¹The Use of Roller Bearings on Freight Cars—An Economic Study.

bearings. This study was based on prices and operating records of 1955.

In 1959, the study was revised based on 1958 prices and 1957 operating statistics. The higher 1958 prices increased the return on the investment to about 25 per cent; being slightly higher for new cars and somewhat less for existing cars changed over to roller bearings.

This economics of roller bearings for freight cars became quite controversial and a number of other studies were developed showing varying degrees of return on the investment. Some of these were based on individual railroads operating conditions and statistics and were not expected to apply to the whole country.

The A. A. R. Research Center in Chicago had prepared a study² which indicated the savings to be expected from the universal use of roller bearings would be considerably less than the study made by the Timken Company.

However, one of the principal factors that produced the lower saving in the A. A. R. study was the values which they used for lost car days and lost locomotive time due to hot boxes on freight cars. In the case of lost car days, the A. A. R. study used the per diem rate, which is the nominal rate paid by each railroad to the other in the interchange of cars. The Timken Company study used the value of a car

based partly on the per diem rate and partly on the revenue producing rate of the car in accordance with a formula worked out by the University of Illinois.

In addition, the A. A. R. study did not recognize many areas of car and locomotive time savings that were considered valid by the Timken Company study.

In passing, it should be noted that the A. A. R. used the revenue producing capacity of a car as the value of a car in proceedings before the Interstate Commerce Commission in connection with higher demurrage rates, so it would appear that under certain circumstances, the ability of a car to produce revenue is a true value of a car and is so recognized by the A. A. R.

In any event, it would appear from the increasing number of cars being equipped with roller bearings, that more and more railroad people are becoming convinced that roller bearings are a worthwhile investment.

It has been stated previously that more than 85,000 freight cars have been equipped with roller bearings or are on order, of which approximately 65,000 are on Timken bearings and the balance on other types of roller bearings.

A tabulated list of these cars separated as to type of car and size of car is as follows:

SUMMARY OF FREIGHT CARS EQUIPPED WITH ROLLER BEARINGS—ALL TYPES

Axle class Nominal Journal Size Nominal Car Capacity	Class C (5" x 9") 40-Ton	Class D (5½" x 10") 50-Ton	Class E (6" x 11") 70-Ton	Class F (6½" x 12") 95-Ton	Class G (7" x 14") 125-Ton	Others	Total
TYPE OF CAR							
Box Cars		18,452	5,996				24,448
Covered Hopper Cars		231	11,607	720			12,558
Piggy-Back Flat Cars	237	2,180	6,765				9,182
Open Top Hopper Cars		816	9,762	200			10,778
Flat Cars		1,059	1,705	96	144	4	3,008
Gondola Cars			3,290	5,573			8,863
Refrigerator Cars	1	2,104	4,191				6,296
Bulkhead Flat Cars	1	2,021	1,125				3,147
Caboose Cars	158	29					207
Tank Cars	37	210	412	174		20	881
Livestock Cars	198	776				48	974
Miscellaneous and Undetermined	97	351	4,277			10	4,732
TOTALS	729	28,229	49,127	6,763	144	82	85,074

²Comparative Economics of Journal Bearings.

It is noteworthy that most of these cars are in interchange service, although some remain exclusively on owners lines. At first, railroads generally refused to spend the money for cars that might go into interchange service, but this has largely disappeared.

Railroads having the largest number of freight cars equipped with roller bearings and percentage of total freight car ownership on roller bearings are shown in the following table:

Railroad or Car Owner	Number of Cars. On Roller Bearings	Percentage of Their Total Ownership On Roller Bearings
Quebec, North Shore and Labrador	3,036	100.0%
Trailer Train	4,267	100.0%
Boston and Maine	2,000	35.4%
Atlantic Coast Line	9,348	30.2%
Western Maryland	3,053	21.0%
Fruit Growers Express	1,598	12.6%
Union Pacific	5,899	10.9%
Louisville & Nashville	6,482	10.8%
Seaboard Air Line	2,310	8.1%
Southern Pacific	4,785	7.2%
Southern Railway	4,039	7.2%
Northern Pacific	2,456	7.1%
Pacific Fruit Express	2,053	6.8%
Great Northern	2,672	6.7%
Santa Fe	5,615	6.4%
Missouri Pacific	2,101	4.8%
Burlington	2,038	4.6%

The Timken bearing application offered to the railroads for freight cars is known as the heavy-duty AP type bearing. The initials AP are an abbreviation for "All Purpose". The bearing was given this name because the bearing can be applied to all standard A. A. R. side frames, including the integral box type side frame used with friction bearings, as well as other designs of side frames still in use, but which are no longer in the A. A. R. manual.

Since the same heavy-duty bearing can be used for new cars as well as for the changeover of existing cars, the bearing is truly an "All Purpose" bearing. This feature is of particular importance in two respects. The railroads do not have to stock two different bearings for each axle size; the same bearing being used on both new and existing cars. Secondly, it enables the bearing manufacturer to concentrate their manufactur-

ing efforts on only one bearing for each axle size which leads to lower costs.

The bearing application is designed to operate a minimum of four years without requiring lubricant attention. In the case of some high mileage cars, wheel turning may develop before the four-year period has elapsed and relubrication by the addition of eight ounces of grease should be done at this wheel work period.

Also, the bearing designed so that maintenance work on the bearing itself and the related parts, such as the seals, can be done when wheels and axles are in the shop for wheel work. If wheels are to be replaced, the bearing comes off the axle ahead of the wheel. While the bearing application is off the axle, the bearing should be disassembled and all parts cleaned and examined. If examination shows evidence of wear or fatigue, decision is made as to whether parts are suitable to be returned to service for another wheel work period.

If the wheels and axles are in the shop for remachining the wheel tread, the bearing should be examined visually for condition of the bearing and for evidence of any abnormal grease loss. It will not be necessary to remove the bearing from the axle unless there is some visual indication that a complete examination should be made or unless there is an indication of roughness in rotating the bearing by hand.

A complete set of tools and fixtures has been designed and is available for purchase from a tool

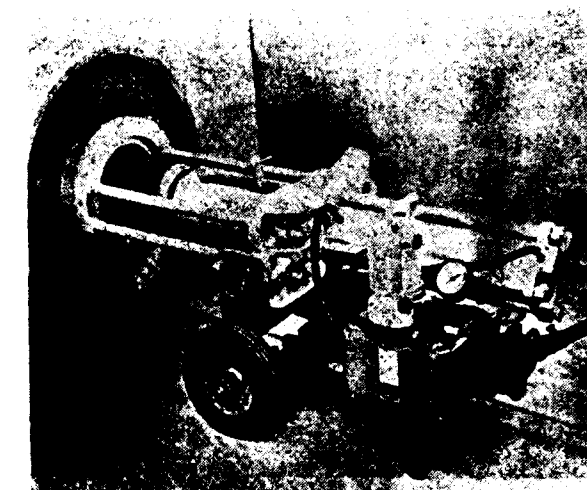


Fig. 5A. Portable Machine Used for Both Removing and Remounting AP Bearing Application Without Disturbing Wheel.

manufacturer to completely disassemble and reassemble and relubricate the bearing application. These tools and fixtures include a portable puller (Fig. 5A) which can remove the bearing from the axle without disturbing the wheel fit and the same device can be used for remounting the bearing on the axle. The entire maintenance setup can be established on a time saving and efficient basis.

As stated previously, the AP bearing application (Fig. 3) consists of a double cup or outer race with counterbored extensions into which the cases containing rubbing type seals are press-fitted. The seal cases are locked in place by a lip which fits into a groove in the counterbores in the cup. While this is a positive lock, the seal case is not destroyed when removed during disassembly. The seal case can be reused even when the seal element is worn out and must be replaced.

The two cone and roll assemblies are separated by a spacer of the proper length to provide correct lateral running clearance. This spacer is selected at the time of assembly in the production line and stays with the two cone and roller assemblies and the double cup.

The two seals run on two seal wear rings which are located at the outside ends of the cones. These seal wear rings are case hardened to the same hardness as the bearing parts and are finished with a good finish, such as is used on the bearings. The seal wear rings are finished by plunge grinding to avoid spiral grinding marks which can cause lubricant loss.

The cone backing ring goes between the inner seal wear ring and the axle fillet and this piece contains the air vent which relieves a build-up of excessive internal pressure due to changes in temperature or from additions of lubricant. The air vent also allows excessive grease to escape in case of too much grease being added, and thereby protects the seal against high internal pressure.

The axle end cap with three bolts and locking plate complete the bearing assembly. The locking plate has tabs which, when bent into place after the bolts have been torque wrenched into place, lock the bolts and prevent them from turning loose. The axle end cap also contains a counter sunk head pipe plug. This plug is removed at relubrication periods and lubricant is added. After relubrication, the pipe plug is reinstalled in the end cap. Fig. 6 shows a cross-section of the bearing application and all of the parts as indicated by name.

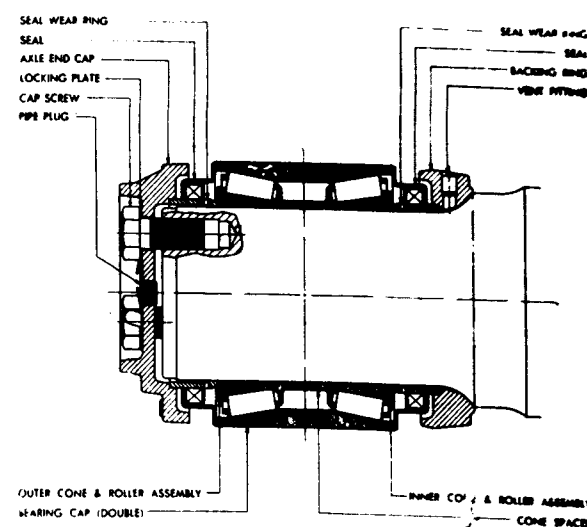


Fig. 6. Cross-Section of Timken Heavy-Duty AP Type Application

Certain application parts are given a phosphate coating as a means of reducing possibility of damage from corrosion to a minimum. This is accomplished by giving the finished metal parts a bath in a zinc phosphate solution. A chemical reaction between this solution and the steel develops a phosphate coating firmly intergrown with the metal surface. Such a surface has a high absorptive capacity for lubricants to provide increased protection against corrosion. This phosphate coating also has a secondary function to prevent galling and seizure between the contact surfaces of the cup and adapter. It is desirable to have the cup creep in the adapter since it will increase bearing life by having a different roller path surface presented periodically for carrying the load through the rollers.

The molded seal element is of the double lip type made of synthetic rubber and has been adopted after much study and research on the part of the Timken Company engineers and the seal manufacturers. Many thousands of hours of testing in laboratories have

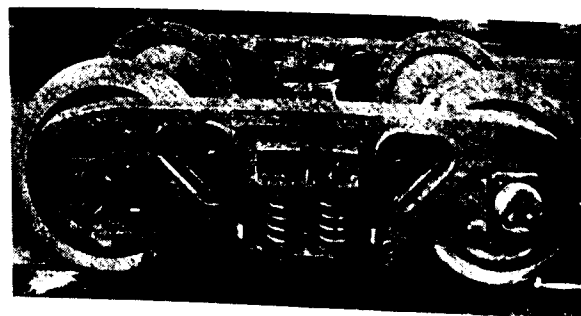


Fig. 7. View of Narrow Pedestal Type Side Frames usually used for New Cars.

entered into the final design that has been adopted. In addition, tests are made on seals selected at random from each production run before the product from this run is approved for use.

The bearing and all of the application parts are assembled and proper bearing lateral established in the bearing manufacturing plant and the initial charge of lubricant is added during the assembly processes. The initial charge of lubricant fills approximately 40 per cent of the internal air volume of the application. This was found by test to be the optimum amount of grease for best performance.

The bearing unit is packaged and palletized for shipment to the car builder or railroad in quantities of either two or four car sets per pallet.

The bearing is ready upon removal from the shipping carton for mounting on the axle so that the builder is not required to clean or wash the bearing nor to add any lubricant.

The bearing is manufactured for all standard A. A. R. axle sizes from $4\frac{1}{2}'' \times 8''$ through $6\frac{1}{2}'' \times 12''$; and in addition, an AP type bearing is produced for a $7'' \times 14''$ axle.

For new cars, the rail roads have generally specified a pedestal type side frame (Fig. 7) for use with the AP type bearing. However, the AP bearing can also be used with all existing types of side frames.

Modification is required to the integral box type side frame customarily used for existing friction bearing cars. This modification consists of cutting out the dust guard ribs at the back of the box and also reducing the height of the thrust carrying ribs, which will

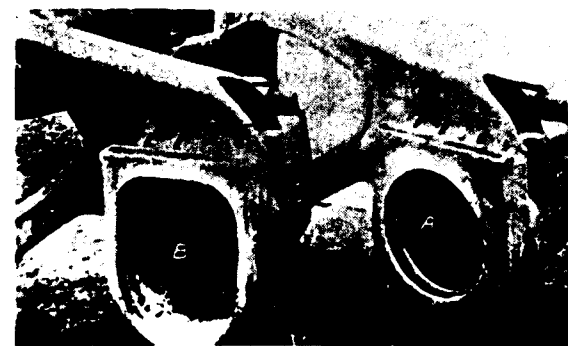


Fig. 8. Frame A shows Side Frame with Existing Conditions for Friction Bearings. Frame B Shows Side Frame after Modification for Roller Bearings.

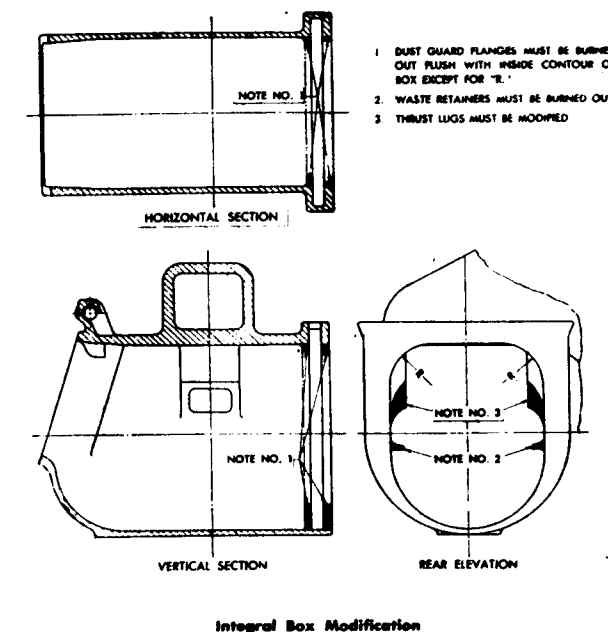


Fig. 9. Cross-Sectional View of Friction Bearing Journal Box. Shaded Sections are Removed with Torch to Make the Side Frame Suitable for Roller Bearings.

thereby permit the assembly of the side frame over the AP unit mounted on the axle. Both of these cutting operations can be done with a torch and then the rough edges are dressed up with a hand grinder. Fig. 8 and Fig. 9 show views of the frame modification.

If sufficient quantities of side frames are involved in the change-over project, an efficient setup can be made using duplicating equipment with jigs and fixtures.

Also, existing worn friction bearing axles can be machined to take the AP bearing providing the axles have not been worn below the roller bearing standard size. The roller bearing standard journal diameter is $5/16$ inches less than the new friction bearing journal

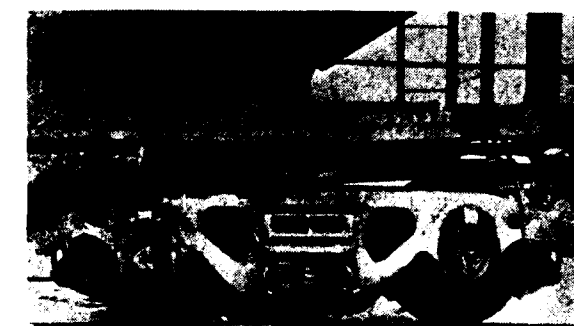
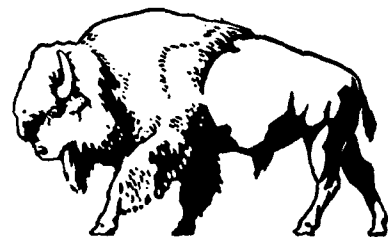


Fig. 10. View of Vulcan Type Side Frame with Adapter and Roller Bearing. No Frame Modification Necessary.

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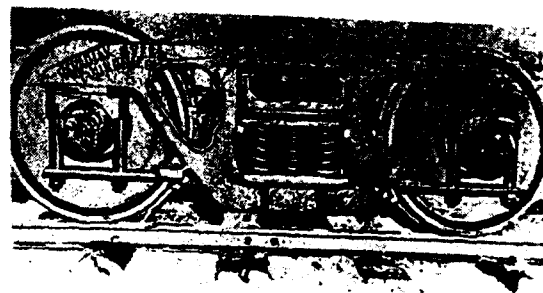


Fig. 11. View of Andrews Type Side Frame with Adapter and Roller Bearing. No Frame Modification Necessary.

diameter, except in the case of the $4\frac{1}{2} \times 8$ axle, which is reduced by $\frac{1}{4}$ inch, so the axle can be worn to that extent.

The AP bearing can also be applied to existing Vulcan type frames (Fig. 10) and to Andrews type side frames (Fig. 11) without requiring any changes to the frames.

The advantages which are inherent to the AP design of bearing application have made it adaptable for use on passenger train cars and diesel locomotives. It has been used on many new as well as existing head end cars, and has been used on the changeover of existing passenger cars.

The diesel locomotive builders are also finding that this design is well adaptable to and economical for both switching and road type diesels, and one builder is using the AP design on large percentage of the diesel locomotives they build for both industrial and main line service.

Pioneer All-Electric Loco Still Going Strong

The locomotive, which went into service in Brazil, in 1921, was the first ever made by General Electric for a Latin American railroad. One of 12 units, the historic "first" was an all-electric locomotive running on 3,000 volts direct current supplied by overhead wires.

Three years after these locomotives were made, G-E developed the first practical diesel-electrics. Since then, several hundred diesel-electrics, bearing G-E name plates, have gone into action in Latin America.

Altogether, G-E has supplied over 1,000 locomotives for Latin American railroads. Together, they would develop enough horsepower to haul a fully loaded train long enough to stretch from Venezuela to Tierra del Fuego (Chile and Argentina).

January 1961

THE INDIAN RAILWAY ENGINEER

I.C.F.15

Method Study in the Integral Coach Factory

By D. R. R. Sastri

Mechanical Engineer/Work Study

THE Integral Coach Factory came into being in October 1955 with the aid of Foreign Technical consultants, who had themselves been engaged in Railway Coach manufacture in Switzerland, a country noted for its high efficiency. In helping us to establish this Factory, the foreign consultants were, therefore, able to bring to bear their rich experience and to introduce the latest ideas in Coach building technique. The Integral Coach Factory thus had a flying start and then aided by the enthusiasm of its workers, who quickly learnt the operation of modern machines and who adopted up-to-date technical methods it has gained the reputation that it at present enjoys.

Obsolescence, however, swiftly overtakes all things complacent and slow, and the Integral Coach Factory is aware that unless it keeps racing forward its ultra-modern of to-day will become the ancient past of tomorrow. The Integral Coach Factory in the effort to keep pace with a changing world, employs various means amongst which 'Method Study' occupies prime position. Method Study itself is a part of the larger subject of Work Study, which is gaining stature every day in the great national drive for Higher Productivity.

METHOD STUDY

Method Study as the name implies is the study of the method employed and through such a study it is always possible to find a better way, for there is nothing so good that cannot be done better.

Method Study essentially is a science derived from commonsense, which can be applied alike in a factory or an office, in a small or large establishment, in a backward or a modern industry. Method Study, for instance, teaches the elementary axioms that by performing work with both hands instead of by one hand only greater production results and that by performing work in bent position the operator is sooner fatigued than in erect position. The principles of Method Study are thus already largely known to many, but the value of Method Study lies in its method of approach. Method Study takes nothing for granted. It does not accept the traditional "we always did it this way";

it is not content with a brainwave "That's a first-class idea!"; it only believes in detailed questioning, critical and demanding, and the answers through an analysis lead to a better method.

AIMS OF METHOD STUDY

Method Study recognises the following five principal factors, which contribute to production and endeavours to get the highest productivity from each within its capacity:

- (1) Man
- (2) Machine
- (3) Operation
- (4) Tools and
- (5) Transport

(1) *Man*: The capacity of an operator can broadly be divided into mental and physical and it is obvious that if a large amount of thinking is involved in an operation the output is low. Therefore, every complicated operation is broken down (not necessarily the most elementary as repetitive work of too elementary operations can have adverse effects on the operator) but to an optimum stage so that with reduced effort in thinking, the output is increased.

As the second step all unnecessary body movements are eliminated so that physical energy is conserved and directed towards useful work. Thus, without imposing any additional strain on a normal operator higher production can be expected. For this purpose, Method Study has listed out five basic movements—

- (1) Finger movement
- (2) Wrist movement
- (3) Elbow movement
- (4) Shoulder movement
- (5) Waist movement

The swiftness of executing each of the above movements, is in the order stated, commencing with the finger movement as the maximum, and the energy expended is also in the same order but with finger

movement as the minimum. Method Study therefore aims at reducing the movements to the fastest possible and the least energy consuming.

Again in respect of arm movements the following principles are followed to get the maximum production with least strain on the operator (See Fig. 1).

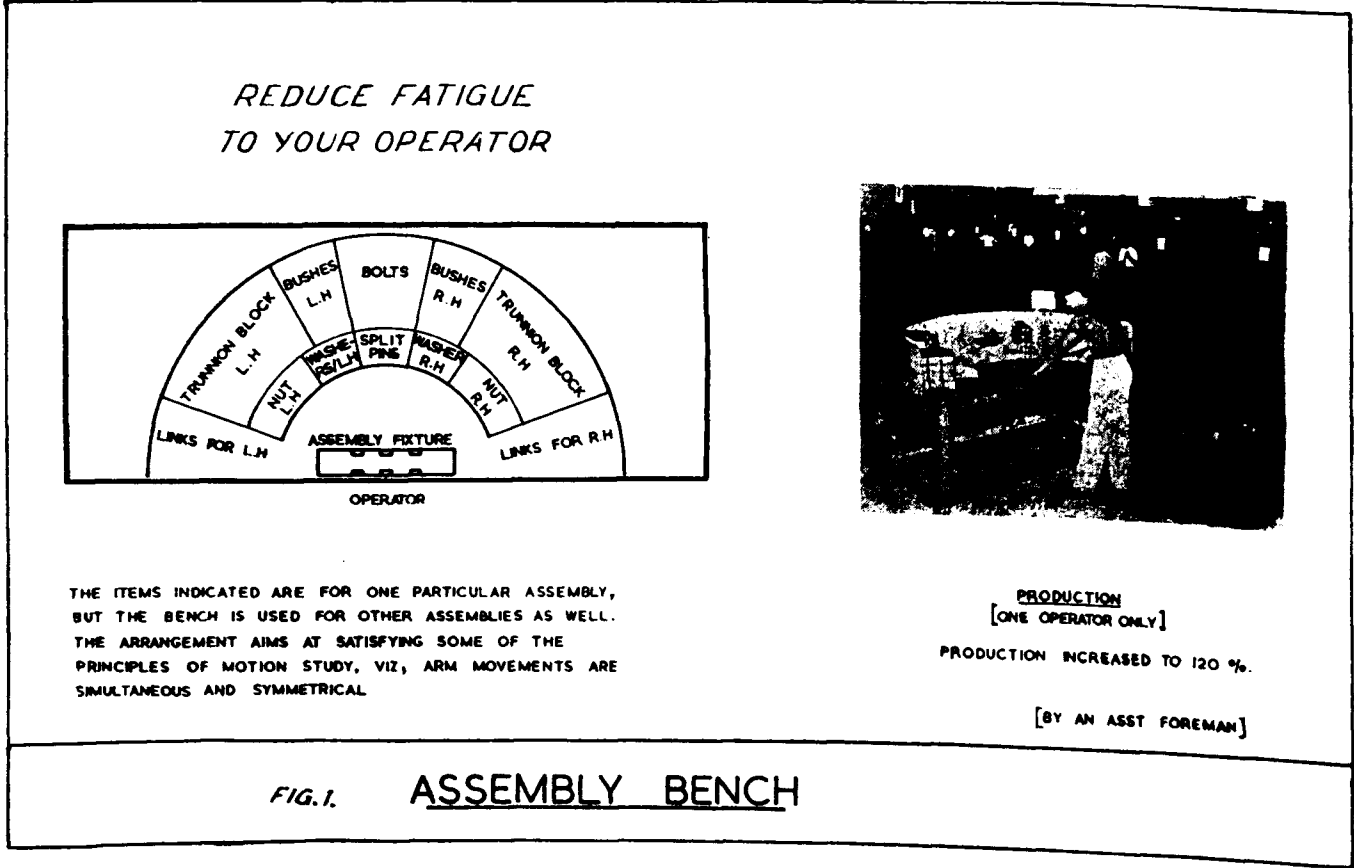
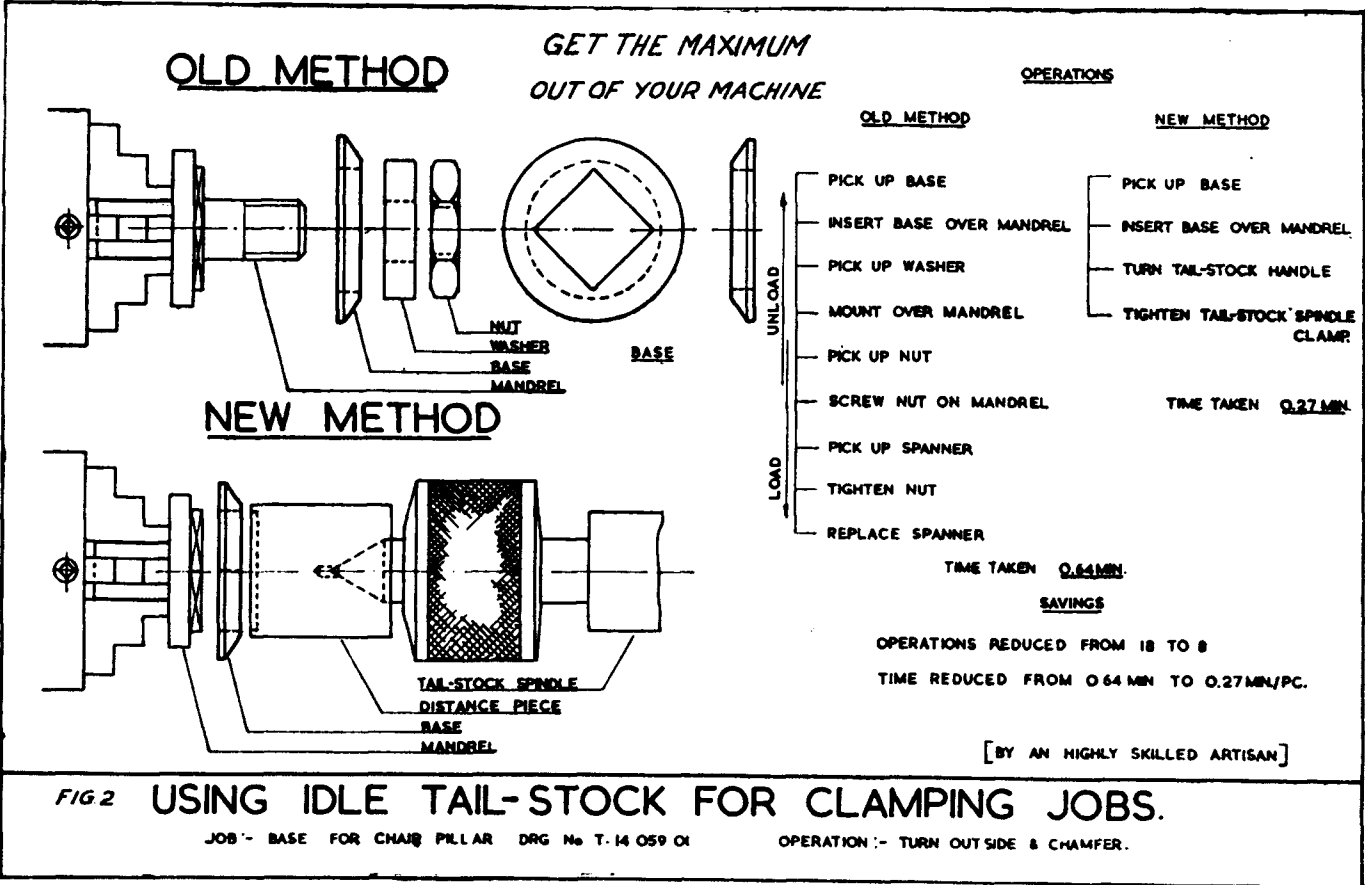
- (1) Begin and end each movement simultaneously with both hands.
- (2) Use simultaneous arm motions in opposite and symmetrical directions.
- (3) Keep motion path within normal working area.
- (4) Avoid operations above shoulder level.

The feet and legs of an operator can also be used to assist the hands and arms. In a primitive way, the street cobbler adopts this principle and while squatting on the ground holds the job between his feet and uses both his hands for passing the thread through. In a

slightly advanced fashion the shop tailor operates his sewing machine with his feet and frees both his hands for guiding the cloth through the machine. In manufacturing operations similarly it is possible to co-ordinate the movements of the feet with the hands and with a little practice all four limbs can be brought into play either simultaneously or in sequence.

A further aspect that is examined is the posture the operator: the more comfortable it is, the less the fatigue and higher the production. Method Study, therefore, prefers sitting to standing, and upright working to bending. Specialised study has even been made to provide the operator with a seat that is best suited to the operations. It will be seen that in all the above principles, the ultimate aim is comfort to the operator, so that even without imposing any additional strain on him more can be produced.

(2) *Machine*: Method Study does not aim at the installation of new machines as its first objective, but instead endeavours to utilise the existing equipment to its maximum capacity. Each machine is defined by



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its size, horse-power and accuracy and the points, which have therefore to be satisfied are :—

- (c) Can the operation be combined with any other operation? (See Fig. 3)

(4) **Tools:** Tools may be categorised as cutting tools or hand tools. In the former case the following points are examined :

- (a) Is the tool steel used for the cutting, the best under the circumstances; high carbon steel can be replaced with High speed steel and even more efficient cutting materials are the Tungsten Carbide (400 ft./min) and Cemented Oxide (7000 ft./min).

- (b) Is the Tool design satisfactory, that is, are the cutting angles and clearances correctly provided?

- (c) Is the tool correctly positioned with respect to the job?

- (d) Has sufficient support been provided to the cutting edge of the tool?

- (e) Can the tool clamping arrangement be

- (a) Is the machine in use the most appropriate for the operation?

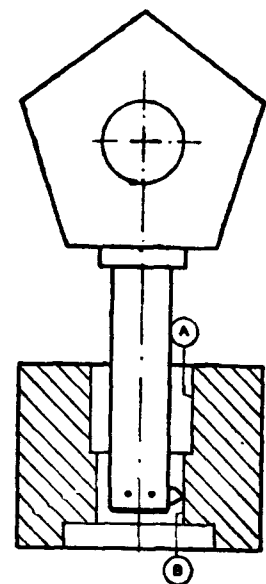
- (b) Is the machine being used to its maximum with regard to its size, accuracy and power?

- (c) Are the fittings and accessories on the machine being utilised to maximum advantage (See Fig. 2)

(3) **Operation:** Here, the Method Study asks :

- (a) Is the operation necessary at all?

- (b) Is there an alternative and more advantageous form of carrying out the same operation? For example, forging may eliminate machining, blanking may replace gas cutting, semi-automatic lathe-production may be more advantageous than Centre Lathe.



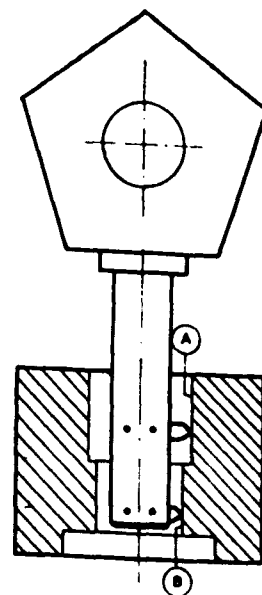
THIS IS A BORING OPERATION PERFORMED ON A VERTICAL TURRET LATHE.

ACCORDING TO THE ORIGINAL METHOD SURFACES (A) AND (B) WERE BEING MACHINED AS TWO DIFFERENT OPERATIONS.

ACCORDING TO THE IMPROVED METHOD (MODIFIED TOOL HOLDER) SURFACE (B) IS BORED SIMULTANEOUSLY WITH (A)

SAVINGS

TIME PER PIECE REDUCED FROM 18.38 MIN. TO 10.31 MIN



(BY. A CHARGEMAN)

FIG 3 COMBINING OF OPERATIONS

improved to reduce time and effort of the operator.

In regard to hand tools, it is essential that the most appropriate are used, being neither too large nor too small and being the most efficient in regard to time and effort. The location of tools is also important so that the operator may reach them without strain or loss of time. Where they are heavy they can also be balanced to relieve the operator of the weight.

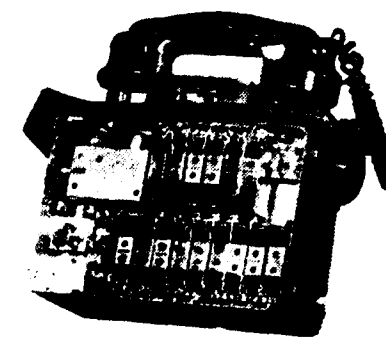
(5) **Transport:** This is an item, which lends itself to a great economy through method study since its inefficiency is not readily noticeable. Transport may involve movement of materials from one work place to another or at the workspot itself i. e., from the in-tray to the bench or machine table and back to the out-tray.

For studying any particular case, where the materials move from one place to another, a work flow chart is prepared using either string or line diagrams: the work places through which the job flows are plotted to scale on a paper and the path

followed by the job is represented by means of a string or line. A study of the diagram would reveal whether the path is unidirectional, whether there are unnecessary cross movements and whether the path is too long. It may then be possible to re-route the job to other close-by machines so that transport is reduced and economy achieved. In some cases it may even be advantageous to relocate a work place for this purpose, no doubt taking into account all other jobs also which flow through the same work place. When the transport distance of a single item is considerable or the job is heavy it may be economical to set up an exclusive "belt" otherwise termed a 'Product line'. Several such belts have been organised in the Integral Coach Factory (see Fig. 4) based on the work flow charts and considerable economies effected.

In regard to transport at the work spot itself, it is essential that both the in-tray and out-tray are conveniently located to the operator so that he does not have to strain himself by walking, bending or stretching. A principle of motion economy applicable in this case is to adopt slide motion, avoiding pick up and

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THIS "BELT" WAS SETUP AS A RESULT OF A STRING DIAGRAM WHICH INDICATED THE WORK FLOW.

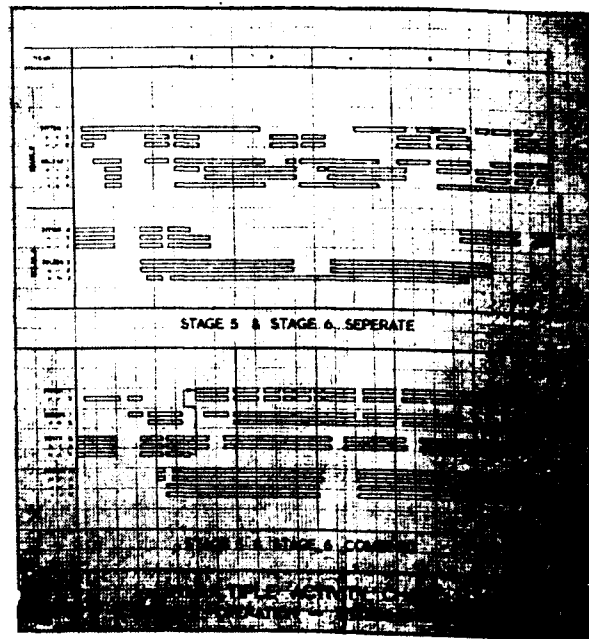


FIG. 4. A BELT FOR AXLE BOX MACHINING.

carry. To relieve further strain on the operator gravity chutes may be installed both for feeding the job to the work-place as well as disposing of the finished piece into the out-tray.

The first objective of Method Study is to get the maximum with the available facilities, and only as the second does it suggest new equipment, here again aiming to get the desired result with the minimum equipment. This applies to machine, tool, transport and all else.

Organisation : In the I.C.F. a separate Work Study Department has been created within which a section is devoting its time to method improvements. In addition to the examples already given a multiple activity chart prepared by it is shown in Fig. 5, by means of which it was possible to increase the activity ratio from 55.5% to 73%. Some officers and staff have received training in Method Study and it is programmed to enlarge this nucleus through inplant instruction. Besides, improvements by shop staff have been encouraged through the suggestion scheme, and prizes have been awarded to good ideas. A section of the staff have also carried out method improvements in their own sections and work places without looking



for any material benefits. In fact, some of the examples quoted in this article have been taken from ideas initiated by such staff.

That Method Study increases the working efficiency and decreases costs is never a point in doubt, but

some hold the view that it is a part of production planning and there is no need for a separate Method Study organisation. In a very general way, this opinion is correct but just as production planning has been separated from Works Management for increasing the efficiency of an organisation, so also should Work Study be separated from Production Planning. This does not mean that the Work Study Department alone should deal with Method Improvements, but it will be able to bestow full time attention on problems and achieve results through a systematic approach. The Work Study Department will also be responsible for creating method study consciousness amongst all staff, since, the best and quickest improvements can be achieved only if every single individual in the organisation devotes some of his time and thought to Method Improvements.

U.S. Locomotive Builder Announces Changes

The General Electric (U.S.A.) Locomotive & Car Equipment Department, one of the major manufacturers diesel-electric locomotives for Asian railroads, recently announced the appointment of Joseph T. Bailey as Manager of its Locomotive Section

At the same time, Frank A. Compton, Jr., was named to the newly created post of Manager of Locomotive Engineering.

Wilson also announced that the firm's Mining and Industrial Locomotive Subsection was being more fully integrated into the Locomotive Section. Mr. W. Speicher, the former Manager, has been named Manager of the Locomotive Engine Sub-section, succeeding the late J.C. Rhoads.

Locomotives made by General Electric are in wide use throughout Asian countries. A large fleet of diesel-electrics is operating in the Philippines where it has been responsible for a revitalization of the country's rail system. Other countries in which G-E locomotives are operating include Indonesia, India and Pakistan.

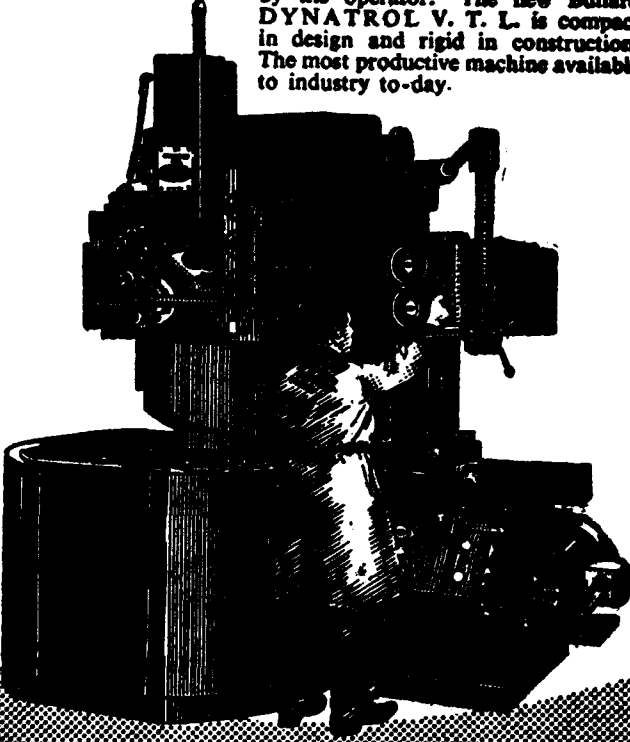
General Electric has also been a major supplier of locomotive for Latin American countries and the Union of South Africa.



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Train Lighting of Integral Coaches as Furnished in the Integral Coach Factory

By D. R. Naha

District Electrical Engineer, Integral Coach Factory, Perambur

THE Integral Coach Factory was designed to manufacture passenger coach shells of the Integral design and the intention was that the furnishing work would be economically distributed over the existing Railway Carriage Workshops. With the ever increasing traffic demand for more coaching stock, it was not possible to spare any of the coach building capacity of Railway Workshops for furnishing all Integral coaches. Hence, interior furnishing and provision of lights and fans in shell coaches is undertaken by the I. C. F. Furnishing Annexe, south of Shell Factory.

Electric lighting of coaches on trains was introduced in England in 1894 by employing axle driven Dynamo which is still the basic system in general use to-day all over the world. Electric lighting of coaches was first introduced in our country in 1920 with individual equipment. Block system of train lighting with axle driven generator and double battery equipment is adopted on the Indian Railways. Tourist cars, Inspection Coaches, Postal Vans, Air-Conditioned coaches and Restaurant cars have their independent train lighting equipments with straight through wiring.

The Train Lighting of the Integral Coach employs the 24-Volts, double battery system. With this system, the battery is divided into two sections, one section is being charged from the Dynamo whilst the other floats at the requisite voltage for lighting and fan loads. In recent days there has been considerable increase of amenities to passengers and thereby heavier and variable electric load have to be catered. The third brush generator in combination with controlling equipment combines the functions of automatically controlling generator output lamp voltage and precludes battery over-charging.

The Generator is a shunt-wound, totally enclosed, variable speed, reversible machine of 24/32 volts, 100 amps. capacity specially designed to operate on Railway Carriage underframe and driven from one of the axles, is of rigid construction and of minimum weight

and bulk, besides being vibration and shock proof and weather proof. The Generator when connected to the battery has inherent self-regulating properties due to the provision of the third brush. The out-put of the generator is at its maximum at low speeds and it drops at high speeds. The phenomenon is particularly valuable for both slow and express services (i. e) the battery charge in ampere hours over a given period is approximately same for either type of service. The brush gear of the Generator is designed with an automatic pole changing device to ensure constant terminal polarity of the Generator with relation to rotation.

Each of the two batteries comprises of 12 lead acid cells of 300 ampere hours capacity, iron clad type housed in metallic battery boxes suspended from the underframe. The cells are of special design to withstand the hazardous duty in moving coaches. The batteries are charged alternatively by the Generator by the function of the battery change-over mechanism which is incorporated in the auto cut-in and cut-out switch. Generally, in the Train Lighting shops of the Indian Railways, motor Generator sets are installed for charging batteries. Metal rectifiers of modern design with all facilities for smooth charging and fine adjustments (Fig. A) are installed in Integral Coach Factory for charging batteries with a view to conserve space.



Fig. A

for
skilled
hands
A POWERFUL
TOOL!



....Small and seemingly insignificant, yet packed with tremendous power....so indispensable in converting masses of metal into bridges and structures, ships, and locomotives, rails, rolling stock and automobiles, pipelines and penstocks, blast furnaces, industrial plantsthe silent builder whose influence permeates the entire fabric of our growing industry.

Ranking in importance with power and fuel, the arc welding electrode is a vital and flexible tool for industry.

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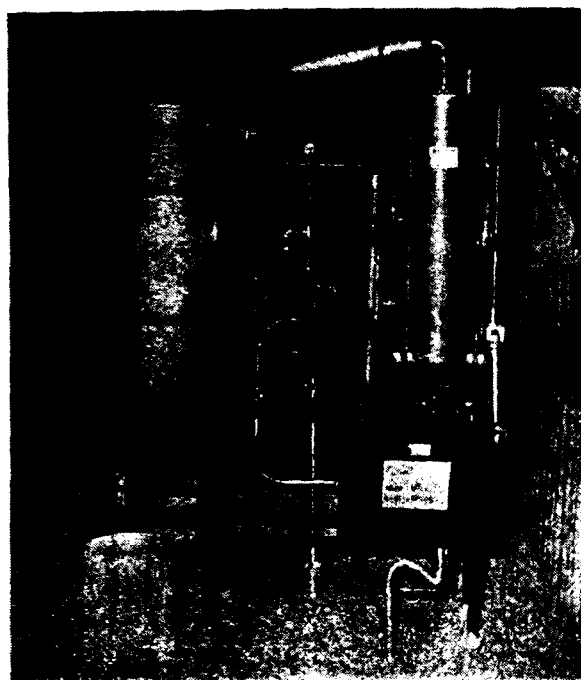


Fig. B

Electrically operated Water Distilling plants are installed (Fig. B) in the Train Lighting Shop for distilled water required for the preparation of electrolyte to guard against contamination and to conserve space as against the out-moded coal fired Distilling plants with elaborate arrangements adopted in the Train Lighting Shops.

A combined over-charge and over-voltage relay is provided on the Switch Panel suspended from underframe. The over-charge relay obviates over-charging of the battery from the dynamo circuit and reconnects the same when the voltage of the battery falls below pre-set value, generally set at 29 volts. The over-voltage relay usually set at a higher value—say 40 volts—is intended to isolate the dynamo from the battery circuit in the event of any undue rise in the generator voltage. This protects the armature, field coils, etc., from over heating and consequent damages.

A magnetic load switch which is mounted on the Switch Panel controls the operation of fans and lights in the coach. The load switch is controlled by the Three-Push Button control switch fitted at one end of the coach externally to operate fans and lights in an individual coach by the Guard of the train. Fans and lights for use by night or fans only for use by Day and OFF can be operated by the operation of the three-push button control switch provided in the

Guard's compartment which operates all the magnetic load switches throughout the train. Every fully equipped feeder coach is provided with one three-push button switch.

The lamp resistance mounted behind the switch panel of the coach is intended to regulate the lamp voltage. The Resistance comes into circuit only when the fans and lights are switched ON and automatically shunted when the fans and lights are OFF so that both the batteries get discharged in parallel.

A combined auto cut-in and cut-out switch is mounted on the Switch panel and incorporates also a battery change over mechanism. This gear controls supply from the Dynamos to the batteries.

The wiring of the coach can be divided into three sections :—

- (1) Main Roof wiring from 24 Way fuse and junction box to 15 way link junction box with connected branch wiring for the control of fans and lights.
- (2) Wiring to inter-vehicle coupler male and female.
- (3) Underframe wiring.

Main Roof Wiring: This comprises of 5 Mains and 4 auxiliary mains. The 5 Mains are intended for Block-Rake system of working. The auxiliary mains are intended for the operation of equipment in that particular coach only.

Inter-vehicle Coupler: This wiring is provided at the two end walls of the coach and are intended in conjunction with the couplers for Block-Rake operation.

Underframe Wiring: This comprises of all wiring between the Generator, control gears and batteries which finally terminates at the 24 way fuse and junction box.

The fittings provided in the Integral coach of various types are of the latest design. The external lights are automatically controlled through auto Cut-in and Cut-out switch, so that the lights are ON when the train is slow or at stand still and go OFF when the train picks up speed of 12 to 15 miles per hour. These lights assist in lighting up of platforms that are not electrified and also serve as external illumination of the coach and light the vicinity of the train when stops between stations for signals, etc., and also helps in



Fig. C

security measures. An interior view of a Third Class Sleeper coach can be seen at Fig. 'C'.

The wiring of the Integral coach which is all steel requires suitable modification over the system employed in the conventional timber-bodied coaches. Special care is taken to see that all cables are completely isolated from metal work. The Roof Mains are

run in the centre of the coach from end to end and suitably cleated and encased. The branch wiring to the fan and light points are suitably clipped to the timber car lines. The wiring between the junction boxes and inter-vehicle couplers is run through G. I. pipes suitably bushed.

Dis-similar to the usual practice of running underframe wiring on wooden cleats, the wiring in the underframe of shell coaches is taken in steel conduit with necessary inspection boxes, etc., and terminated in the Switch Panel on the underframe. This has the advantage of eliminating pilferages of cables on the underframe, as experienced on coaches wired otherwise.

This Factory is at present engaged in the manufacture and furnishing of Third Class, Third Class Sleepers and Guards Compartment with Third Class coaches. The furnishing of First Class coach has just been taken up.

The furnishing and provision of electric lights and fans in the Integral shell coaches manufactured in the Integral Coach Factory was started in May, 1957. It is proposed to furnish 300 First Class coaches during 1961—62 and 350 First Class coaches during 1962—63 under Third Five-Year Plan. It is also anticipated that the furnishing of Upper Class, Electrical Multiple Units will also follow in the years to come by, which time with the wide experience gained on Train Lighting and Furnishing, further advancement is expected to be achieved.

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Signature of Publisher

India's Bid for Export of Railway Coaches

By K. Swarup,

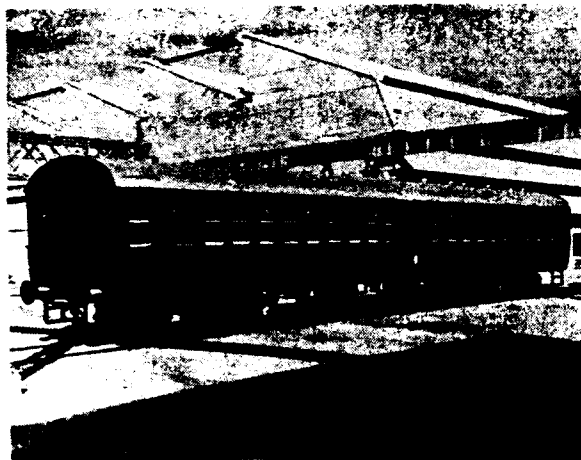
(Chief Administrative Officer, Integral Coach Factory, Madras.)

A couple of years ago India was importing Railway Coaches and Underframes from abroad. Immediately after Independence, in the year 1948, the Railway Board in its effort to achieve self-sufficiency in the matter of rolling stock decided to put up a new factory for manufacture of passenger coaches in India. The Integral Coach Factory at Madras was thus set up as a commitment under India's First Five-Year Plan at a project cost of Rs. 7.35 crores. The production in this factory was inaugurated by Shri Jawaharlal Nehru, Prime Minister of India, on an auspicious day, October 2, 1955, the Birthday of Mahatma Gandhi. The progress made by this factory during the last 5 years has been phenomenal and in the 5th production year (October 1959—September 1960) it has produced 502 coaches as against the full production target of 350 coaches according to the Supplemental Technical Aid Agreement of 1953 between the Government of India and the Swiss Collaborators.

TYPE OF COACH

The Integral Coach Factory produces light-weight all-welded steel coaches which have been accepted as the most modern even in the European countries. The advantages of these coaches are :

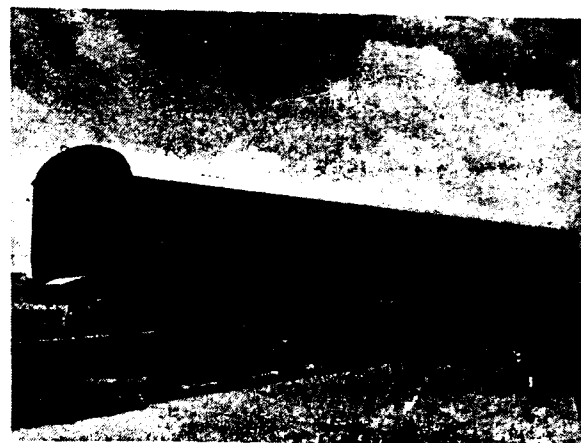
- (i) The light-weight coach has better riding qualities due to unsprung weights having



A T type of integral coach built at ICF

been reduced to the minimum. This factor also means that the wear and tear on the track will be much less than that in the case of the conventional coach.

- (ii) The operating costs of hauling a light-weight coach are much less.



A Third Class Sleeper Coach built at ICF

- (iii) The coach possess an extraordinary high compression rigidity, particularly over the entire length of the passenger compartment. This feature ensures greater protection in case of accidents, which is still further increased by the fact that the end sections where the lavatories are located possess lower compression rigidity. In the case of accidents these end sections will absorb most of the collision energy and be destroyed first.

- (iv) The stability of the coach has been considerably increased due to use of well-curved roofs to lower the point of application of the wind pressure.

DIVERSIFIED PRODUCTION

When setting up this Factory original ideas were that only one type of coach shell would be produced

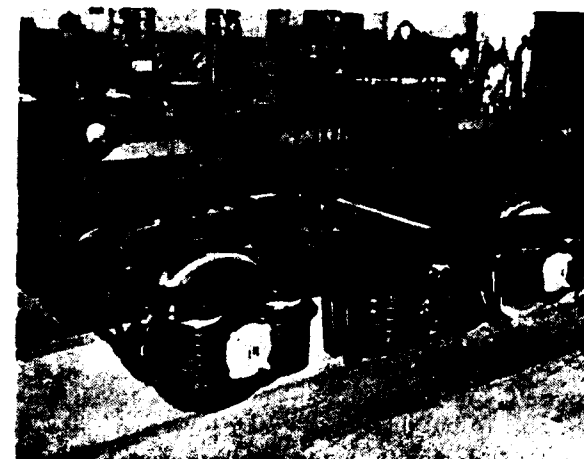
and this would be furnished to the individual requirements of First, Second and Third Class Travel. With the gradual progress in the country this idea however could not be pursued. To provide better and varying standards of amenities and comforts different types of shells had to be designed e. g. First Class, Third Class, Third Class Sleepers and



A TLR type of integral coach built at ICF

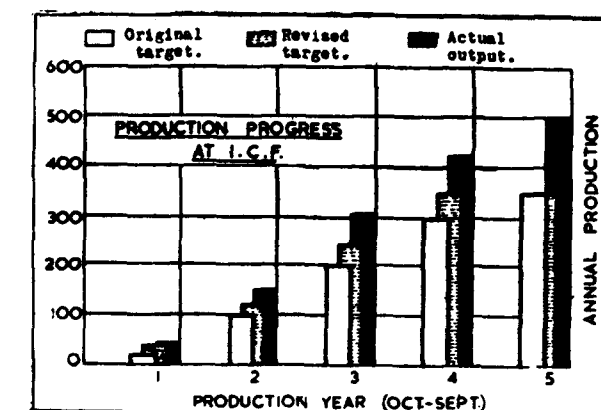
composite Third Class-cum-Luggage & Brake Vans (TLR) etc. In the last 5 years I. C. F. has geared up to design all these types of coach shells and has already produced third class, third class sleeper and TLR coaches in large numbers. The first class coaches are now under production and it is expected that the turnout of fully furnished first class coaches will commence early next year.

The latest all-coil spring bogies with loads on the side bearers instead of on the centre pivot has also been developed in this factory. According to



The latest all-coiled spring bogie

the reports from the International Railway Congress Association these types of bogies have been reckoned to be better in riding and provide more comfort to the passengers. I. C. F. has designed and produced special bogies for the Refrigerator Fish Vans and also for the high speed deluxe trains.



For the requirements of Metre Gauge coaches setting up of a separate factory in the North was under active consideration of the Ministry of Railways. But with the increased productivity from this factory it has now been decided that I. C. F. will produce also the Metre Gauge coaches required for the Indian Railways. I. C. F. is also working on the plans to manufacture A. C. Electric Multiple Unit (EMU) stock required for the Railway Electrification Scheme in Calcutta area. Both motor units and train units are to be produced in collaboration with A. E. I. who will supply the electrical equipment of such type that will be produced eventually in the country at Heavy Electrical Project in Bhopal.

During the Third Plan period I. C. F. has production programme for a total of 3735 coaches for the Indian Railways as given below :

Type	Gauge	No. of coaches
T	BG & MG	1221
TLR	BG	235
F	BG	462
FT	BG	592
Motor Van	MG	73
Motor & Parcel Van	MG	343
EMU	BG	612
Diesel Rail Cars	BG, MG & NG	197
Total during III Plan		3735

With such diversified production I. C. F. is gaining considerable knowledge and experience towards producing the best among coaches required not only in India but also for the export market.

EXPORT OF COACHES

The Government of India and the Ministry of Railways have been very keen to develop export market for Railway Rolling Stock i. e. steam locomotives, coaches, wagons etc. The capacity for manufacturing coaches in the country is now established as follows:—

I. C. F.	700
H. A. L.	300
Jessops	300 plus 70-75 electric multiple unit stock.

This capacity make us not only self-sufficient for our internal requirements but also enable us to develop export markets for our coaches. Our unit production costs are very competitive and the quality is of a very high standard. The first attempt in export of our coaches made against the tender for supply of coaches required by Pakistan. These tenders were opened on 28.7.60 and it is a matter of great satisfaction to say that the quotation from India for 60 metre Gauge coaches was the lowest among 7 countries that participated in this Global Tender. In the case of Broad Gauge coaches we were slightly higher than the lowest Japanese quotation due to the fact that several new features, of which we had little experience, were incorporated in the Pakistan specifications.

320,000 KW TURBOGENERATOR

The construction of the first 320,000 kilowatt turbo-generator has been completed on the threshold of the third year of the Seven-Year Plan by the Kirov "Elektrosila" Works in Leningrad.

Our new generator, TASS was told by the chief designer of the plant Nikolai Ivanov, will be installed together with the turbine built by the Leningrad Metal Works at the Cherepets district power station of the Moscow grid where Soviet turbogenerators of 150,000 kilowatt each have been operating long since.

The new generator which is twice as powerful as the 150,000 kilowatt units is no bigger or heavier than them. The doubling of the capacity of the unit without increasing its dimensions has been assured by the use of a combined system of cooling of the electric

Delegations have had gone to Ceylon and Argentina to develop export markets for Railway Rolling Stock in these countries. Argentina has published a tender for supply of 300 coaches and against this I. C. F. has quoted for 170 coaches. These tenders are due to open on the 14th December, 1960. The Ceylon Government Railways are also interested in our coaches and we are awaiting their tenders which have yet to be advertised by them.

In the short span of 5 years the I. C. F. has not only increased its production but has also been able to compete successfully in the world market. This establishes beyond doubt that given requisite facilities our public sector industries in Indian can come up to the high standards expected of them to bring India in competition with highly developed countries.

DEDICATION

All the workers at I. C. F. from the highest rank to the lowest in the ladder are dedicated to give their best in the industrialisation of the country and towards raising the standards of living in India. A feeling of oneness—feeling that the workers are the owners of this factory, prevails at I. C. F. and it is this teamspirit that has been mainly responsible for the unique progress of this factory.

I. C. F. has now about 7,000 workers on its rolls and they all take pride in working at this factory and keeping it clean. The factory layout, the production flow, the skill of our workmen and the cleanliness all round in this factory are admired by all people of this country and from abroad while visiting I. C. F.

windings: the stator windings are cooled with water and the rotor windings with hydrogen at increased pressure.

During the first years of the Seven-Year Plan the plant has launched serial production of 165,000 and 200,000 kilowatt turbogenerators with a similar cooling system.

On the drawing board now is a 500,000 kilowatt unit which estimatedly will weigh only 50 tons more than the 320,000 kilowatt generator.

As a result of the use of such big units, Nikolai Ivanov said concluding the interview, the Soviet Union will be able to build great thermal power plants even more quickly and with a considerable saving of metal, construction materials and money.

Picture Story of Integral Coach Factory

By Shri K. T. Jethmalani

Secretary to the Chief Administrative Officer,
Integral Coach Factory, Perambur

THE State-owned Integral Coach Factory located at Perambur—5 miles from Madras, is one of the largest coach building units in the world. As a commitment under India's first five-year plan,

the shell unit of this factory was set up with a project cost of Rs. 7½ crores to achieve self-sufficiency in matter of passenger coaches for the Indian Railways:



The construction work on the project started with pile foundations in February, 1952.



The first machine was installed by Shri Lal Bahadur Sastri, the then Minister for Railways, on 20-1-1955.



It soon gained momentum and the work was in full swing in September, 1952.



Project thereafter took shape with the completion of the factory.



for
SELF SUFFICIENCY
and now
towards
HIGHER PRODUCTIVITY

Production from I C F has now reached the satisfactory figure of 600 coaches per annum and is still going up.

Besides meeting requirements of conventional coaching stock I C F should soon be producing Electric multiple unit stock and Diesel Rail Cars to cater for faster trains. Export markets to earn valuable foreign exchange also being tapped.

OUR MOTTO IS TO SERVE YOU
INTEGRAL COACH FACTORY
MADRAS - INDIA



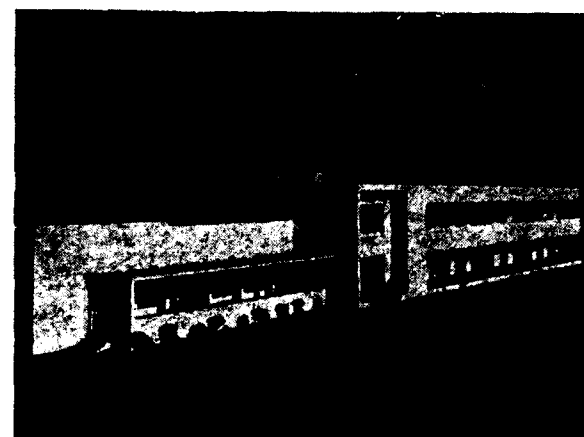
Equipped with, Modern machine tools—



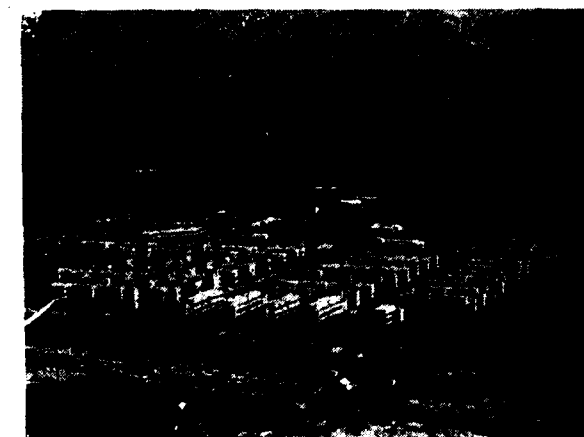
Electric welding machines.



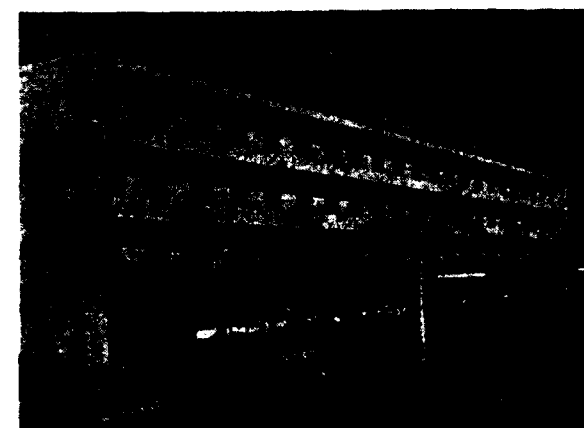
Jigs & Fixtures for uniflow production of all-welded light-weight steel coaches.



The project also consisted of the Technical Training School.



Staff Colony etc.



The Administrative Office



The production was inaugurated by Shri Jawaharlal Nehru, Prime Minister of India on an auspicious Mahatma Gandhi's Birthday—2nd Oct. 1955.

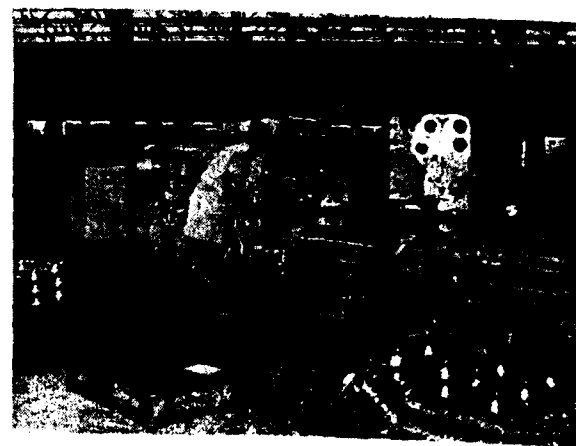


Canteens

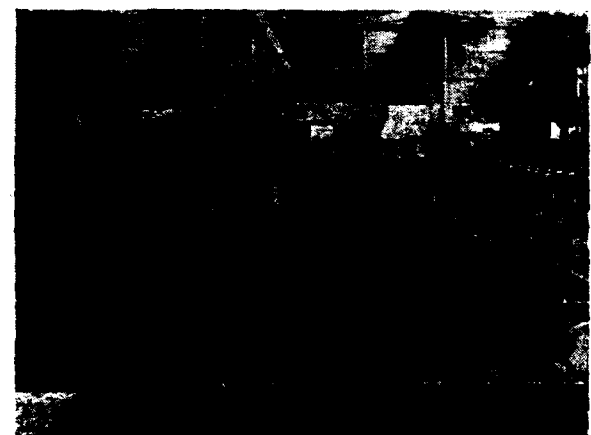
Starting humbly with the assembly of coach shells with imported components from Switzerland, the factory took up simultaneously manufacture of Integral Coaches from the raw material stage. This process of manufacture consists of :



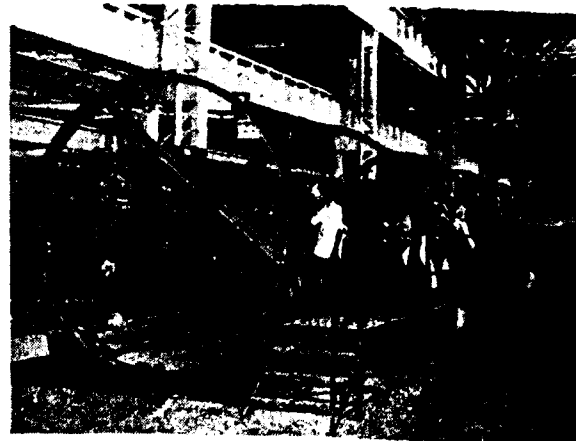
Processing of steel sheets and plates



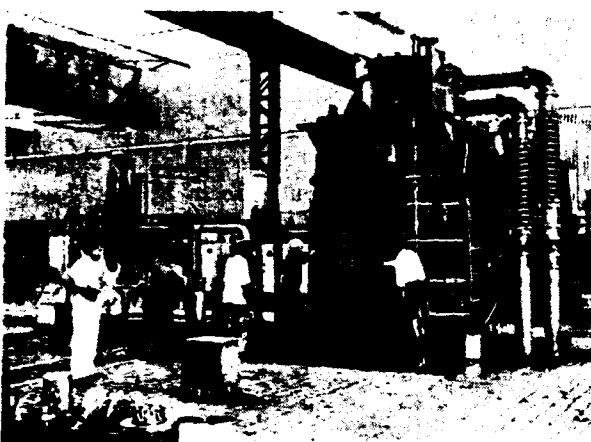
and their machining.



and their assembly by welding.



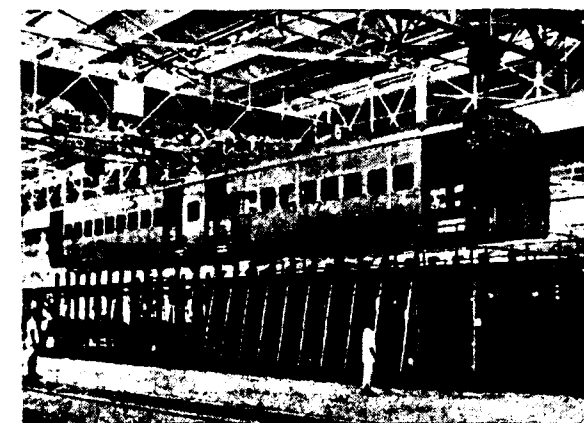
All components are then fed into the Main Assembly Shop where roof is assembled in the roof jig



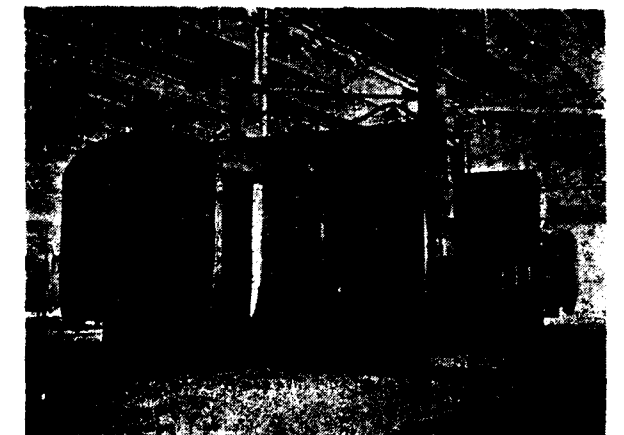
Forging of components from steel sections,



Assembly of underframe is next stage



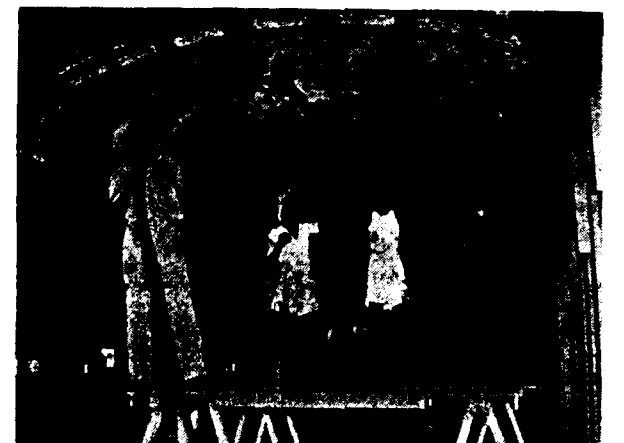
And thereafter the complete body is welded together in the Main Assembly Jig.



In the final finishing shop before painting the exterior surface of the coach body is thoroughly cleaned by grit blasting.



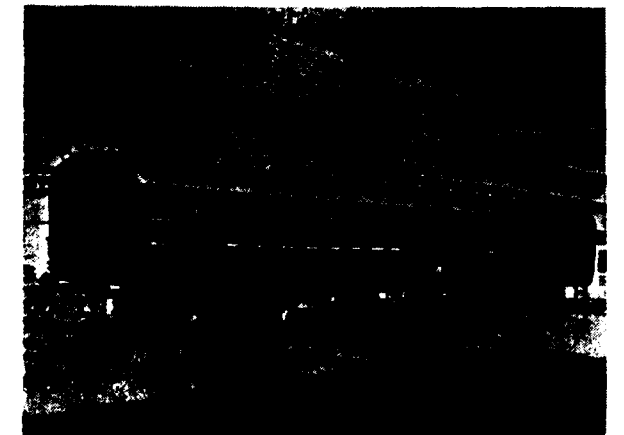
Bogies are manufactured separately



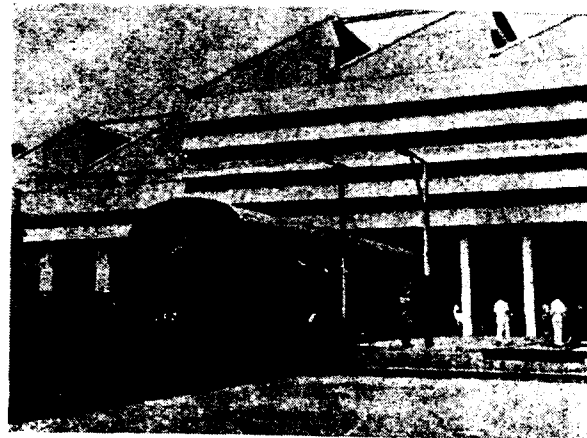
The interior surface of the coach is sprayed with asbestos to make it heat and sound proof.



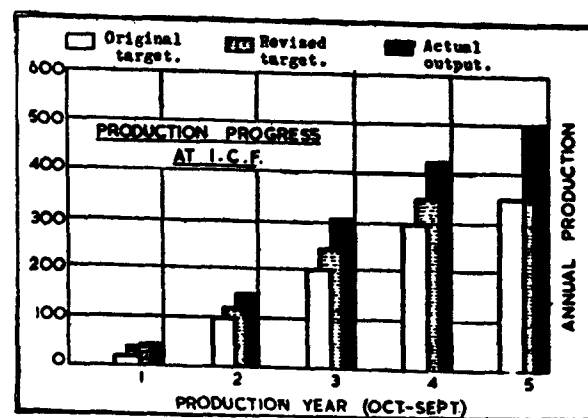
And each completed bogie is given a load test to ensure its smooth running and riding comforts.



The completed coach shell with body and bogies joined together is thereafter made ready for despatch.



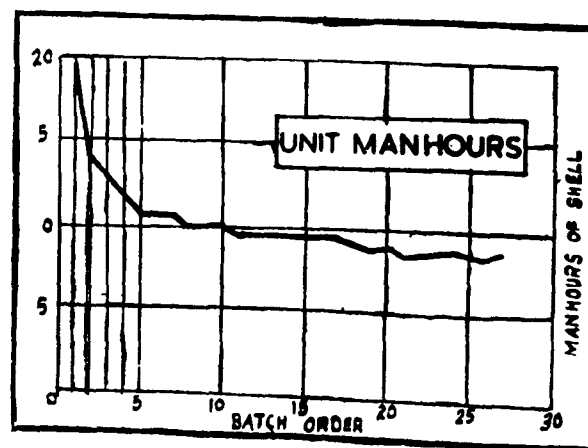
The first such coach produced completely at I. C. F.



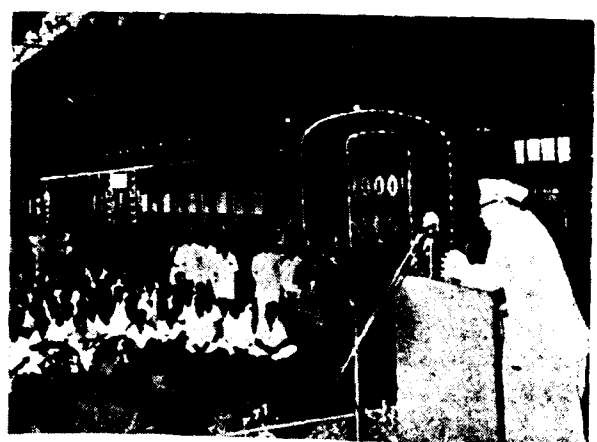
The factory has repeatedly beaten its production targets.



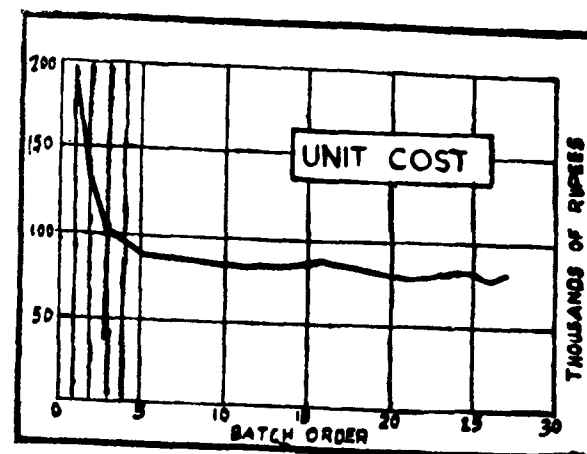
was turned out by President Rajendra Prasad, on 14-8-1956



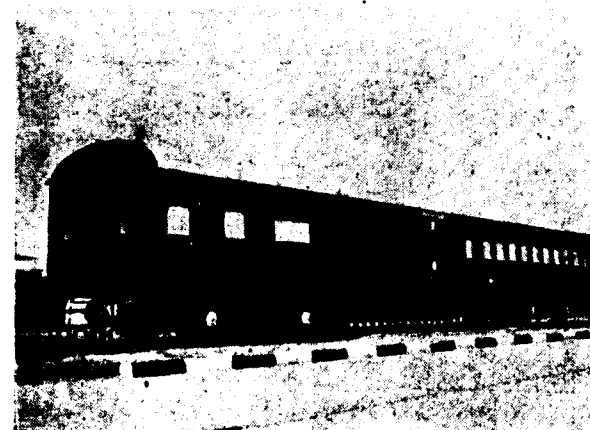
At the same time the unit manhours



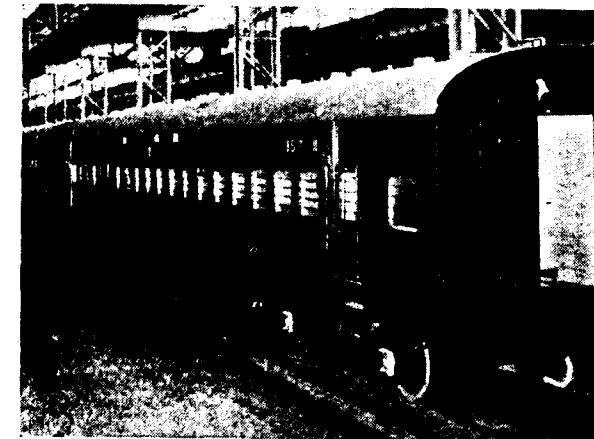
The 1000th Coach was ceremoniously launched on 22nd January, 1960 by Shri S. V. Ramaswamy, Deputy Minister for Railways.



As well as cost of production have come down steadily, the present manufacturing cost at I.C.F. being less than half the cost of similar imported coach.



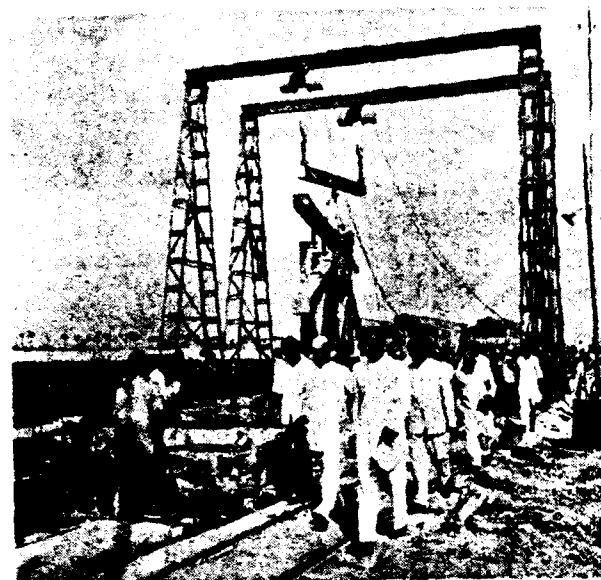
Apart from increase in production the factory has also diversified its manufacturing activities and has built other types of coaches like Passenger-cum-luggage vans.



Third Class Sleeping Cars and is now geared up to build any type of coach for any gauge to suit any particular specification.

FOR GREATER SAFETY

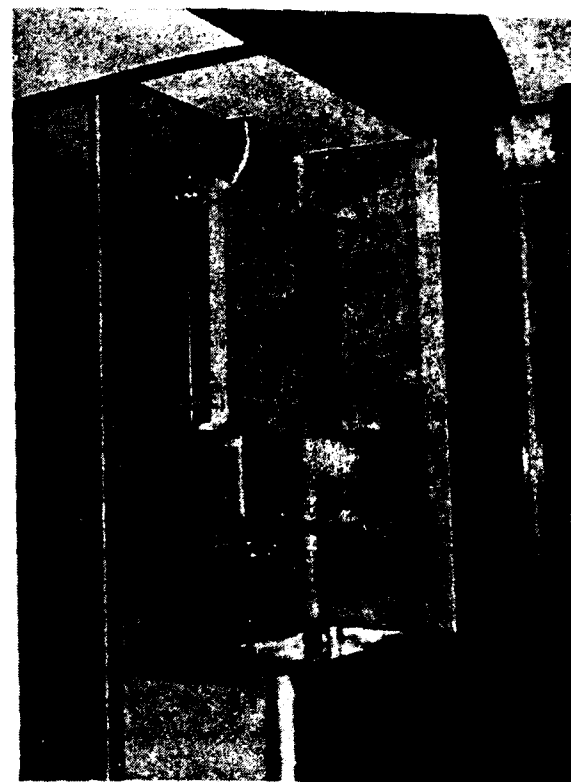
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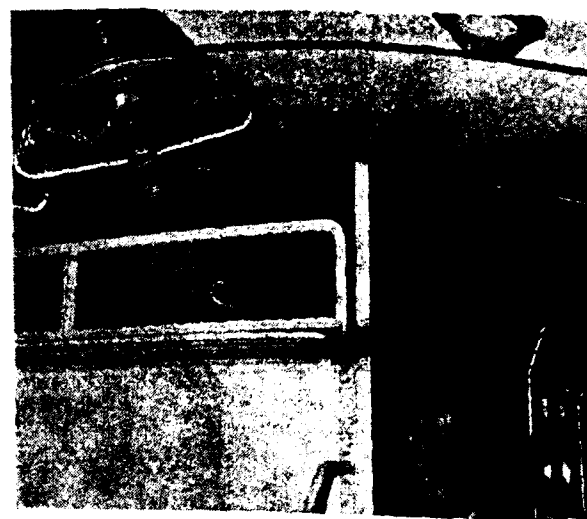
A furnishing annexe is also being set up at I. C. F. to enable fully furnished coaches ready for passenger traffic being turned out in the shortest possible time and with maximum efficiency and economy. The work for this Furnishing annexe, with a project cost of Rs. 3.7 crores, is in hand and is expected to be completed in the earlier part of the Third plan period.



In the meanwhile, by providing temporary furnishing facilities Interior furnishing of coaches with seating arrangement.



Passenger amenity fittings.



Train lighting equipment etc., is being done at I. C. F. for about 50% of the coaches produced in the Shell Unit.

Having attained self-sufficiency in matter of passenger coaches for the Indian Railways, the Integral Coach Factory is now looking forward to build coaches for the Export Market.

What Rumania can offer from among the Range of Rumanian Rolling Stock Exports

By An Engineering Correspondent

MULTIPLE-UNIT RAILCAR TRAIN

THE rapid development of the machine building industry of the Rumanian People's Republic led to the manufacture of certain multiple-unit railcar trains of increased speed capacity, with electric transmission and automatic controls, ensuring faultless operation. Such a train is composed of two modern units with 5 axles each, between which 4 trailers with 4 axles each are attached. The maximum speed is of 115 km. p. h.

The mechanical equipment of a railcar consists of: a main 600 HP Diesel engine driving a 400 kW d. c. generator. Traction is achieved by means of two 186 kW electric motors actuating the two end axles of the driving bogies; an auxiliary 120 HP Diesel engine which actuates the auxiliary services (fans, compressors, amplidyne, etc.) The welded, rolled steel body of the railcars and trailers is of partially self-supported design. The front of the railcars is stream-lined to reduce air resistance, while internal and external folding heads are provided between the cars. Thermic and noiseproof installation is provided: cork for the floor, and aluminium



Railcars of Rumanian manufacture.

sheets and mineral wool for the side walls and roof. The inside walls of the compartments and corridors are made of blockboards lined with walnut veneer on the lower part and plastics on the upper part.

The train is divided up as follows: one of the railcar has a 2nd class compartment seating 40 people; of the four trailers, one has nine first class compartments of six seats each, while the others will



Tank cars of Rumanian manufacture.

seat 80 second class passengers each, in two compartments of 24 seats and one of 32 seats. Altogether the train will seat 54 first class and 280 second class passengers.

The multiple-unit railcar train is provided with a modern and varied car heating and ventilation system and with normal and fluorescent lighting.

On request, the internal arrangement may be modified to suit the clients' requirements.

28 TON COVERED FREIGHT CAR ON 2 AXLES, UIC TYPE

A freight car of recent designs which may be used for the transport of grain or of animals. The car is fitted either with mobile shutters or with rings for the straps and sliding racks, according to requirements.

The box is made of a metal frame whose side walls are covered with deal boards 25 mm thick, while the lining of the end walls is 40 mm thick up to 1,486 mm from the floor and 22 mm thick higher up. The side walls are provided with 2 sliding doors and 9 ventilation shutters.



Rumania's industry turning out rolling stock and boasting an old standing production tradition supplies through

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January 1961

THE INDIAN RAILWAY ENGINEER

I.C.F. 31

The metal frame of the roof is likewise covered with deal boards 18 mm thick over which comes sheet metal 0.65 mm thick.

The underframe of welded and riveted construction, rests on 2 axles through the intermediary of 4 leaf springs. The axle box is one solid piece of cast steel sliding between 2 axle-box guides and thus following



Rumanian-made freight cars, type UIC.

the movements of the underframe. Traction is continuous and elastic. The buffers are fitted with 16 ton volute springs.

The freight car is provided with an automatic com-

pressed brake, Hikp type, acting on the 4 wheels through 8 brake shoes.

The car is manufactured in 2 models viz. with or without hand brake; the latter is operated from the brakesman's cabin. The hand brake model is also provided with an emergency brake.

Main characteristics are as follows:

— gauge	1,435 mm
— wheel base	5,700 mm
— serviceable floor surface, approx.	25 m ²
— serviceable volume of car	60 m ³
— real load, evenly distributed	28 tons
on 1.5 m	14 tons
on 3 m	16 tons
— tare weight, approx	12 tons

The clearance gauge complies with RIV standards and the design with UIC prescriptions. The car is approved for a service speed of upto 100 km/h and may negotiate curves of 150 m radius on traffic lines and of 100 m on shunting lines.

U. K.'S STAINLESS STEEL OUTPUT EXPANDS

The United Kingdom produced 220,000 tons of stainless steel last year—nearly five times the 44,300-ton output in 1945.

Announcing this in London, the Stainless Steel Manufacturers' Association says that with the expansion schemes in hand, the industry will produce 280,000 tons a year by 1963.

Stainless steel is being used increasingly in a number of trades and industries. It is exported to India, Canada, South Africa, New Zealand and Australia, although Australia is now producing from home-based plant. Other exports go to Belgium, Switzerland, the Netherlands, and the Scandinavian countries.

In the United Kingdom, bulk users are manufacturers of domestic appliances and the motor-car industry.

The chairman of the Stainless Steel Manufacturers' Association gave the figures at a London exhibition of

stainless steels covering industries ranging from cutlery and medical supplies to sport and aircraft.

** ** ** **

U. K. FIRM TO BUILD £ 2,000,000

DAM IN SIERRA LEONE

A contract for an earth dam costing £ 2,000,000 in the Guma valley of Sierra Leone has been placed with Taylor Woodrow (Sierra Leone) Ltd. by the Crown Agents for Overseas Governments, it was stated in London on March 9.

The 900 ft.-long dam will augment the water supply of Freetown, capital of Sierra Leone. This West African territory attains independence in April.

Of the money needed, £ 1,000,000 will be provided by the Colonial Development Corporation.

There is a possibility that at some time in the future, the dam will supply water for a hydroelectric station.

Tests to determine the most suitable Type of Air Filter for Electric & Diesel Electric Railway Locomotive use in Industrial Areas

By An Engineering Correspondent

ELECTRIC and diesel-electric locomotives possess many characteristics making their use preferable to that of steam traction but their introduction has raised certain additional problems. Not the least of these is the necessity to supply a considerable volume of clean air for cooling and intake supply. Preliminary assessment of the requirements suggested that a number of aspects of the problem were not fully understood and the best approach seemed to be a series of controlled tests in service conditions with filters of varying characteristics.

It was necessary to narrow down the field, firstly on the basis of a theoretical assessment, and secondly, to those types shown by Laboratory tests to hold most promise. These aspects will be covered briefly in this report before proceeding to describe the field trials which were conducted on a series of electric locomotives running over the recently electrified Manchester-Sheffield-Wath extension.

THEORETICAL CONSIDERATIONS

The dust arresting performance of an oil wetted filter is dependent on two processes:

- (a) effective impingement of dust on a large area of oily surface, and
- (b) adequate retention properties to obviate subsequent re-entrainment of particles as the oil is "dried up" by collected solids.

If the oily surfaces are separated by relatively small passages, accumulation of dust causes appreciable reduction in flow area; ultimately the spaces will be occupied by a porous bed of solids having the effect of maintaining filter efficiency even after the oil has been absorbed, at the cost of increased pressure loss.

Such filters are termed the "constant efficiency type", and possess the advantage that solids "carry-through" does not occur, and need for servicing is positively indicated by increased back pressure.

However, it may not always be convenient to effect servicing immediately, and alternative filter arrangements are possible in which the spaces between oil wetted surfaces within the filter medium are purposely increased. Usually steps are taken to maintain adequate wetted area despite the increased voids by disposing the collecting surfaces in greater depth. It is possible to devise such filters with internal surface spacing sufficiently large to ensure adequate flow passage without this "bridging" tendency. During this process, the rise of pressure loss is small, at the expense of steadily reducing efficiency until ultimately the air passes through substantially uncleaned.

Although this may be advantageous where maintenance of full airflow is more important than transmission of solids if servicing is delayed or overlooked, dangers exist in that dislodgement of "cakes" of previously arrested dust may occur under conditions where vibration can accompany sudden surges of air flow, as for example when entering a tunnel at speed. Consequently, the use of filters with such "reducing efficiency" characteristics cannot be recommended.

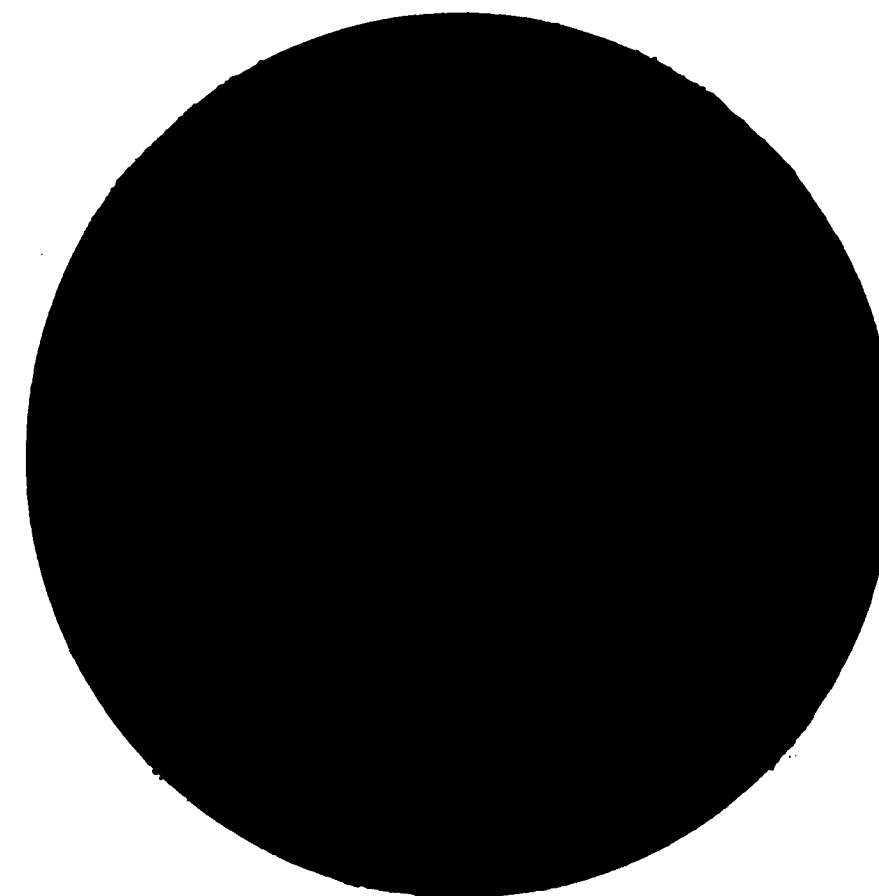
The "herringbone" crimped wire mesh panels referred to later represent an improved version of this type, but even a short period of running following servicing suffices to show a marked reduction in efficiency, this continues progressively during subsequent running. This was later confirmed by the relatively dusty internal condition of the locomotive after test.

A prime aim of these tests was to ascertain the feasibility of combining both characteristics to a degree permitting full protection to be afforded in emergencies, over service intervals double that normally recommended. For a given pressure loss, more positive arrestation of particles is secured by employing the minimum possible spacing between wetted surfaces, and then securing maximum total open area by deploying the filter medium in deeply pleated formation. Oil wetted filters of this type include the

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Vokes 3-ply and 5-ply panels and so these both figured in subsequent tests.

Other types of filter which held promise employed various configurations of oil wetted surface, including knitted wire, variable density woven wire, herringbone crimped sheet metal, and neoprene bonded hair. All these were submitted to Laboratory testing as described below:

Laboratory Testing

Panels were made up of suitable dimensions for test, employing the following arrangements:

1. *Vokes 5-Ply*: The medium consists of three layers of wire mesh interspersed with two layers of cotton gauze. The latter serves the dual purpose of decreasing the average air passage dimensions, and acts as an absorbent to increase the effective mass of oil the panel can accommodate. The whole is deeply pleated to increase the total developed area to a maximum.
2. *Vokes 3-Ply*: Similar to 5-Ply but with only two layers of wire mesh and a single layer of cotton gauze between.
3. Wire mesh screens of variable bulk density, the more open mesh being upstream.
4. Neoprene bonded hair.
5. Woven wire screen; material similar to conventional oil bath scrubber pack.
6. Herringbone crimped wire; alternate layers with flutes in opposition.
7. Herringbone crimped sheet, with similar arrangement of layers.

Complete discussion of the Laboratory results is outside the scope of this report, but the following figures, indicating efficiency on test dust to B.S.

Specification 1701 will indicate the trend:

Filter Medium	Efficiency %		Pressure Loss ins. W. G.	
	initial	600 gms./ft. ² load	initial	600 gms./ft. ² load
Vokes 5-ply (oil wetted)	99	98.9	0.13	0.73
Vokes 3-ply (oil wetted)	99	98.8	0.06	0.48
Variable Density wire	93	74	0.13	0.62
Neoprene bonded hair	99	98.5	0.18	0.32
Woven wire	97	82	0.22	0.50
Herringbone Crimped wire	99	55	0.04	0.05
Herringbone crimped sheet	75	50	0.08	0.09

Inspection of these figures, indicates a marked variation in performance up to a considerable dust load, but it is possible to observe the fundamental differences between the virtually constant efficiency media such as the 5-ply and 3-ply, and the reducing efficiency types such as the herringbone crimped wires and sheets. Some types obviously possessed poor overall performance, and so were deleted from further work.

SERVICE TESTS

Although not covered in the Laboratory tests, some past experience on the 5-ply filter had been obtained in the dry state, and it seemed logical to include a number of these.

Practical limitations on service tests and desirability of obtaining fullest information on those chosen, made it necessary to exclude certain types with intermediate performance, such as the woven wire screen. However, from the service results it is possible by interpolation to estimate the performance to be expected from this pattern; efficiency would be considerably lower than with the 3-ply type but better than the herringbone crimped wire. Dust load capacity on the other hand would normally be rather inferior to either of the other varieties, but good pressure loss regulation would be achieved, in

conjunction with substantially non-clogging characteristics.

Finally, therefore, the following were chosen for test:

- (a) The Vokes 5-ply filter (dry).
- (b) The Vokes 5-ply filter (oil wetted).
- (c) The Vokes 3-ply filter (oil wetted).
- (d) Oil wetted Neoprene bonded hair panels.
- (e) Panels consisting of layers of wire mesh corrugated in herringbone formation with channels of adjacent layers running in opposition.

The prime aim of the investigation was to ascertain the most suitable type of filter for use in average conditions including those experienced in highly industrialised areas of the United Kingdom. Past experience in certain overseas markets had proved the 5-ply dry filter to be capable of satisfactory performance in conditions where dry inorganic dust predominated, but application of this type of filter for use in industrial areas had not met with such complete success and conventional reducing-efficiency oil wetted panels were equally open to criticism on account of low dust separating efficiency.

For the purpose of the tests, the recently electrified line between Manchester, Sheffield and Wath was chosen as this encountered a fair cross-section of conditions including areas where much soot and potentially corrosive contamination would be experienced. The tests were carried out on four locomotives of the Bo+Bo type used for both light goods and passenger transport. Each locomotive requires 18 panel filters passing a nominal 600 c. f. m. each, 17 being installed in the side walls and one to the H. T. compartment, which is an internal unit.

One type of filter only was fitted to a single locomotive but in some cases, opportunity was taken to employ alternative wetting oils and with the 5-ply filters, four dry units were employed with 13 of the wetted variety, to act as controls. Previous running had already been effected with the 5-ply filters in their dry state and criticism incurred through corrosion and difficulty in cleaning. It was in order to compare directly these effects with those experienced on the various oil wetted panels that the four dry filters were employed. Examination of used dry 5-ply panels had indicated that corrosion of the metallic

parts had occurred and this assisted in the formation of a bond between the metal gauze and the tarry deposits, which was difficult to break down by normal solvent cleaning. There is little doubt also that this effect was aggravated by the inefficient performance of water separating louvres in front of the filters which had allowed rain to penetrate and assist in corrosion effects, particularly when other atmospheric agents were available.

Attempts were made to check the performance of the filters in terms of depression inside the locomotive at monthly intervals and in most cases, the filters were removed after operating for 60 days and returned to the Laboratory for individual pressure loss testing and assessment of collected solids. In certain cases, through service limitations, it was necessary to carry out this exercise at an earlier or later stage with the result that occasionally filters were left in situ for as long as 150 days.

Previous experience on the dry type 5-ply panels was largely reproduced in that rise of pressure loss with solids accumulation occurred more rapidly than with the oil wetted version of the same filter, and servicing by normal solvent processes was considerably more difficult. Also, performance of the bonded hair fibre panels showed a marked tendency in the same direction regarding pressure loss increase with dust load.

The oil wetted 5-ply panels exhibited quite good characteristics in respect of pressure loss rise and this has previously been proved due to the considerable quantity of oil which can be absorbed by the two layers of cotton scrim, allied to the large developed area of the deeply pleated 5-ply panel. These tests have proved that the oil wetted version is capable of retaining a larger quantity of solids than the dry version for a given rise in pressure loss.

Of all the types tested, the 3-ply oil wetted panel stood out as possessing the best combination of characteristics, with an efficiency assessed on the basis of locomotive cleanliness very little short of the 5-ply but with the capacity to operate for a considerably longer period without excessive rise of pressure loss. In one case, service contingencies made it impossible to clean the filters on the 3-ply fitted locomotive for 150 days and over this period the depression inside the cabin increased only from 0.09" w.g. to 0.28" w.g. Perhaps of even greater interest is that up to 120 days, only a very small increase to 0.12" had occurred.

Assessment of dust arresting efficiency was not directly possible but on the basis of internal cleanliness of the locomotive, these tests have shown that the 5-ply and 3-ply oil wetted filters maintained a cleaner condition than that possible with the other varieties of which the Neoprene bonded hair was considerably better than the herringbone wire.

DISCUSSION OF RESULTS

The Vokes 5-Ply (Dry) Filter

Past experience has shown this type to give good performance in certain overseas conditions, but this series of tests has confirmed that difficulty in servicing may be experienced with a combination of industrial pollution and rain ingress to promote corrosive bonding of contaminant to the filter.

Furthermore, whereas the oil wetted versions of this filter could retain over 200 grams of atmospheric contaminant for a pressure loss rise (on average) from 0.16" w. g. to 0.20" w. g. the dry 5-ply showed an increase from 0.13 to 0.46" w. g. under the same conditions.

This indicates that the presence of oil on the filter assists rather than inhibits the formation of a highly porous bed of solids.

Experience showed that on an average, between 3,000 and 4,000 grams of solids (up to 9 lbs.) would be collected by the 17 main filters on a locomotive in 60 days average running.

If 60 days is accepted as a satisfactory filter servicing interval, the 5-ply dry filter would be excluded on grounds on excessive pressure loss increase, allied to difficulty in cleaning.

The Vokes 5-Ply Oil Wetted Filter

A few figures were quoted as comparisons under "5-ply dry filter", and it has been shown that this filter, despite its "constant efficiency" characteristics, can accommodate a remarkably large dust load for a modest increase in back pressure. Regular 60 day servicing by the means described later would ensure satisfactory performance under any circumstances likely to be experienced in other than dust storm conditions, and some latitude would exist to accommodate limited abuse due to delayed servicing.

The extent of this could not be determined, as the one extended test with the 5-ply filters to 130 days

was rendered abortive through servicing having been effected on site without the filters first being returned to our Laboratory for testing in the loaded condition; however, a final depression in the loco of 0.7" w. g. was recorded, and this is considered excessive. We would suggest the maximum emergency interval with 5-ply oil wetted filters should not exceed 90 days.

These filters maintained the locomotive interior in exceptionally clean condition throughout.

The Vokes 3-Ply Oil Wetted Filter

Owing to operating contingencies, it was not possible to effect servicing of the 3-ply filters until 150 days operation had been completed. Over this period, a solids weight of 8,580 grams was recorded on return of the panels to VOKES' Laboratory and as some would inevitably be lost in transit, the total collected must have been considerably greater.

This represents a loading of approximately 500 grams, or well over 1 lb. of solids per filter, and it is interesting to record that the locomotive depression only rose from 0.09 to 0.28" w. g. over the whole period. At 120 HRS. a depression of 0.12" w. g. was recorded, suggesting that approximately 1 lb. of atmospheric solids per panel can be accommodated on each oil wetted 3-ply filter panel for a very small increase in restriction. Allowing for contingencies, a normal servicing interval of 60 days would provide at least a 2:1 factor of safety against neglect or inability to service at the correct time.

The locomotive cabin condition was but little inferior to that noted following the 5-ply oil wetted filter tests.

The Neoprene Bonded Fibre Filter

Performance on laboratory tests had suggested that this type was a good intermediate between the constant efficiency 5-ply on the one hand and the reducing efficiency herringbone crimped types on the other. It was disappointing therefore, to record on the field trials, that these hopes were not borne out in practice.

Unfortunately, the first series of tests over a period of 60 days proved inconclusive due to a tendency for the expanded metal facing to the hair pack to choke prematurely; as a consequence, an unduly rapid restriction rise was recorded, being 0.23 to 0.61" w. g. for a period of 60 days and dust load of 3,337 grams (7 lb.).

The test was repeated with the offending facing replaced by a suitably open mesh, and results improved considerably over the ensuing 60 days. For some reason not fully understood, the weight of dust collected during the second period fell to just under 2,000 grams (4.5 lb.), for which load the restriction rose from 0.21" w. g. to 0.27" w. g.

Test results for later running periods of longer duration are not yet complete, but the indicated pattern to date is similar.

The conclusion to be drawn so far is that this type of filter possesses a reasonably flat pressure loss/dust load characteristic, but this is at a generally higher level—over double—that recorded for the 3-ply type filter.

Examination of the locomotive interior during and after test revealed that more solids had penetrated this filter than was the case with the 3 and 5-ply varieties, and the overall balance was considerably in favour of the latter types.

It was subsequently learned that use of this type of filter would be excluded from locomotive wall service on account of excessive fire risk from hot cinders, etc.

The Herringbone Wire Panels

Although a considerable running period has been effected with these panels in situ (115 days), unfortunately servicing had been effected on site, and it was not possible to carry out the usual inspection and pressure loss tests at our Laboratory.

However, a surprisingly rapid locomotive depression rise was recorded, from 0.10" w. g. initial, to 0.7" w. g. at 115 days. This was considerably in excess of that noted for the 3-ply filters after 150 days, despite the positive retention characteristics of the latter. In view of the markedly dirtier condition of the locomotive during and after test, this type of filter is definitely not favoured, especially as the hoped for non-clogging characteristics were not realised in practice to an extent justifying the observed rapid efficiency reduction with increasing dust load.

FILTER SERVICING

For the purpose of these tests, the filter panels

were returned after use to VOKES Laboratory so that inspection and pressure loss tests at standard airflow could be effected before cleaning; washing off and re-oiling were then carried out in a special machine devised to facilitate these operations. One such machine has now been installed at Reddish Depot, Manchester, by British Railways, and is in regular use.

The machine includes suitable washing and wetting tanks disposed around a centrifuge to accelerate drainage of excess fluids from the panels. The most effective cleansing agent has proved to be "Liquid Solvex", a product of the Fletcher Miller Company, and one tank contains this hydrocarbon base, water soluble solvent, and emulsifying agent.

A second tank contains hot water (60—70°C.) for the purpose of wetting out the solvent and removing the collected solids, and the third tank holds the wetting oil.

WETTING OILS

Opportunity was taken of the field trials to compare two wetting fluids, a straight mineral/vegetable blend oil in wide use for the purpose, and a water soluble emulsified oil of generally similar characteristics.

Performance of these two fluids as filter wetting agents proved to be very similar, and no conclusions can be drawn to favour one or the other. However, the water soluble oil proved of great advantage for servicing as soaking times in the solvent and water tanks could be usefully reduced for equal effectiveness. We tend therefore to favour use of the soluble oil for wetting filter panels for this service.

A word should be added regarding the special air filter wetting oils recently made available in Great Britain. Test results have been quoted by the sponsors indicating a usefully improved performance when applied to "reducing-efficiency" filters in certain overseas service.

The special oils were not available in time to permit inclusion in the field trials, but Laboratory tests have been carried out by us in co-operation with the suppliers. Briefly, the object of these fluids is to secure at once the good wetting and wicking characteristics of a light mineral oil, together with

anti-draining properties offered by the presence of a semi-soluble additive. The effect is to increase substantially the mass of oil a given filter can retain after servicing, and so provide good surface wetting of the accumulated dust pack beyond the point at which a conventional oil would be fully absorbed.

The advantages are greatest with the "reducing efficiency" type of open pack filter which is enabled to operate for a longer period before serious deterioration of collecting performance sets in. Applied to filters such as the 5-ply and 3-ply however, which are themselves designed to possess good wicking and anti draining properties, the advantages are not so marked, and unless due precautions in draining at an adequately high temperature are observed, a possibility of excessive oil retention exists, which could cause abnormally high back pressure. Experimental work is continuing in cooperation with the suppliers. Advantages are greatest when applied to filters possessing poor retention characteristics.

EXCLUSION OF RAIN WATER

Comment has already been passed on the effects experienced due to water ingress on the dry 5-ply filters. Presence of water on any dry or viscous panels is obviously disadvantageous and if the recommended water soluble wetting oils are employed,

long term performance would be affected due to removal of wetting fluid.

The VOKES "Monsoon" type louvre has been expressly designed to exclude rain water, which it does most efficiently, and irrespective of the type of filter employed, fitment of these or equivalent louvres is highly desirable to secure optimum filter performance.

CONCLUSIONS

The field trials show one type of panel filter, namely the VOKES 3-ply (oil wetted) to be markedly superior to all the alternatives, and using the ratings applied during these tests—i. e., a face velocity of approximately 300 feet/minute—excellent performance, with neither efficiency fall off nor premature choking, can be achieved over a period of 120 days average operation under industrial conditions in the U. K.

Allowing for emergencies and service contingencies, a nominal service interval of 60 days, would provide a factor of safety of over 2:1. Such performance could not be achieved with any of the other filters, including the herringbone crimped wire mesh and Neoprene bonded hair panels.

(Vokes Limited wish to express their gratitude to Mr. K. J. Cook, O.B.E., Chief Mechanical and Electrical Engineer, Eastern Region, British Railways and his staff for their co-operation during these tests.)

INDIA ORDERS MACHINE TOOLS FROM U. K. FIRM

Craven Bros. (Manchester) Ltd., the Stockport (England) firm of machine-tool makers, have been awarded orders from India valued at more than £600,000.

The firm were told by cable of the order, the precise value of which will not be known until they receive details of the additional equipment required with the machines.

Craven Bros. specialize in large, heavy machine tools for general purposes.

This latest order brings the intake of new work since the beginning of this year to well above £1,000,000, and further substantial contracts are at present being negotiated.

Craven Bros. have already fulfilled a number of orders in India.

ELECTRIC TRAINS—

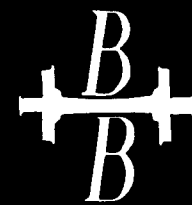
I. C. F. TO MAKE COACHES

The Integral Coach Factory, Perambur, have undertaken a new line of production—electric multiple unit coaches for the Calcutta Railway Electrification Project authorities.

The Railway Board have placed orders for the supply of 64 E.M.U. four-unit trains at a cost of about Rs. 15 crores and the first unit is expected to be delivered by the last quarter of 1962 or the beginning of 1963.

Mr. K. Swarup, Chief Administrative Officer, Integral Coach Factory, said that production of an electric multiple unit coaches was an entirely new line of production. With the help of the French collaborators of the Calcutta Electrification Project as well as the factory's own Swiss collaborators, they hoped to meet this urgent request on an emergency basis.

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An Important Announcement

- We have great pleasure in announcing to all our Readers and Advertisers that we are incorporating the following Supplements as usual on various aspects of **RAILROAD ENGINEERING** in our **1961 Annual Number** to be released by the end of August 1961.
- Advertisers desirous of buying advertising space in any one of the Supplements should intimate the fact to the Technical Editor (Advertising Branch) on or before 20th July 1961. We can accept only a limited number of advertisements due to space restrictions.
- Technical articles or write-ups concerning Engineering Products would be published free of charge and twentyfive reprints would also be supplied without any charges. For other details please address your enquiries to the **Technical Editor, INDIAN RAILWAY ENGINEER, Flats 17 & 18 "Ashoka" (Second Floor) 15, Ghodbunder Road, Santacruz West, Bombay-54 (India).**

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