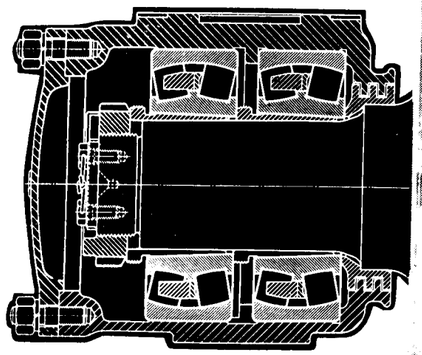
Five Times Round the Equator in a Year!



Every year each of eight Swedish express trains, types Xoa 5 and Xoa 8, cover approximately 125,000 miles — equal to five times round the Equator. They have been doing this for nearly ten years and it has not been necessary to replace one of the 416 SKF bearings used in the axleboxes of these trains during some 10,000,000 miles of operation. Moreover the bearings do not require any lubrication or attention between periodic overhauls — in fact they run nearly 200,000 miles without any maintenance whatever.

Type: Xoa 5
Total weight: approx. 150 tons
Motor output: 4 × 340 h.p.
Max. speed: 84 m.p.h.

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DISCIPLINE AND PRODUCTION IN RAILWAY WORKSHOPS

APART from well trained personnel (workmen as well as Supervisors) and good and upto-date machines in sufficient number, one of the most important factors which make for greater production in any workshop is Discipline.

Discipline does not consist of blind obedience to orders, but an attitude of mind which enforces regular and systematic working without loss of precious production hours irrespective of the quality of supervision.

Judging production with this yard stick, it must be admitted that work in Railway Workshops has deteriorated and the out turn of pounds per man hour has been gradually diminishing until today it is at a pretty low ebb.

Prior to the Second World War and in the early nineteen-thirties the Railway Workshops were predominantly controlled by Englishmen in the Superior Services and by Indians in the subordinate supervisory services and at that time discipline stood at a high level.

The Englishmen of those days belonged to a disciplined nation and discipline was a part and parcel of their life and they saw to it that it was observed by all with whom they came into contact.

Punctuality was a habit in which Englishmen generally excelled. When an Englishman made an appointment with anybody, he was usually present a few minutes early, but very seldom even a few minutes late What punctuality he observed himself he demanded it from others and definitely enforced it on his subordinates.

If a meeting was fixed for a particular time, it was customary for all members attending the meeting to assemble outside the meeting hall a few minutes before time and walk in on the stroke of time.

If trains were scheduled to arrive at a particular station at a particular hour they saw to it that they were not even a minute late and also after their due halt they left the station on the stroke of time. Failure to achieve the time schedules was frowned upon on the first occasion, but a repetition brought on severe disciplinary action including reduction in grade on drivers, guards and others concerned.

If orders were given and if they were not clear, this had to be disclosed by the subordinates at that time and then the matter was explained clearly. But once the matter was supposed to be understood the subordinates were expected to carry out the instructions to the letter in detail and no explanation for failure to carry them out was accepted. The normal rejoinder which a subordinate received if work was delayed sometime was "I want work and I am not prepared to accept excuses".

In those days, Works Manager and his Assistants and the Senior Supervisors of the Foremen Class in the Workshops had a considerable amount of power, which is an essential feature of discipline. For a mistake or inability to carry out orders or dereliction of duty a workman or Supervisor was fined a fairly heavy amount or was reduced in status or sent home for a period on loss of pay. If the action or omission was serious, he was removed from service and in the interest of discipline and at times dismissed and the orders once passed were upheld by superior authority unless they were palpably unjust or unfair.

Englishmen, as a rule, had a very high sense of what is known as 'fairplay' and dispensed justice without fear or favour and it was an extremely rare occurrence if at any time the orders once given were ever reversed.

The Indian Workshop Supervisors with grades of Foremen and Senior Chargemen taking the queue from the English Officers and Managers extracted work from their workmen, especially if these orders came from any high authority. Further, as these foremen themselves were capable of working with their hands, having risen to their present position from the lowest rung of the ladder of workmen, when it came to emergency or a time limit was fixed for a job, they often forgot their higher status as Supervisors took off their coats, rolled up their sleeves and worked with their hands side by side with their workmen day and night until the job was completed within the limited time.

The Supervisors, because they knew the work of the branch of which they held charge, were respected by their workmen, who learnt a considerable amount of work and the various trade secrets from them.

There were, however, black sheep in every fold and Supervisors were no exception. Some of them undoubtedly accepted illegal gratification from their workmen or they bullied their workmen because they were in the position of Supervisors or they were harsh to the men even to the extent of striking them when the occasion called for it, but on the whole inspite of all their defects they did maintain a very high sense of discipline and extracted a fair day's work for a fair day's pay from the workmen under their charge.

What is the picture today? Punctuality is very seldom observed. If a man comes to his appointment 15 minutes to half an hour late and makes the necessary excuse that the train was late or the buses were crowded and he could not get room etc., such an explanation is accepted without a question. It never strikes the man concerned to start from his home or the starting point half an hour earlier to offset any such obstacles indicated above. The saddest part of it all is that he gets away easily with his excuses and so keeps on propagating unpunctuality on various occasions.

At important meetings, sometimes, the convener of the meeting or the Chairman himself is late and the members invited, should they have come in time, have to cool their heels for considerable periods before the meeting starts, with the result that on future occasions when such meetings are called for they deliberately come late because of the example set.

Train services are habitually late these days and the arrival of a train at a station at the scheduled time according to the Time Table is looked as a great achievement. When signals are

lowered and the Guard blows his whistle and waves his green flag very frequently nothing happens. The Driver or the Fireman or the Khalasi probably hold up the train in order to meet their requirements in the nearby bazar or elsewhere.

It has now become a habit in most Railway Workshops for the workmen to arrive at the gates of the Workshops when the second buzz is blowing and they still have all way to walk to their places of work, which often take them ten to fifteen minutes and by the time they remove their clothes and get into their working clothes they waste anything from half an hour to three quarter of an hour before starting their work. Similarly, they just wash and change their clothes ready to go at least half an hour before the actual blowing of the buzz indicating the stoppage of work. This happens twice a day and as a result anything from 2 to 2½ hours are wasted out of the 8 hours work per day. This has now come to be looked upon as normal and if 6 hours work can be obtained from the workmen out of 8 hours, the management is quite complacent of having fulfilled its demand.

Orders given are very seldom carried out either completely or in time and it is not unusual to find that for some reason or other the job has not even been started on the day it is supposed to be completed.

Supervisors have very little power over the men because they know the limitations of the disciplinary powers that could be exercised by supervision, particularly when they have rights of appeal which can in most cases have the Supervisor's orders reversed as and when required. Further, the Supervisor who tries to enforce discipline is sometimes assaulted outside the works and has no redress because the occurrence occurred outside the workshop premises. In the circumstances, Supervisors are diffident to enforce discipline.

The service rules regarding discipline and appeal are so much in favour of workman and there are so many loop holes that in 9 cases out of 10 he has an opportunity of being reinstated in service from which he has been removed.

With the dice so much loaded against management and supervision with poorer quality of work and so much loss of time, what is the use of talking about production and increase in production—it just cannot be achieved under present conditions.

Discipline first and discipline last is the only answer which will solve this great malaise under which our Railway Workshops are working today.

Improvement in output can only be expected if the power is put back into the hands of management and supervision where it rightly belongs.

There must be simplification in the labour rules of discipline and appeal and there must be support for every just action taken by the Supervisor against his men so that the men are made to realise that they just cannot get round the disciplinary action by appealing to rules. If all this is done and greater responsibility put on the shoulders of management and supervision and implicit trust is imposed on them at each rung of the ladder of supervision, then and there only can we expect greater production in pounds per man hour in Railway Workshops.

RAILWAY SIGNALLING RELAYS

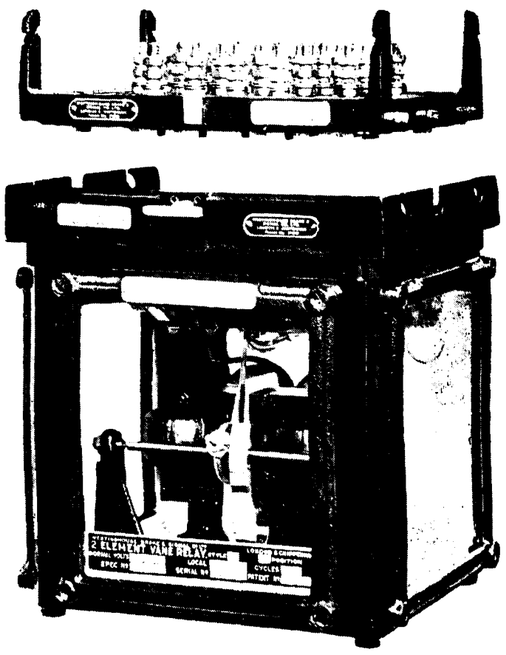
By H. C. Towers, M.I.E.E., M.I.R.S.E., M.Inst.T.

THE invention of the railway track circuit may undoubtedly be accepted as the beginning of railway signalling relay development. Without the track circuit, relays controlling other circuits would not have been in demand so early. The first track circuit originated in England in the early sixties. Installed on the Crystal Palace line it was invented by Mr. W. R. Sykes. It was not a success, but the experiment was repeated in 1871 by a Dr. Robinson. In 1879 trials commenced in the U. S. A.

In 1890, two track circuits were put down on British Railways, one at Cannon Street, on the London, Chatham and Dover Railway, and the other through Kings Cross Tunnel, on the Great Northern Railway. The latter was part of a very complete scheme which dispensed with the use of two mechanical slots, two mechanical wires through the tunnel and two levers, in the signal boxes. For the insulated rail joint, a fibre bar was used in place of fishplates, and the ends of the rails rested in separate joint chairs which were fixed to a special sleeper.

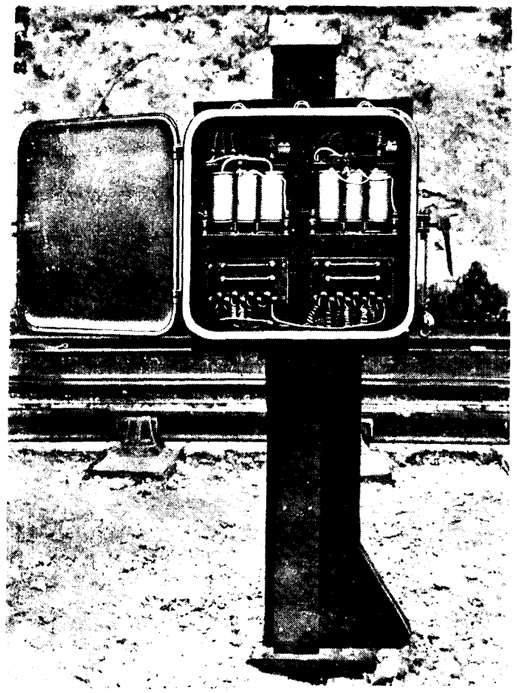
The use of this primitive form of track circuit was discussed at some length at a meeting of the Institution of Electrical Engineers held in 1897 and most of the members present, showed considerable scepticism. Some of the questions asked were: how the track circuit functioned when the line was flooded; how could sufficient insulation resistance be afforded to make the track circuit operate in such a damp climate as England; and what assurance was there that the track relay would operate when a train stood on the track circuit. The fact that fifty years later thousands of track circuits are in use all over the world proves the reliability of this appliance. In 1901, track circuits were introduced on the London and South Western Railway between Grately and Andover, and in 1905 they came into general use on the District Railway and tube lines with the installation of power and automatic signalling.

The track relay varies in shape and design according to the manufacturer's patents. The essential requirement was that it should operate on a minimum current. The earliest designs had two coils enclosed in vulcanite tubing which were fixed outside the case containing the relay armature and contacts. The case was circular with a glass wall for purpose of observation. In Great Britain, D. C. track relays have a coil resistance of 9



Two element vane relay with detachable terminal top.

ohms, while in the U. S. A. 4 and even 2 ohms are used. The relay's contacts are screwed to the relay armature and suitably insulated from it. The ends of the contacts are connected to terminals on the case by flexible conductors. In the earlier relays, platinum to graphite was the usual combination for 'front' or energised contacts, and platinum to platinum for 'back' (de-energized) contacts. The design of the direct current relays has been improved in regard to the number of contacts per assembly and other details, but generally they are very much the same in shape and appearance and operate on the same voltages. This type of relay is quite suitable for steam railways, but cannot be used on railways where electric traction is in operation. In these cases the running rails have to be used for the return traction current and as they have to be insulated at intervals to make the necessary divisions between the tracks circuits, the return traction current has to be passed around the insulated joints by a device known as



Brown's polarised DC track relays. The case contains the 'A' relay of one track circuit and the 'B' relay of the next. The track armature can be seen at the bottom, the swing coil in the middle and the signal control contacts at the top.

an impedance bond. A. C. has to be used for the signalling track circuits. On the railways of London Transport, a negative conductor rail is in operation leaving the running rails free for signalling purposes.

The original power signalling on these railways included D. C. track circuits, and special arrangements had to be made owing to the possibility of the track relays being operated by false feeds caused by grounded traction motors. The signal main was fed from the sub-stations at a pressure of 60 V and the positive pole of the signal generator was connected to earth. In this way the signal main became a negative main. The track circuits were fed at a pressure of from between 2 V to 6 V and the voltage was reduced by 450 and 900 ohm resistances wound in the form of a tube and coated with porcelain.

The relays were of a special polarized type and consisted of three coils, two being known as the track coils and the third the swing coil.

Two relays were used on each track circuit, one at each end. The signal circuit was taken over the swing coil contacts at both ends. On a train entering the track circuit, both sets of track coils were shunted causing the track armature to fall, thereby breaking the circuit to the swing coil. Both swing coils assumed the vertical position and the signal control circuit was broken at each end of the track circuit.

The object of the polarizing arrangements was to guard against traction earths operating the relays incorrectly when the track circuit was occupied. It follows that a traction current passing through both sets of relay track coils would operate one relay but not the other, since the polarity of one relay would be reversed because of the fixed polarity of the swing coil. The first relays to be designed, had four coils, the swing coils being duplicated and in series with each other. They were pivoted at an angle of 90 with respect to the track coils. A latter design used a single coil only for the swing portion. The two relays per track circuit were designated A and B relays and the signal control line between them was called the A to B line. They were known as Brown's polorized relays and were named after their inventor. The Brown relay was in use on the London Transport lines from their earliest electrification days and remained in service for many years.

An early type of A. C. track relay was the ironless galvanometer type. This relay consisted of a local coil, permanently energized, and a track coil arranged to partially rotate between the local coil. The track element or armature was a loop made of a few turns of heavy wire secured to but insulated from, a frame which was pivoted. The connection to these coils was made by two flexible copper spirals attached to the terminals on the outer case. This coil was fed from the track circuit current. The local coil was supplied from two terminals connected to the signal main, the voltage of which was generally 110 on A. C. circuit. The armature was balanced by small adjustable weights and stop-screws were provided to limit its travel so that it could not strike against the fixed coils.

The electrical principle of the relay is that at any time, when the track element is energized, there is continual attraction between the top of the field coil and the armature, but repulsion at the bottom. The armature is thereby subject to a continual torque which closes the relay contacts. The relay is immune from operation by direct currents on the traction side since such currents flowing through the armature coil produce polarity which is not affected by the alternating magnetic field of the local coils.

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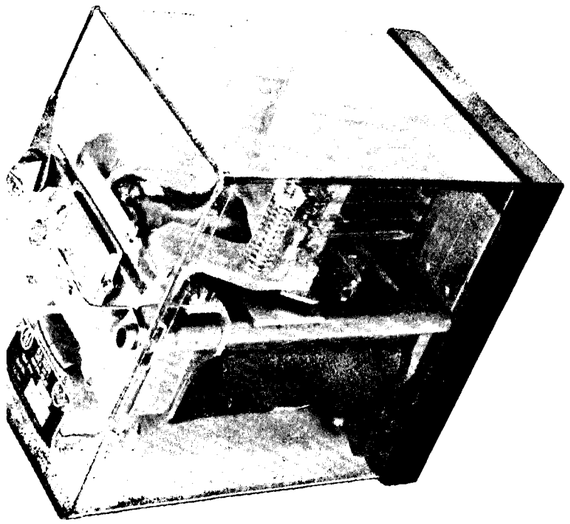
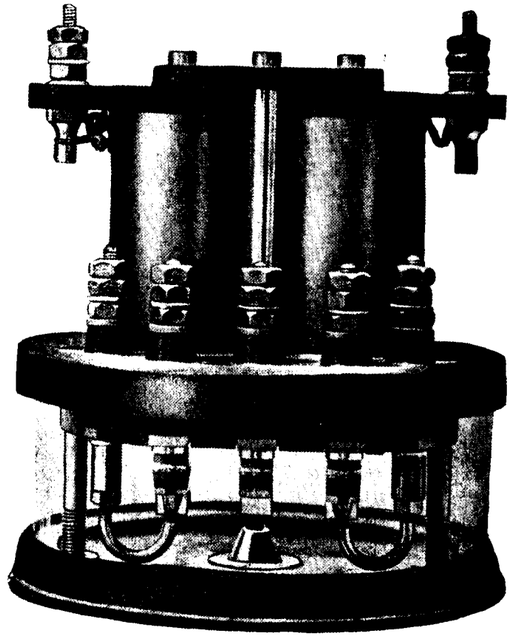


Plug in type signal relay.

Another early type of A. C. track relay was the single-element vane relay. The moving element of this is an aluminium vane pivoted and arranged to move vertically between a C-shaped laminated magnetic core. The electrical principle of the relay is magnetic induction. The sector shaped vane is mounted so that it can rotate between the poles of the electro-magnet. Each pole face is partially covered with a heavy shading band of copper. Currents are induced in the shading band by the main magnetic field and these are in opposition to the latter which causes the main field to shift towards the unshaded portion of the pole face. The main flux also produces an eddy current in the vane at that particular part which is in phase with the eddy current produced in the shading band. There is, therefore, attraction between the two, and the vane being free to rotate is lifted, thereby closing the relay contacts. When the relay is de-energized, the vane drops and rests against a roller fixed at the bottom of the case. The two-element or double-element vane relay was designed for use on long track circuits or those having low ballast resistance since the energy required to operate the vane and galvanometer type relays was high. This relay has two iron systems, one magnetized by a local coil, which produces the major portion of the operating power. The other iron system is energized by a coil fed from the track circuit and for which comparatively little energy is required. The two coils are fixed at right angles to one another, the local coils forming a verticle slot in which an aluminium vane is pivoted. The eddy currents induced in the vane are given definite paths by the introduction of slots cut in the vane. When the track coil is energized, it produces a flux 90 out of phase with that of the local coil. It therefore exerts a force on the conductors of the vane which tends to move it in a vertical direction, either upwards or downwards, according to the direction of the current in the track coil with respect to that of the local coil. The most efficient operation of the relay is obtained when the respective currents are 90 out of phase. The double element vane relay is now almost universally used for A. C. track circuits.

Other relays used in railway signalling circuits are those which repeat track circuits in the signal boxes, relays for indicating the position of points, and others for lock-stick circuits, inter-cabin slots, and for special features. There is an operating limit to the length of cable connecting the rails of a track circuit to the track relay and not all the track relays can be placed in the relay room of the signal box. The balance have to be accommodated alongside the track in cast iron boxes or special cubicles. These track relays operate repeater relays in the signal box which are known as track



Early type of signal relay.

Rack of plug in signal relays.

repeater or line relays. D.C. or A.C. relays are used for this purpose, but generally the A.C. single-element relay is favoured.

The advent of the copper-oxide rectifier brought about the introduction of a number of useful appliances in the signalling field. The inclusion of a small rectifier in series with an A. C. signal circuit permitted a small D. C. telephone-type relay to be connected across it, the contacts of which operated the signal repeater visual lights in the lever frame and other auxiliary and detecting appliances. Rectifiers are also used in A. C. signalling circuits where electro-magnets and solenoids are in operation, enabling the quite D. C. coil to be worked off an A. C. circuit without the attendant chattering and overheating associated with A. C. electro-magnetic devices.

Direct current for railway signalling was utilized from the very beginning where the early telegraph circuits were operated by weak currents from primary batteries. Some three or four decades past, A. C. came into favour chiefly on account of its immunity from interference where D. C. electric traction was present and also for its ease in transmission and voltage reduction. It also brought with it the disadvantages of operating electro-magnetic appliances by A. C. power.

Present day signalling schemes increasingly favour a combination of A.C. and D.C. circuits. A.C. is used for track circuits and for operation of colour light signals where only small transformers are affected. For all others circuits, D. C. relays, electric locks, etc. are employed ; the D.C. power usually being obtained through a charging unit connected to the main A.C. supply.

In modern signal boxes, many miles of wire are run for connecting the various types of relays together for the interlocking and selection circuits. Relays may have as many as forty or fifty wires attached to their terminals. In the case of a relay becoming defective, it has to be changed and, with so many wires to contend with, the task is one occupying considerable time and calling for great care. Each wire has to be labelled to ensure that it is correctly replaced. When the work is completed each circuit affected must be tested.

In order to overcome the risk of possible wrong connection and also to reduce the time necessary for changing a relay, detachable tops were introduced. This mean that the top of the relay, containing the terminals, is plugged into the relay proper and secured by a clamping device. If the relay has to be changed it can be done in a few movements without the necessity of disconnecting a single wire. Another type of relay which has been recently used on new signalling works, is the plug-in type. Here the base containing the terminals is rigidly fixed to the mounting rack and the relay is plugged in.

CHITTARANJAN TOUCHES NEW PRODUCTION PEAK

THE Chittaranjan Locomotive Works, which recently turned out the 400th locomotive, touched a new production peak by completing 14 locomotives during August, 1956.

The output at Chittaranjan has increased rapidly from six locomotives per month in the early part of 1954 to ten per month from January to June 1955. Thereafter, production was increased to 11 locomotives per month, and subsequently to 12 per month.

GERMANIUM RECTIFIERS FOR TRACTION SERVICE

(By our Technical Editor)

TRIALS BY BRITISH RAILWAYS

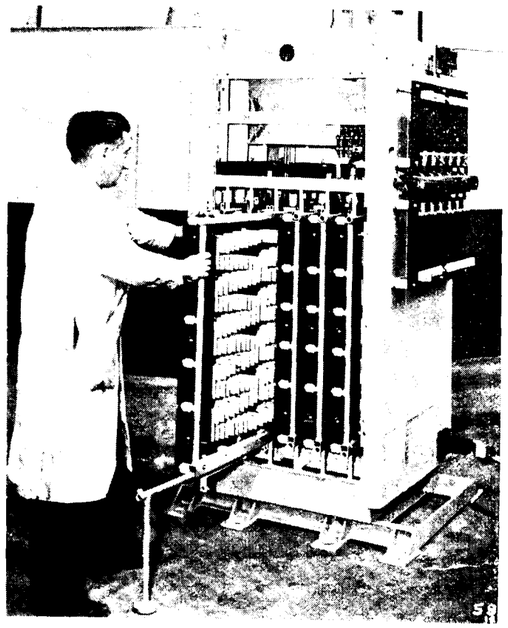
THE first electric train in the world to be fitted experimentally with a germanium rectifier for converting a. c. from the overhead wire to d. c. for driving the traction motors is running in London following successful trials on the Lancaster, Morecambe and Heysham section of British Railways (London Midland Region). These trials are being undertaken in conjunction with the British Thomson-Houston Co., Ltd., which has developed and produced the 750 kW full-wave rectifier unit used on the train. The conversion of the train to accommodate the germanium rectifier unit was carried out in the London Midland Region's workshops at Meols Cop near Southport.

The present experiment is of particular interest in view of the British Transport Commission's recent decision, subject to the approval of the Minister of Transport, to adopt the 25kV, 50 c/s system with overhead equipment for future electrification. The Eastern Region line between Frenchurch Street and Bow Junction, on which the trials are being made, is at present electrified on the 1,500V d. c. system, and the trial runs have therefore to be made at night when the d. c. can be switched off and an a. c. supply put on the overhead wires at 6.6 kV. (This is the voltage to which the new B. R. standard of 25kV will be reduced when the conducted wires have to the carried under certain bridges and tunnels, and at other places where clearances are restricted.)

Interest in the possibilities of using 50 c/s single-phase power for railway electrification has increased during the past year or so due to the success which has attended the use of this system on the French Railways Valenciennes-Thionville line and the British Railways experiments on the Lancaster-Morecambe-Heysham line. By using converting equipment on the rolling stock it is possible to obtain the inherent advantages of high voltage a. c. for distribution along the track and of d. c. series traction motors with their ideal performance characteristics.

TYPE OF UNIT EMPLOYED

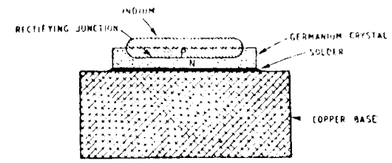
The use of the 25kV 50 c/s single-phase a. c. traction system in Great Britain has been assisted by the

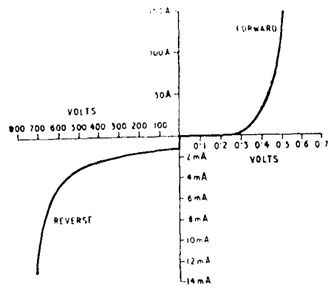


BTH Germanium Rectifier of 750-kW capacity. Shown with one of the banks exposed for examination.

recent development of the germanium power rectifier. Great importance is attached to the 750 kW B. T. H. germanium rectifier unit installed in a British Railways 6.6 kV 50 c/s multiple unit train, since this is the first application of this type of rectifier for traction service. The unit consists of an enclosed angle iron framework containing vertical trays on which the rectifier units are mounted. These trays are arranged on runners and can readily be taken out for inspection and maintenance. An extractor fan at the top of the cabinet draws air over the units for cooling purposes.

About 50 years ago the only method of conversion from a. c. to d. c. was by converting the a. c. power to mechanical power and the mechanical power to d. c. power, i. e. by the use of an a. c. electric motor, such as an induction motor, driving a d. c. generator. This involved two machines each capable of handling the full





Characteristic of GP germanium rectifier at 20 deg C

amount of power. The next step was to combine the two machines into one, so producing the rotary convertor; although a transformer was required there was an overall improvement in efficiency. A further step produced the motor convertor which required no transformer; with suitable conditions this gave an even higher efficiency than the rotary convertor. Meanwhile the mercury-arc rectifier was being developed, first in glass bulbs, then in water-cooled steel tanks with vacuum pumps; and finally in ignitrons and pumpless air-cooled steel tanks. In these rectifiers there is no conversion of electrical to mechanical power; the rectifier operates simply by permitting the current to flow through it in one direction, but not in the other; the only power loss, therefore, is produced by the voltage drop or arc drop in the rectifier. At medium and high d. c. voltages the mercury-arc rectifier has a higher efficiency than rotating convertors.

More recently the contact rectifier has made its appearance. This rectifier eliminates the arc by using mechanically operated metal contacts which open and close at each cycle. It has set a new standard by giving an overall efficiency, including the transformer, of about 97 per cent.

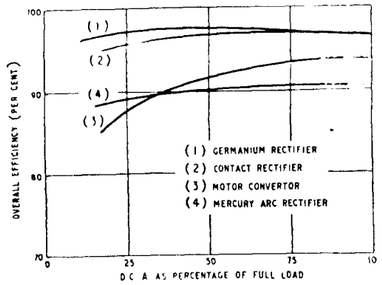
GERMANIUM RECTIFIER

The introduction of germanium has provided a power rectifier which combines the high efficiency of the contact rectifier with the static nature of the mercury-arc rectifier, and, in addition, is applicable over a wider range of voltage and kilowatt rating. Apart from high efficiency, the germanium power rectifier offers other features of great importance for traction application. These are:—(1) simple, robust mechanical construction; (2) the complete unit can be built up in practically any shape to suit the space available; (3) air cooling; (4) load can be applied immediately without the need for any warming up period; and (5) it requires a minimum of control gear.

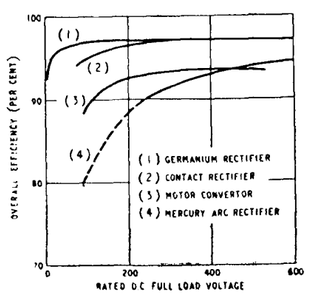
Elaborate precautions have to be taken, not only during the production of the germanium crystal but also during the construction of the units, to avoid contamination of any kind. The unit is finally enclosed in a hermetical sealed case to exclude moisture. The unit shown will carry a mean current of 50 A and is rated at approximately 1 kW.

OVERALL EFFICIENCY

When a d. c. voltage is required higher than can be obtained from a simple three-phase bridge, it is necessary to connect units in series. Owing to the variation of the characteristics between units the reverse voltage



—Comparative efficiencies of convertors for 15,000 A 250 V d.c. rating



will not be divided evenly between them unless suitable precautions are taken. For currents greater than three times the rating of a unit, units or strings of units must be connected in parallel. The forward voltage drop varies slightly between units, but to equalise the currents in the parallel paths by means of series resistors lowers the efficiency, and to do so by series reactors is cumbersome. The best solution is to reduce the average current slightly so that no unit is overloaded.

The power loss occurring during the reverse part of the cycle is small compared with the forward loss, which is itself small. The reverse loss can, therefore, be neglected and the efficiency calculated from the forward loss only. The forward voltage drop at full load is approximately 0.5 V; in the bridge connection the current flows through two units in series, making a total drop of one volt. If the peak inverse voltage across a unit is limited to 70 V, corresponding to a full-load d. c. voltage of 65 V, the loss is 1 V in 66, or 1.5 per cent. Connections, cooling fan, and fuses account perhaps for a further 0.2 per cent, giving a total loss of 1.7 per cent. The loss in the main transformer for a 1,000 kW equipment would be about 1.3 per cent. The overall efficiency of the equipment would, therefore, be 97 per cent. Since the only losses occurring at no load are in the transformer core and the fan, the efficiency is high down to 10 per cent of full load.

The very low voltage drop in a germanium rectifier results in high efficiency even at very low output voltages. It will be seen that even at 10 V d. c. the germanium rectifier equipment has an overall efficiency of 90 per cent. Copper oxide and selenium rectifiers thus provide a means of obtaining low d. c. voltages at high efficiency, where no means previously existed.

VOLTAGE CONTROL

At present, germanium rectifiers have no means of voltage control comparable with grid control on a mercury-arc rectifier. The d. c. voltage can, however, be controlled by varying the a. c. input voltage to the rectifier by one of three main methods. Firstly, by transformer tappings which can be of the off-load type for infrequent operation, or the on-load type where operation is more frequent or where automatic control is required. Secondly, where smooth stepless variation is needed a voltage regulator can be interposed on either primary or the secondary side of the transformer. For reasonably frequent operation this can be a transformer type of regulator with a contact moving over the winding. For very frequent operation an induction regulator is preferable, but is more costly. Thirdly, for automatic control of voltage where the variation

BTH Type GP Germanium Rectifier Unit.

needed is almost continuous, a saturable reactor may be interposed on either the primary or the secondary side of the transformer. This method gives smooth and rapid control, but as it reduces the power factor in the same ratio as it reduces the d. c. voltage it must be used in moderation and supplemented by transformer tappings if a wide range of control is required.

By the use of one or more of these methods any voltage control requirement can be met, and although the solution may not be so elegant as grid control, it will also not be so "sharp-toothed".

The one thing that cannot be done by germanium diodes is conversion d. c. to a. c. For this we must wait for the power transistor or the power triggered diode.

Germanium rectifiers can be used effectively for supplying power at any d. c. voltage from 10 V upwards, and for any current. There are, however, particular applications where they have outstanding advantages, and where they are likely to be used first. In electrolytic processes the cost of power is a major operating cost, and on a large modern equipment, an improvement of even a fraction of one per cent in efficiency may save thousands of pounds a year; here the use of germanium rectifiers seems inevitable. It is worth noting that a 270 V 300 kW unit has been in continuous service on electrolytic work since 1953.

Although the application of germanium rectifiers to traction service is novel, and experience so far is very limited, the B. T. H. germanium power rectifier has reached a very advanced state of development. While the small voltage drop of the germanium rectifier is of less concern in traction where output voltages are relatively high and voltage drops from other causes also high, the other very useful characteristics listed above are particularly attractive in connection with a. c. traction.

—*Electrical Review*, London.

NEW G.E.C. AUTOMATIC ANNOUNCER

THE General Electric Co. Ltd., represented in India by The General Electric Co. of India Private Ltd., has developed a novel automatic announcing system which can reproduce, at the touch of a button, any one of 25 pre-recorded announcements or signals, which can then be relayed over a loudspeaker system.

The messages are recorded side by side on a special loop of 3 in. wide magnetic tape, and the appropriate one selected by push-button when required. To make the system fully automatic, particular announcements such as shift changes, meal breaks or other messages can be triggered off by a master clock mechanism without the need for any human attendance. Also, of course, the push-button can be mounted remotely from the instrument so that announcements, emergency calls such as fire alarms, whatever broadcast is desired can be initiated from other parts of the premises.

The automatic announcer was originally developed by the G. E. C. for British Railways (Eastern Region) and first installed at Startford Station. In this installation the platform announcements for passengers are automatically initiated by the trains themselves, first as they approach the station and then again as they come to a standstill at the platform. Equipment of this type has now been adapted for general industrial use and may be applied in any situation where numbers of routine broadcasts have to be repeated fairly frequently.

BRIEF DESCRIPTION OF EQUIPMENT

The paper-backed magnetic tape used is made in the form of a continuous loop 3.1 8 in. wide, which normally lasts 30 seconds. Special loops can be supplied, however, having any duration between 10 seconds and about 4 minutes. A short length of metallic foil is spliced in at the point where the two ends of the loop join. At the end of the announcement the foil completes the circuit between two contact fingers, automatically switching off the mechanism and preparing it for the next announcement.

The loop of tape is moved past the playback head at a steady speed of 7½ in. per second by a mechanical drive system powered by a 1/20 h. p. motor. The motor is dynamically balanced and resiliently mounted at the rear of the panel, the drive being transmitted by a flexible shaft, nylon helical gears and two large diameter pulleys coupled by a nylon loaded fabric belt. On selecting the required announcement, either by push-button or by remote control, the playback head is moved to the correct tracking position by a specially designed mechanism patented by the G. E. C. Control of the tape motor and the head positioning device is effected by a 25 position rotary selector switch associated with seven switching relays mounted under detachable covers.

The method of storing the tape is also original to the G. E. C. As the tape is played it passes through a guide into a perspex-fronted casket, where it falls naturally into folds or convolutions. The use of a continuous loop of tape eliminates the need for spools, and of course no re-winding is necessary.

The three basic units comprising the complete equipment are designed in panel form so that they may be mounted on a standard Post Office type rack frame. These units are the Announcer Unit; the Pre-Amplifier and Monitor Unit; and the Power Unit consisting of a heavy duty transformer and rectifier assembly providing 50V D. C. and 24V A. C.

The price of the complete set of panels, complete with spares, is £620 and delivery can be made from stock.

TRAINING OF INDIAN ENGINEERS IN THE USSR

Indian engineers are undergoing professional training at the Giprokoks Institute where a coking and chemical plant for the iron and steel works now under construction in Bhilai was designed. During the four months training they will study the principal elements of designing and the technological process to be applied at the new works in India. The Indian engineers will also study the organizational work at the Soviet coking and chemical plants.

TWO-STOREY TRANSCONTINENTAL TRAIN NOW OPERATING IN U. S.

By a Special Correspondent

A Revolutionary new two-storey train, the "Hi-Level El Capitan," recently started operating on the Santa Fe Railway's regular service between Chicago and Los Angeles.

The Santa Fe's new passenger coaches are high, heavy, luxurious and costly. Each car is 15.5 feet high—two feet higher than conventional U. S. railroad coaches—and weighs 159,000 pounds, as compared to 126,000 pounds for a conventional U. S. coach.

The two-storey Hi-Level El Capitan train was specially designed for luxury transcontinental travel. All of the present El Capitan trains, which are of conventional one-storey design, will be completely replaced by five new Hi-Level El Capitan trains.

"We decided on a two-storey train, not just to be 'different' but to help solve some of Santa Fe's special problems," said F. G. Gurley, president of the Atchison, Topeka and Santa Fe Railway.

"To passengers going more than halfway across the continent, it is obvious that comfort and lots of room to roam around in are of vital importance. And we wanted people to ride everyone of the 2,224 miles between Chicago and Los Angeles in complete comfort.

"So to achieve maximum comfort, we designed the train to fit people themselves.

"People have legs. So we have given them seats with legroom enough for everyone from a school girl to the tallest Texan...seats that let people stretch out for comfort.

"People have eyes...and like to use them. So we have boosted them up to the 'second floor,' where they get the most sweeping view of the scenery, and we have wonderful scenery on the Santa Fe.

"People have ears. So we have moved them as far as possible—a full storey—above the sound of the rails.

"People have to eat. So we have given them a big, quiet dining room to make their meals as pleasant as possible. We moved the kitchen, with its clatter, downstairs. The whole upstairs of the dining car is devoted to tables—so we can seat 80 instead of 36, as in the average railroad dining car. In addition, we provided soft music.

"People need recreation. So we gave two floors of it—a two-storey lounge car. Downstairs is a cozy lounge and bar seating 26. Upstairs, a huge dome-type lounge with seats for 60 with rest-rooms, card tables, another bar, even a newsstand.

"After a year of testing two 'sample' cars in actual use, we bought 49 of these two-storey cars—enough to make up five complete trains.

"Naturally, we expect our investment of million of dollers to pay off, over a period of time. How? Through greater economies, in both operation and maintenance, and greater revenue.

"In the new Hi-Level El Capitan coaches, we can carry 72—or 24 to 28 more passengers than conventional coach cars, even after giving them more room. That's because the entire 'upstairs' is devoted to seating passengers; rest-rooms, machinery, and baggage space are 'downstairs.'

"All this means that we can carry 496 people in the new seven-car train, against only 350 in the present eight-car El Capitan trains.

"To sum up with the new El Capitan trains, we can serve more people in more comfort in fewer cars at less cost."

Each Hi-Level El Capitan train will have seven chair cars, a dining car, and a lounge car. In the chair cars, passengers sit on the upper deck, eight feet above the wheels, after climbing a centre stairway. In the dining car, two small elevators carry the food from the kitchen to the upper-deck dining room. Because the dining car can seat 80 diners compared with the usual 36, one dining car can serve the entire train instead of the two now used.

The Hi-Level El Capitan trains are being built by the Edward G. Budd Company of Philadelphia.

General Manager, Central Railway inaugurates Full Divisional System on Jhansi Division

BEFORE a large and distinguished gathering, the General Manager, Central Railway Shri M. N. Chakravarti performed the inaugural ceremony of the introduction of the Full Divisional System on the Jhansi Division, at the Divisional Offices at Jhansi today. Earlier, Shri M. A. Qadeer, Divisional Superintendent, welcomed the General Manager and other distinguished guests and gave a brief account of the importance of the Jhansi Division in the transportation set-up of the Central Railway.

Shri Chakravarti operated a miniature electric lever switching out the illuminated organisational chart showing the old administrative set-up and simultaneously switching on the schematic chart showing the new set-up, thus symbolising the introduction of the Full Divisional System on one of the major Divisions of the Central Railway.

Shri O. V. Alagesan, Dy. Minister for Railways & Transport, Government of India, who was to have inaugurated the Full Divisional System but could not come, owing to indisposition, in a message, which was read out on the occasion stated that the Second Five-Year Plan called for the utmost effort on the part of Railwaymen; its success depended mostly upon the capacity of the Railways to move the traffic generated. Continuing, he added that the gap in the resources could only be filled if railwaymen rose to the occasion. He had full faith in them and had no doubt that they would rise to the occasion and do their job well.

Shri M. N. Chakravarti, General Manager of the Central Railway gave an account of the various endeavours made by the Railways in the past to gear the administrative organisation to a pitch that would enable it to meet the country's increasing transport requirements. Indian Railways, he said, had therefore been regrouped in November 1951 to achieve economies and greater efficiency. The integration enabled the introduction of a number of operational reforms which helped the Railways to meet more fully the demands of the rapidly increasing volume of traffic.

The Jhansi Division, Shri Chakravarti said had been in the forefront of the all-round progress registered by the Railway. The net ton miles carried on this Division on the Broad Gauge rose from 1,030 million in 1950–51 to approximately 1,842 million in 1955–56 representing an increase of 79%. Operational efficiency also made a notable improvement with 914 net ton miles being moved per wagon day in 1955–56 as against 565 in 1950–51, thus recording an increase of 61.8%. It was mainly as a result of this increase in operational efficiency that the Railway was enabled to carry so large an increase in traffic.

The development of agriculture and industry under the Second Plan would bring about a substantial rise in

Shri M. N. Chakravarti, General Manager of the Central Railway delivering his inaugural address on the occasion of the inauguration of the Full Divisional System on the Jhansi Division, at the Divisional Offices, Jhansi on September 15, 1956.

Left: Shri M. N. Chakravarti, General Manager of the Central Railway in the unavoidable absence of Shri O. V. Alagesan, Dy. Minister for Railways & Transport, performed the inaugural ceremony of the introduction of the Full Divisional System on the Jhansi Division of the Central Railway at Jhansi on September 15, 1956. He is seen here operating the miniature electrical lever which switched out the illuminated organisational chart showing the old administrative set-up simultaneously flashing on the schematic organisational chart showing the new set-up thus symbolising the introduction of the Full Divisional System at Jhansi.

the volume of traffic to be carried and to execute expeditiously the many railway projects that would be necessary for the purpose, the need for the introduction of the Full Divisionalisation scheme, as an administrative reform, involving several far-reaching economies was keenly felt, Shri Chakravarti said.

Under the New Divisional System, the Unit is administered by a Divisional Superintendent of sufficiently high rank who is helped by a number of executive Officers specially qualified to handle Operation, Personnel, Power, etc. Shri Chakravarti stated. The Divisional Superintendent would be responsible to the Heads of Departments for the maintenance of high standards of technical efficiency and the efficient discharge of the obligations placed on the Divisional Officers besides being responsible to the General Manager for the overall efficiency of the Division. In short, the Divisional Superintendent functions on his Division as a Regional Manager with adequate powers to take decision on matters connected with the working and the development within his Division, he added.

Concluding his address, Shri Chakravarti said that while planning to expand the transport capacity and to improve the standards of operative efficiency, the Railway Administration would, with even greater determination, endeavour to move all the goods traffic offering and to make passenger travel more comfortable and ensure the highest standards of safety for the future.

EXTENSION OF EXPRESS GOODS SERVICE ON THE WESTERN RAILWAY

A Special scheme for the quick transit of goods both wagon loads and smalls was introduced on Western Railway from 1st April 1956 between Carnac Bridge and Delhi and later between Ahmedabad and New Delhi on the Broad Gauge. The basic features of the scheme are that the goods are conveyed by express goods trains within a guaranteed period and their movement is specially watched. A small percentage fee is levied extra for the service, which is refunded if the guarantee is not fulfilled.

There has been very good response from the trade to the scheme and it is now proposed to extend the scheme to other sections on Western Railway from 1st October 1956.

The quick transit service will now be made available between Carnac Bridge, Bombay and Ahmedabad, between Kandla and Jaipur and between Surendranagar and Jaipur.

The guaranteed period for transit is 4 days between Carnac Bridge and Ahmedabad and 5 days for the express service between Kandla and Jaipur and between Surendranagar and Jaipur, from the date of booking.

For this express service, an extra fee of 6 pies per rupee on the 'total freight' subject to a minimum of 4 annas per consignment will be levied in respect of every consignment which is booked under this scheme. The extra fee will be refunded if the goods are not offered for delivery within the guaranteed period.

AXLE JOURNAL FINISHING BY ROLLER BURNISHING

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

A Major weapon in to-day's war against the critical hot box problems is no doubt the process of obtaining a better finish on journals.

This finish is either obtained by grinding or by burnishing by means of hardened steel rollers, after the journals have been turned. There is however a certain amount of controversy as to which process produces the best results, but since in most of the Indian railway workshops, the practice is to roller burnish the journals, the same is being discussed in this article.

SMOOTHER SURFACE

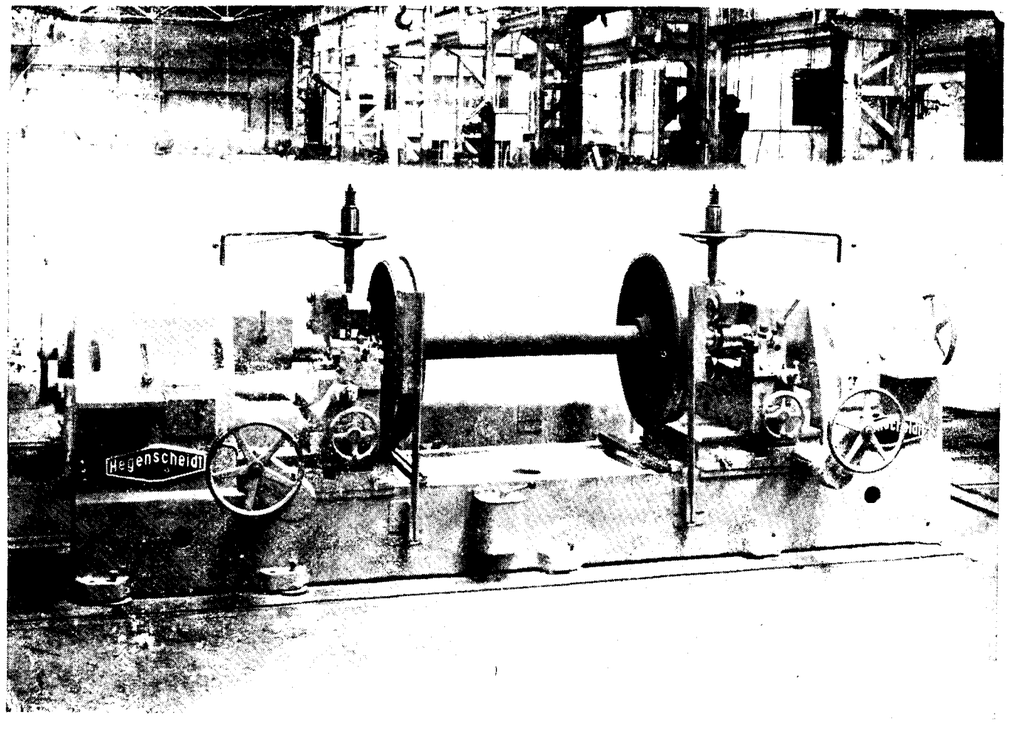
The purpose of burnishing is mainly to attain a smoother and a harder surface so as to improve the anti-frictional qualities within the plain bearing and the chief advantages derived from this process are :—

(1) Best surface quality with resistance to wear

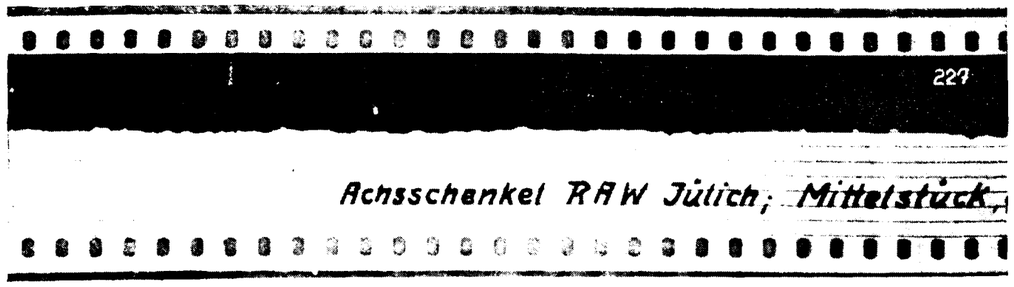
(2) Increase in tensile strength and hardness

(3) No occurrence of occlusions of hard particles in the surface skin

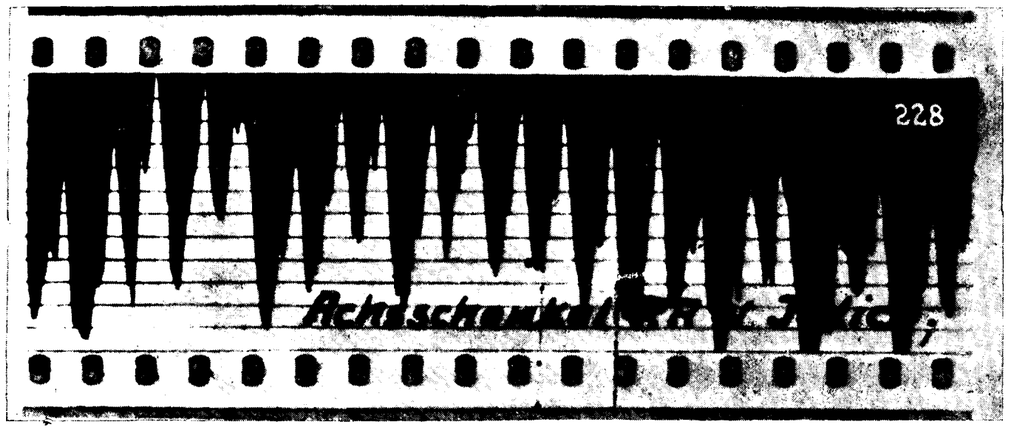
Burnishing removes all surface defects such as chatter marks, feed spirals etc. and there are therefore no projecting defects to churn the oil film or cause metallic contact.



Wilhelm Hegenscheidt Model 462 Journal Turning and Roller Burnishing Lathe.



Stylus diagram of roughness on a journal surface after a single burnishing procedure (Metal below the graph)



Stylus diagram of roughness on a journal surface after finish turning.

In course of the pressing process, the soft Ferrite is squeezed deeper due to the cold working of the surface and the hard Pearlite is concentrated on the surface and involves an increase in tensile strength and hardness. The increase in tensile strength and hardness in relation to the corresponding value of the axle is about 20 to 25 per cent according to the respective material and conditions.

No matter how smooth a ground surface may appear, examination will reveal imperfections in the form of grinder scratches and ridges, feed spirals, and partially loosened metal splinters. Upon contact, these minute peaks and ripples interlock with the mating surface of the bearing, tending to rupture the protective oil film. Fragmented metal is torn from surfaces to mix with lubricant and cause abrasive wear. Furthermore it has been noticed that in course of a grinding operations, occlusions of hard particles occur in the surface skin and essentially contribute to hot boxes arising and to an increased wear and tear.

BURNISHING PRESSURE

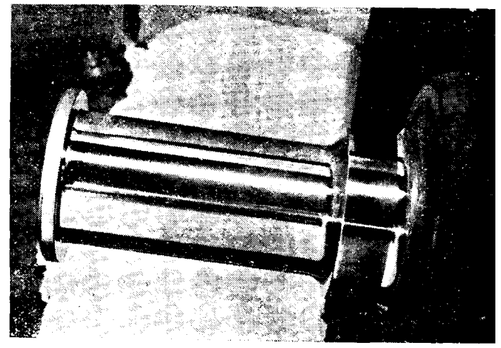
The roller burnishing, which is done by means of an axle journal turning and burnishing lathe, as depicted in the picture reproduced elsewhere, is in fact a pressing process in which the pressure is exerted by means of rotating rollers. In the case of the machine illustrated, two rollers, fitted to mutually confronting position, are employed for the purpose, each exerting the same rate of pressure. The pressure induced is considerably high so that the burnishing and pressing effect takes place in the Plastic zone of deformation and not in the elastic zone. An excess pressure has of course to be avoided as otherwise it might involve a structural destruction and in extreme cases, a peeling-off effect to a surface. It has been observed that best results are obtained when the process is executed at an apportioned burnishing pressure of 2 to 3 tons immediately after a preceding turning operation.

In other designs of such a lathe, burnishing is effected by one burnishing roll and two freely suspended counter rolls. This arrangement, where the burnishing pressure is balanced by two counter rolls freely swinging, has the advantage that the full burnishing pressure actuated only by the roll on the revolving head, whereas the two counter rolls share themselves in the balance by about half the pressure each. Thus the counter rolls, so to say only 'pre-burnish' the surfaces and the main role completes the process.

OPERATION SPEEDS

From a series of careful tests, it has been observed that the best surface quality is achieved only when the operations are carried out at high speed.

In the lathe illustrated, the turning operation is done by means of carbide tools at a depth of cut of about 0.01". The cutting speed is between 330 to 400 feet per minute and the feed is about 0.01' per revolution. Due to this high cutting speed, built-up cutting edges are prevented from arising and the flow of properly curled cuttings is greatly favoured. The turning characteristics thus achieved, result in the very best conditions for the subsequent roller burnishing process.



Burnished journal of a carriage axle.

While on roller burnishing operation, the wheel is revolved at a speed of about 150 revolutions per minute

(Continued on page 28)

STOCK CONTROL

By A. Deb, B. E.

QUALITY Control is an essential feature in modern industry. Stage inspection, which falls within the ambit of quality control, arrests faulty production and reduces cost of manufacture. Minimum cost, maximum out-turn is the motto in all industries. Industries start with stores, in the form of raw material and culminates in the form of finished product. The role of Stores cannot, therefore, be too highly exaggerated. If the Stores are not forth-coming according to programme, then progress will be adversely affected. And what is Stores? Stores are nothing but articles in exchange of hard cash. Just as we invest capital, in cash, in Bank; we can, as well, invest capital in kind in Stores. We submit cheque to the Bank for drawal of cash. We submit requisition to Stores for drawal of material. There should be no fundamental difference, in principle of operation. A Banker administers by controlling his cash. A Store-keeper serves by controlling his stock. Stock-control is, therefore, the key to Store-keeper's success. Efficient Stock control ensures expeditious flow of material to constituents, with the investment of minimum capital. Stock control in Stores is what is quality control in Industry. As Stores are sinquanon for Industry, so stock control is sinquanon for quality control.

Items of Stores, for which there is a regular turn-over caused by constant demand are held in stock for drawal by constituents against requisitions. These items fall under the category of stock items. There are items, for which there is no regular turn-over, caused by constant demand. Nevertheless, these are also procured and distributed by Stores department. Such items, are, however, called non-stock items and these are procured as and when required. Stores for construction Projects or Works for which separate estimates are prepared or items for which there is specific demand, as apart from regular demand, for maintenance work constitutes non-stock item. Funds for these non-stock items are provided from the working expenses and charged direct to the relevant head of allocation. The stock items are, for facility of control, charged against a suspense head which is release as and when Stores are drawn by submission of requisition, indicating head of allocation, under the working expense. Collection of all charges for procurement of stock items under one head is a step towards stock-control.

The investment of capital for procurement of stock should be guided by the Principle—Minimum investment, maximum service or maximum service with minimum stock. To work out this principle in practice, certain procedure have been evolved by experts on store-keeping. The success in stock control depends, to the extent these procedures are observed by store-keepers.

Ledger is the heart of the organisation. All information pertaining to procurement, distribution are systematically and chronologically maintained by ledger keepers. Purchase order—reference, quantity ordered, date of maturity of orders, date of receipt, date of issues, balance, pending demand, surplus stock, reserve stock, stock level for submission of recoupment (minimum) quantity to be ordered at a time (maximum) etc. are very useful data, readily available from the ledger.

Store-keepers make free use of these data and assess the consumption of stock in true perspective. Incorrect assessment would lead to incorrect estimate for procurement and would result in either surplus stock in stores

(Continued from page 27)

with a feed of about 0.02" per revolution. During burnishing, which is done in a single-pass operation to only one direction, an actual plastic deformation and compression of the journal surface takes place and results in a reduction in diameter of about $1\frac{3}{4}$ thousandths of an inch and an amazing smoothness of the surface is achieved.

In view of the reliable and successful roller burnishing method, this procedure of finishing axle journals is now the rule in Germany and in a number of continental Railway Workshops; and the Duetsche Bundesbahn make the following prescription :—

"The cylindrical part of the journal of axles and auxiliary journals and the flange must be burnished and the groove be polished."

or pending demands for indentors. While experience and discretion are the main factors in correct assessment, the following basis should be pursued.

(a) Period of assessment—There are items which are drawn from Stores every month, there are items (say machinery or rolling stock component) which may be drawn every three years. There are seasonal issues, erratic issues. Every care and caution has to be exercised for determining, the period to be considered, for assessing the consumption.

(b) Consumption—After reckoning the period, the consumption for the period is assessed excluding—

(i) Consumption against capital programme for which separate budget provision is made,

(ii) Consumption against non-recurring revenue demand such as arrangement of fair, exhibition, popular celebrations.

(iii) Consumption as substitute issues, in the absence of proper item.

(iv) Issue of Stores to other depot on transfer account, is to be offset against consumption.

(v) Issues for finishing, re-conditioning or repairing.

(vi) Issues on loan.

(vii) Issues as sample.

(viii) Sale.

(ix) Return of Stores by indentor is to be offset against the consumption.

The object of exclusions, as enumerated above is to assess "true issues" only.

After assessment of consumption on the basis of 'true issues', the minimum quantity to be ordered is to be fixed. The minimum quantity, is the quantity that will be consumed during the period of procurement. As Stock level falls to minimum, fresh Order for stock is submitted to the procurement branch. The minimum quantity, therefore represents Stock-Order-point level and provides for time lag for procurement.

The time lag for procurement depends on

(1) Proximity to the source of supply.

(2) Market condition.

(3) Whether the item is for meeting emergency.

After determining the minimum quantity i. e. the level when fresh recoupment is to be arranged for, the quantity to be ordered is to be fixed. The quantity to be ordered depends on

(1) Capital to be locked-up

(2) Storage capacity

(3) Economic size of the order

(4) Number of purchases to be made in a year.

In arriving at the quantity to be ordered, dues against orders, already placed & pending demands are also considered. The relation is expressed arithmetically.

Quantity to be ordered = maximum + minimum + pending demand,
— Stock on hand — dues on order.

In an ideal condition, when the order is placed, Stock in hand is equivalent to minimum and pending demands should be equal to dues on order.

Therefore, quantity to be ordered = maximum.

The term maximum may appear misleading as it is the minimum or lowest quantity that is always ordered, to meet the maximum needs of the constituents. Maximum has no relation with minimum. In fact, imported Stores the minimum is more than the maximum. Minimum controls the time factor in recoupment, Whereas maximum controls the quantity factor in recoupment. Obviously Time and Quantity cannot be equated to proportions Various phases in procurement and phases of stock can be shown graphically. (See Indian Railway Engineer Vol. 3 No. 2 page-30).

The aim of Stock Control is to invest the minimum for the maximum service. The term maximum has, therefore, to be understood in proper perspective. The deliveries against orders may be staggered that there is no accumulation of stock, with the result of keeping the least capital at charge.

Procuring more quantity than necessary to meet the maximum demands, means creation of Surplus Stores. Procuring less quantity than necessary to meet the maximum demands, means accumulation of pending demands of indentors. So, the best course is the middle course such that there is no surplus, no pending demands. There cannot be any better Stock-control than the establishment of this balance.

A Chart is given below showing the maximum & minimum according to type of Stores. When the consumption varies, the minimum may be revised. The Stores balance may be controlled by controlling the minimum.

MAXIMUM & MINIMUM FOR RECOUPMENT

Type of Stores	Maximum (in months)	Minimum (in months)
Imported item to be specially manufactured for Railways Superheater elements, Fog Signal, Thermic Syphon, Roller Axle box, Weldless angle ring for boilers, dome-ring	12	16
Imported items not specially manufactured for Railways—recoupments and not readily available in the country in sufficient quantities. Pipes, cutting tools, Crucible	12	12
Imported items readily available in the country—Lubricator, Ball bearing, ejector, Head-light, Pressure-gauge	12	4
Indigenous items specially manufactured (Steel castings)	12	15
Indigenous items specially manufactured (other items) Fire-brick, cables	12	9
Indigenous items not readily available but used by Railways. Grinding wheels, Wire rope, Rivets, All manufactured items, Paints, Crucibles, Carbon brushes, Telephone equipments	12	6
Indigenous items readily available. Brushes of Sort	12	4
Iron & Steel (Controlled items)	3	13
Timber	12	4
Work-shop manufactured items	4	6

* Summary of a lecture delivered before Store-keepers at Howrah. For details refer to the book, Stores Manual, by the author.

General Considerations in the Design of a Locomotive

By M. S. Surma

THERE is enough of published literature—experimental as well as analytical—available on the design of the locomotives. It includes the works of some of the eminent investigators and railway engineers, who have set definite recommendations for the locomotive designer to make his machine a stable, freesteaming, efficient and economical unit. Although the designer is helped to a very great extent, in the broader essentials, by the data published in this literature, he still finds in front of him a tough task to perform, as he has to make a compromise between, or choose one of the factors, which oppose each other, and the protagonists of each of which, advocate for their choice with equal force. Some of the controversial factors are given below as an example :—

(i) Large driving wheel is better for the steam cycle efficiency, but small one is desirable for the stability of the vehicle.

(ii) Coning is a desirable feature but is a source of instability of the vehicle.

(iii) Stiffer springs, raise the "critical speed"* but softer ones improve riding.

(iv) Higher centre of gravity reduces flange impacts on the rails and lower one raises "critical speed".*

(v) As much mass as possible should be disposed of at the end trucks for adequate guiding but maximum mass should be concentrated near the centre of gravity for easy guiding.

(vi) Reciprocating masses left unbalanced give rise to swaying couples but when balanced induce hammer blow on the rails.

(vii) A compromise between higher steam pressure with moderate steam temperature and higher steam temperature with moderate boiler pressure.

Apart from the few consideration given before, the designer has to satisfy certain restrictions imposed by :—

(a) Nature,

(b) The operating department,

(c) The Civil Engineer,

(d) The maintenance engineer and

(e) The legalities.

In the following paras an attempt has been made to discuss briefly the influence of the factors given in para 2.

RESTRICTION IMPOSED BY NATURE

(a) *Weather* :— Weather influences the adhesion between the rail and the tyre. In dry weather adhesion increases and in damp it decreases. The designer has to provide sufficient weight on the coupled wheels taking into consideration, of course, the axle load and the maximum specified load to be hauled in the worst conditions without giving rise to excessive slipping. Here the designer has to decide about the number of the coupled wheels to be introduced to get sufficient adhesion. Very high temperature of the region of operation may possibly necessitate the use of hot water injectors. In a very sandy region, Sanding gear can be dispensed with and protection for bearing surfaces from the Sand has to be provided.

(b) *Fuel* :— The quality of the coal affects the combustion. A low quality of coal calls for comparatively wider fireboxes with greater firebox volume/grate area ratio to obtain good combustion. On account of the higher incombustibles in the low grade coal the necessity arises to use larger ash-pan and even in the presence of rocking grates the maximum length between the steps has to be limited, and more time for fire cleaning is required. It is clear the quality of the coal on the basis of above considerations influences the wheel arrangement and the type of frame suitable for high speed locomotives, as on account of the presence of wider firebox and larger ash-pan a rear carrying axle is necessary and a bar frame preferable. Any decrease in the calorific value of coal means a rise in fuel consumption which is not proportional to the calorific value. For instance if the calorific value of the coal is reduced by, say about 15%, the fuel consumption may rise by nearly 50% to maintain same speed. This results in requiring more wagons to move this extra amount of coal. To maintain the steam production to meet the demand of the cylinder,

* A speed when the energy input by the disturbing forces is balanced by the energy output by the damping forces.

the firing rate has to be increased and coupled with more frequent rocking, limitation is placed on the capacity of the fireman. Much stronger draught, which results in sparking and back pressure, is necessary.

(c) *Water :—* The quality of water affects the performance. Bad quality of water gives rise to priming which reduces the efficiency of the boiler. It decides the number and locations of washout plugs, mud holes and water space dimensions.

RESTRICTIONS IMPOSED BY THE OPERATING DEPARTMENT

The size and the power of a locomotive has to be decided according to the needs of the operating department which gives the information about the maximum load to be hauled, and the maximum speed on a particular region where the locomotive is to operate. This data enables the designer to decide about the rated horse power and the tractive effort of the locomotive after taking into consideration the severest grade the locomotive has to attack, the sharpest curve it has to negotiate, the maximum wind and other resistances all put together. The maximum tractive effort a locomotive has to develop can be determined as,

$$TE = RR + GR + CR + WR$$

where,

TE is tractive effort,

RR is rolling resistance,

GR is grade resistance

CR is curve resistance and

WR is wind resistance.

$$\text{Indicated horse power} = \frac{TE.S}{375}$$

where S is speed in miles/hour.

This sets the ground for determining the further proportions of the boiler required, stroke and diameter of the cylinders and the diameter of the driving wheel.

RESTRICTIONS IMPOSED BY THE CIVIL ENGINEER

(a) *Track Gauge:—* The track gauge of a region is decided by taking into consideration the following factors.

(i) density of the traffic—passenger and goods.

(ii) Terrain of the region.

Its influence on the locomotive may be summed up as follows :

(i) In the case of a wider track gauge, the centre of gravity of the suspended masses can be, where possible, pitched high which will reduce the intensity of the flange impacts on the rails. The friction moment at the wheel treads about the centre of friction in increased, which necessitates higher controls at the ends of a locomotive. The lateral spacing of the bearing springs is increased which is a disadvantage from riding point of view.

(ii) Small track gauge imposes a limit on the maximum operating speed, as the possibilities of overturning on the curves are greater. There is a danger of steam cycle efficiency also being affected due to small driving wheel.

(b) *Permanent way and bridges :—* The strength of the permanent way and bridges in the region of operation decides the nominal axle load, the weight/foot run of the rigid wheel wheel base, of the overall wheel base and of over the buffers of the locomotive to operate. It restricts the virtual wheel load, which is the algebric sum of the following,

(i) Static wheel load, $= W$

(ii) Impact due to speed $= \frac{V}{3\sqrt{U}}$

(iii) Effect of the rail joint $= n^2/_n$

(iv) Effect of the steam thrust $= \frac{\pi d^2 P}{4} \times \frac{r \sin\theta \pm h}{L}$

(v) Effect of the hammer blow $= \frac{M}{g} \times r \times (2\pi n)^2 \sin\theta$

(vi) Extra load due to rolling $= W \times \frac{(b + H\theta)}{2b} - \frac{W}{2}$

(vii) Relief due to adjacent wheels

Where, M is reciprocating masses balanced, lbs.
g is gravitational constant
r is the radius of the crank inches
θ is crank angle
θ is angle of roll
n is number of the revolutions of the driving wheel/sec.
d is diameter of the driving wheel inches
P is the boiler pressure/sq. in.
h is the height of the crosshead above the centre line of the driving wheel, inches
H is the height of the centre of gravity above the axis of roll
2b is the lateral spacing of the bearing springs
W is the weight of the suspended masses lbs.
L is the length of the connecting rod inches
U is the modulus of the track
V is the speed in miles/hour.

Static wheel load can be reduced by boring the axles and by using alloy steel for reciprocating masses which result in reducing the effect of hammer blow as well.

The condition of the permanent way affects the design of the spring gear as well. In the case of excellent permanent way, a simple spring gear with independent bearing spring for each wheel can be used. But compensating gear and soft springs become desirable where the track conditions are not very good.

(c) *Curves and turn-outs :—* Sharpness of the curves and turn-outs decides the length of the main rigid wheel base, overall wheel base and the lateral swing to be provided at the end trucks. These things should be so decided that the locomotive is able to pass the sharpest curve or turn-out with the least possible resistance and making slightest possible impacts on the rails.

(d) *Grades :—* The locomotive should be powerful enough so as to haul the maximum specified load at the maximum required speed without any danger of pressure drop on the steepest gradient. It should be able to develop sufficient tractive effort and should have adequate weight of adhesion so that it is able to start with the maximum specified load, without slipping, if came to stop on the steepest gradients.

(e) *Moving dimensions :—* The maximum width over the cab, the maximum height of the highest part, the height of the lowest part above the rail level and the maximum distance of the projected parts from the platforms and other constructions should be within the specified limits of the moving dimensions.

RESTRICTIONS IMPOSED BY THE MAINTENANCE ENGINEER

(a) Capacity of the over head cranes in the shops imposes a limit on the maximum weight of the loco.

(b) The length of the existing pits, traversers and turn tables limit the maximum length of the locomotive.

(c) The components should be as simple as possible so that they could be manufactured or repaired with the least possible trouble with the existing tools and plants in the repair shop.

LEGAL RESTRICTIONS

(a) Legal restrictions imposed by the government of the country, for the safety of the public, for example, fitting of automatic vacuum brakes and spark arrestors, have to be satisfied.

SURVEY FOR TARAPUR-BHAVNAGAR LINE ORDERED

A preliminary engineering and traffic survey for a broad gauge railway line between Tarapur and Bhavnagar, in Saurashtra has been sanctioned by the Railway Board. It is expected that the proposed rail connection, about 62 miles, will greatly reduce the average distance covered for the movement of export and import traffic from Ahmedabad, with consequent economy in utilisation of railway rolling stock. There is also likely to be a saving in freight on the movement of salt from Bhavnagar and on coal by replacing the present expensive rail-cum-sea route via Bhavnagar.

The Tarapur-Bhavnagar line, when constructed, is expected to relieve the present pressure on Sabarmathi and Viramgam transhipment points, which would consequently be free to provide additional capacity for other parts of Saurashtra.

PAXMAN YH RAILWAY OIL ENGINE

By P. L. Woodall

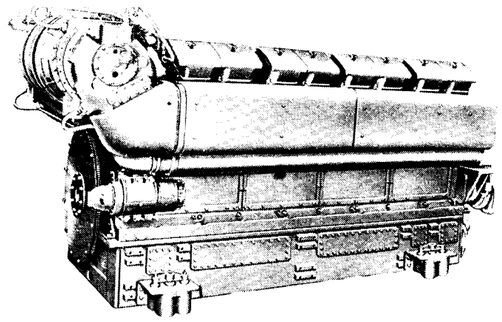
Particulars of high-speed type of 1,000 b.h.p. as ordered by British Railways.

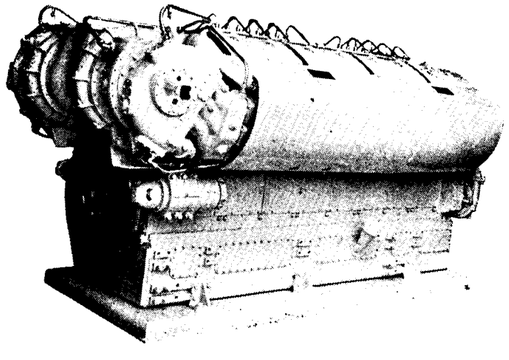
THE ordering of 20 Paxman engines of 800/1,000 b.h.p. by British Railways for installation in light general-purpose locomotives brings the commercial application of the YH range of engine into the traction field.

This initial commercial application has followed closely on the revision of the Paxman production programme for the 7 in. by 7¾ in. railway oil engines, in which the well-known RPH engines and the YH models were dovetailed to cover the whole power range from 165 b.h.p. to 1,000 b.h.p. with no more than seven models, all with a good degree of standardisation of components and wearing parts.

In essence, the RPH traction engines are now made only in naturally-aspirated form, and the YH traction engines only in pressure-charged types, that is, YHX. This is a natural development, not only because the two series built over-lapped in power, but also because while the RPH is a Ricardo-head engine and so does not lend itself so conveniently to a substantial degree of pressure-charging the YH engine is a direct-injection four-valve type which can be pressure-charged 50 per cent power increases, or actually up to a maximum of about 1,050 b.h.p.

This difference in heads is one of the principal distinguishing features between the two types. The second is a complete change in framing, the RPH having cast iron crank-case and cylinder blocks, and the 16 YH having





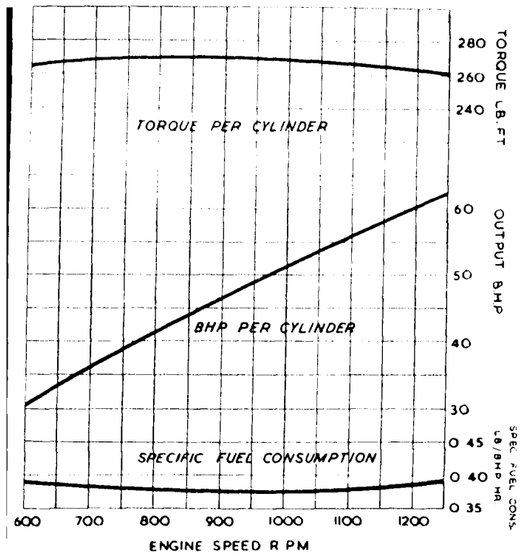
welded steel construction with cast iron for the 6 and 12-cylinder engines. But despite interchangeability of certain wearing parts, there are many differences in general design and in ratings which make the YH engine worthy of a more detailed survey.

In designing the YH the basic objects were to get higher power and lower specific weight within a bulk not exceeding that of the RPH, and without exceeding the 1,250 r.p.m. of the RPH traction applications. The short stroke helps to retain robust construction. Ease of maintenance and accessibility have been improved still further on the basis of RPH experience; on the production side sub-assembly principles have been adopted; and, combining the two, manufacture to interchangeable limits supplements the standardisation of constituent parts between all engines in the range, which standardisation also extends in large part to the RPH series. On the basis of cost per b.h.p., the ratings possible with the four-valve engine result in a lower price compared with the older engines.

Though having a welded steel crankcase extending down well below crankshaft line, and with underslung main bearings, the design of the sump in the 16-cylinder engine as being built for British Railways is not that of a simple thin metal oil pan. Sump and bedplate are combined in one welded steel structure, stress-relieved and shot-blasted. This carries special traction mountings, which can be at three or four points as needed by the particular locomotive design, and the frame can be extended to carry a main generator. It provides a large

6, 12 AND 16 YHX ENGINES

PERFORMANCE CURVES



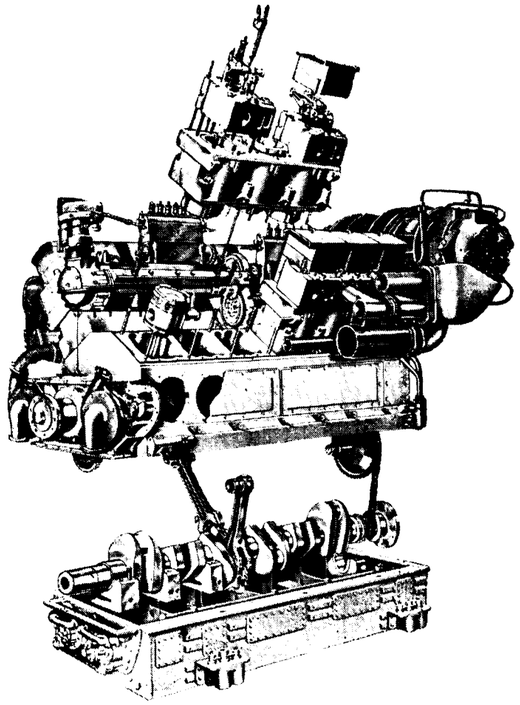
oil capacity, which in the 16-cylinder engine amounts to 80 gal. In the cast iron framing of the 6 and 12-cylinder engine, the bedplate is of fabricated steel with substantial stiffening ribs, the whole producing adequate support for transmitting the engine weight through mounting brackets or direct to the locomotive frame.

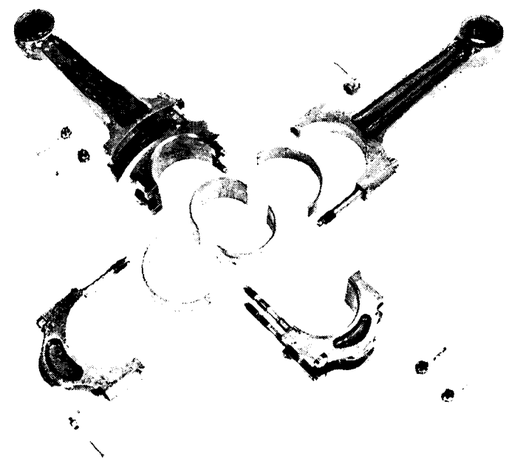
In the 16-cylinder engine the welded steel structure comprises both the crankcase and blocks of the two lines of cylinders set at an angle of 60 deg. But in the 6 and 12-cylinder engines the crankcase is one casting and the cylinder blocks are in two or four separate castings, each covering three cylinders, and surmounted by single-unit cast iron heads, each of which carries two inlet and two exhaust valves bearing on renewable aluminium-bronze seats.

In both types of construction is found that long-standing Paxman feature of exceptional rigidity in a lateral direction of the crankcase structure at or near the shaft centre line, plus deep bearing caps closely fitted into the crankcase and reinforced by lateral bolts as well as tied by the usual vertical studs. These provisions date from the old 1,500 r.p.m. high-power high-speed engines of 1937 38, which formed the introduction of the 7 in. by $7\frac{3}{4}$ in. cylinder engines, now built to the extent of many thousands.

The difference in weights between the aluminium and welded steel constructions is shown strikingly in Table 1. In each case specific weight is low, but the reduction of 20 per cent of 12-cylinder light-alloy engine compared with the steel 'twelve' fits it also for powerful railcars of type found at the head of multi-car trains, and with either bogie mounting or underframe mounting.

In their other details both engine constructions follow the best conventional practice, with chrome-nickel steel crankshaft 70 per cent in diameter of the cylinder bore, and with a resilient gear drive at the front end to cater for auxiliary take-offs; steel-shell copper-lead and lead-flashed precision main bearings; fork-and-blade rods with chromium-plated block for the blade rod bearing; cast Y-alloy pistons; high-pressure lubrication system with dual pumps in a housing outside the front end of the crankcase; a Monikron cast iron chain-driven camshaft in two parts, located in the neck of the V, and with the fuel pump drive off the centre portion of





each section; and with governor suited to diesel-electric or diesel-hydraulic traction. Pressure-charged engines have exhaust-gas turbo-blowers Buchi principles, two for each of the 12 and 16-cylinder engines and one for the 6-cylinder engine at the driving end.

For specialist applications demanding high-power low-weight ratios, the 6 and 12-cylinder engines are also available in high-strength cast aluminium alloy.

TABLE I — PAXMAN PHX 7 IN. BY $7\frac{3}{4}$ IN. TRACTION ENGINES

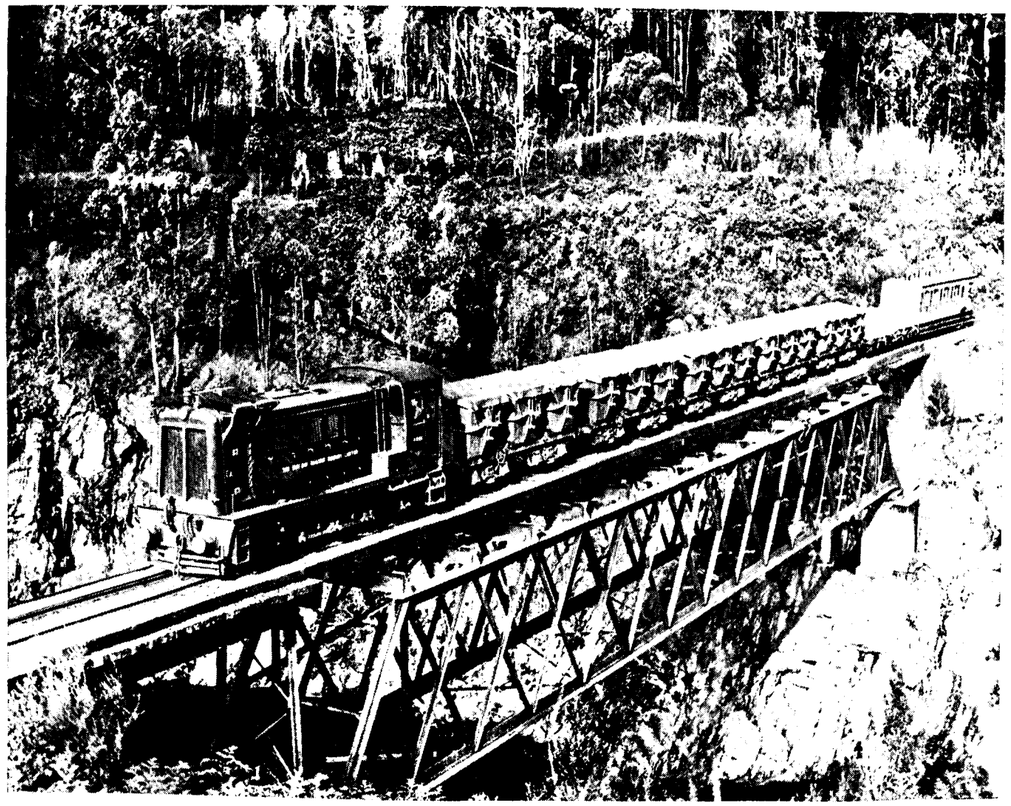
Model	*Construction*	*No. of Cyls.*	*B.H.P.*	*R.P.M.*	*Dry Weight lb.*	*Lb. per b.h.p.*
6YHX	Light alloy	6	365	1250	4600	12.6
6YHX	Cast iron	6	365	1250	6340	17.4
12YHX	Light alloy	12	750	1250	8030	10.7
12YHX	Cast iron	12	750	1250	9080	12.1
16YHX	Welded steel	16	1000	1250	12780	12.78

LOCOMOTIVE OPERATION IN TASMANIA

FOR two years now the 3 ft. 6 in. gauge Emu Bay Railway in Tasmania has been running with great profit a 530 b.h.p. Paxman-engined diesel-hydraulic locomotive in line service. It is used in freight service only, for passenger traffic on the line is handled by railcar.

Silver lead ore is the main traffic on the Emu Bay Railway, the loaded trains coming from the mining area around Rosebery to the sea at Burnie, a distance of 70 miles, in the course of which the track climbs from 640 ft. to 2,306 ft. in 25 miles mainly by 1 in 40 grades, and then falls from the summit to 125 ft. at Burnie at gradients of 1 in 33–40–60. In combination with the heavy grades are almost continuous curves, and full-length ore trains are sometimes on three curves at once. In fact, we believe it true to say that except in stations a full length train is never wholly on straight track for 65 out of the 70 miles; and the locomotive itself is fitted with a Beugniot bogie connecting the two leading axles in order to ease the passage round the numerous 4-chain curves which, along with the track conditions have resulted in a top speed limit of 25 m.p.h. for all locomotives.

Extremes of climate are considerable; in temperature from over 80 deg. F. to under 25 deg. F., and with long-maintained cold winds coming in off the sea into Burnie shed. Routine traffic on the railway calls for two trips a day with load from Rosebery to Burnie, and two corresponding return trips with empties and miscellaneous supplies. One of these round trips is usually made by the diesel, and the other by the Garratt steam locomotive built years ago.



Both forms of motive power take a normal trailing load of 165 to 200 tons, and the diesel pulls this up the 1 in 33 ruling grade at a steady 5 to 6 m.p.h. with great consistency day after day, whereas the steam locomotives have some difficulties with moist rails. Time for a round trip of 140 miles is 11 to 11½ hr., and the return journey is accomplished six days a week. An immersion heater has been fitted into the cooling water circuit to give easy engine starting after lying over the week end Burnie during the winter, and to minimise cylinder liner wear; and the radiators have been moved to the casing roof to help equal cooling in each direction of travel. Apart from these details, no modifications have been made, or special equipment fitted to the Paxman pressure-charged 12-cylinder 7 in. bore engine, which is to give 530 b.h.p. at 1,150 r.p.m. at 2,300 ft., and no troubles have been encountered with it. Compared with steam traction the overall economy is reckoned at about £ 60 per round trip.

"CREATING" NEW RAIL TRANSPORT CAPACITY

RAILWAY BOARD'S APPEAL FOR CO-OPERATION FROM TRADE

In a communication addressed to chambers of commerce and other representative business organisations, in the country, the Railway Board has invited the co-operation of the business community in making a success of the railway campaign to "work the wagons harder".

These organisations have been informed that the Railway Board has decided to reduce to five hours the existing "free time" allotted to the trade for loading and unloading of wagons, so that these may be back-loaded the very same day. The reduced "free time" will be enforced from November 1, 1956, when the new busy season starts.

As part of the campaign to "work the wagons harder", the Railway Board has already issued instructions that the Railway's own coal wagons should, with immediate effect, be released in three hours instead of six and that wagons containing other railway material should be released within five hours instead of in six, as previously. Steps are also in hand to reduce the detention of wagons in collieries and other sidings and port areas.

The Railway Board's communication emphasises that in view of the likelihood of a shortfall in the availability of rail transportation during the second Plan period, it is of the highest importance that the maximum possible use should be made of the railway's existing resources in wagons, engines and line capacity, as more intensive use of existing resources would mean the "creation" of additional transportation capacity.

The Railway Board has urged the business community to extend its whole-hearted support to this and to any other measures which Railway Administrations may be constrained to take, as these measures will not only be in the wider national interests, but also in the particular interests of the large number of individual business organisations which depend for their development on the maximum possible availability of rail transportation.

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FRENCH TEAM'S REPORT ON RAILWAY ELECTRIFICATION PRESENTED

A report on certain technical aspects of railway electrification in India by a team of French railway experts was recently presented to the Railway Board at a ceremony in New Delhi.

The report was presented by the leader of the team Mr. F. Nouvion, Chief Engineer of the French National Railways, to Shri G. Pande, Chairman, Railway Board. Among those present at the ceremony were Mr. M. Christian Belle, French Minister Counsellor in New Delhi, Mr. M. Guy Chaumet, French Counsellor for Economic Affairs, Mr. J. Boulgne, Project Engineer, French Railways, and Members and Additional Members of the Railway Board.

Acknowledging the "very hard" work put in by the team, Shri Pande said that the report would be most valuable in helping the Government of India in coming to a final decision on railway electrification. He requested Mr. Belle, the French Minister Counsellor, to convey to his Government and to the French National Railways, the gratitude of the Government of India for the help given by the team.

In their report, the team has expressed the opinion that the A. C. 50 cycles traction system would be more appropriate for the Indian conditions, and substantially cheaper than the D. C. system.

The services of the team were placed at the disposal of the Government of India about three months ago by the French Government, which had also offered to meet the teams's expenses on travel and stay in India.

The team undertook a tour of certain sections of the Indian railways where electrification is proposed, and flew back to France, where the report was finalised. The report will now be considered by the Railway Board.

INDICES OF PRODUCTIVITY

By Jagjit Singh,

Director, Efficiency Bureau, New Delhi.

ONE of the methods for improving managerial effectiveness is the examination of some index of production or cost per unit output relating to a number of factories. When such indices for a group of factories are examined they are usually found to exhibit a fairly wide range of variation. Some factories may come close to the average, others too far above or below it. The suggestion has been made that an examination of the reasons of such variations cannot but be useful. If this examination shows that the factors leading to below average output of certain factories are, in fact, remediable, the gain is evident. But even if it reveals that the variation is due to something that is unalterable, then no harm has been done. In either case the management would be the gainer either by being able to improve efficiency or by at least knowing that it cannot be done.

The Estimates Committee of the Lok Sabha in their 31st Report suggested the application of this technique so as to make more effective the control exercised by the Indian Railways on their Revenue Expenditure. In order to give a definite idea of how this technique may be applied, it is proposed in this article to describe a special case — a sort of case history — that will bring home the rationale underlying the suggestion more clearly than a lot of generalisations. In this specific investigation we examine the cost per train mile of traffic train staff employed on working passenger and goods trains on the different broadgauge railways. Since the scales of pay and allowances paid to such staff are now by and large fairly uniform, we may expect the costs of different railways to be more or less the same and yet Table I below giving the cost of traffic train staff per train mile on the different railways shows wide variation :—

TABLE I

Railway	*1952–53*	*1953–54*	*1954–55*
	(Cost per train mile in annas)		
Central	1.40	1.46	1.51
Eastern*	2.44	2.58	2.56
Northern	1.99	1.78	1.85
Southern	1.85	1.90	1.82
Western	1.31	1.35	1.44

* Figures relate to the old Eastern Railway prior to bifurcation into two new railways, in August, 1955.

It will be observed that the cost on the Eastern Railway is consistently much higher than that of other railways. This is due to the fact that Eastern Railway loads over 95 per cent of total coal wagons loaded in the country and moreover serves a heavily industrialised belt in the coalfields and Calcutta area. As a result it has to feed a large number of collieries and industrial mills. This is done by running large number of short distance pilot trains for the supply of empties and drawing of loaded stock from the colliery and industrial sidings. In other words, the incidence of uneconomical working requiring the use of extra train staff is relatively much more on the Eastern Railway than on any other railway. An attempt has been made to assess quantitatively the extent to which this factor is responsible for the higher cost.

The quantum of work requiring extra train staff which does not contribute to any extra train miles is measured by siding engine miles. On account of heavy coal and mineral loading on the Eastern Railway the incidence of siding miles is much higher than on any other railway. Table II below shows the siding miles for the B. G. Railways, during 1954–55 as well as the "equivalent" train miles into which they may be converted by multiplying them by 7. The underlying rationale of this procedure is that one siding engine hour is taken as equivalent to one engine hour which would produce 10 train miles if made to work ordinary goods train.

TABLE II

(Figures in thousands.)

Railway	*Siding miles*	*Equivalent train miles*
Central	591	844
Eastern	2805	4000
Northern	129	184
Southern	65	93
Western	64	91

It will be seen that siding engine miles are very much higher on Eastern Railway than anywhere else and nearly the whole of it are contributed by coal pilots. Now a coal pilot is ordinarily worked by a 'B' Grade Guard accompanied by 3 or 4 shunting porters. Some pilots, however, are worked even by two guards and the number of shunting porters accompanying these pilots is proportionately higher being about 6. Consequently from the cost point of view one team of traffic staff including shunting porters working a coal pilot would be equivalent to 3 'C' Grade Guards in respect of emoluments received.

It would thus appear that each equivalent train mile contributed by siding engine miles is worked by three times as many Guards as on ordinary goods train. Consequently the problem of coal loading entails an expenditure which could secure an equivalent of 4,000,000 × 3 = 12,000,000 train miles but for which Eastern Railway receives no credit.

It now remains to take note of one more factor. It is the fact that train miles contributed by the coal pilots when they move on the Main Line are proportionately much less than if the same engines hauled through trains. In fact, a coal pilot moving for 10 hours contributes hardly 10 train miles as against 100 train miles contributed by a train engine during the same period. It, therefore, follows that one train mile contributed by a coal pilot travelling on the main line is equivalent to 10 train miles. It has been estimated that of the total train miles accruing on the Eastern Railway 1.5 per cent are contributed by coal pilots. The basis of the estimate is as under. A theoretical calculation of the total wagon miles that would accrue on the Eastern Railway if all trains ran full load and up to full power quotas on all sections shows that out of a total of 3,533,055 wagon miles 49,747 are contributed by coal pilots on main lines, that is, 1.4% of the total. Allowing for a slight difference in the average loads of trains and coal pilots we may adopt the estimate of 1.5 given above. But the total number of goods train miles on the Eastern Railway is of the order of 20,000,000. Of these, 3,00,000 train miles would be contributed by coal pilots. But these 3,00,000 train miles are equivalent to 3,000,000 ordinary train miles. In other words, an extra of 2,700,000 train miles could accrue but actually do not. In order to reduce the disparity on account of these two factors and make the comparison possible, it is necessary to express the quantum of equivalent train miles that could accrue but do not actually accrue. This quantum is shown in Table III as a percentage of the actual train miles accrued on the railway during 1954–55.

TABLE III

(Figures in thousands.)

Railway.	*Equivalent of siding miles*	*Equivalent train miles after allowing for extra staff on coal pilots*	*Equivalent train miles due to slow movement of coal pilots*	*Total*	*Total actual train miles*	*Extra train miles as percentage of total*
Central	844	844	—	844	33,743	2.5
Eastern	4,000	12,000	2,700	14,700	41,081	36
Northern	184	184	—	184	28,166	.6
Southern	93	93	—	93	14,023	.6
Western	91	91	—	91	12,200	.7

Now suppose total expenditure on a railway under this head is E and train miles N. Consequently average cost per train mile is $\frac{E}{N}$. But this takes no account of unaccrued train miles referred to above. If the percentage of unaccrued train miles is a, "real" train miles produced for expenditure E are $N+\frac{aN}{100}$. Hence the "real" average is

$$\frac{E}{N+\frac{aN}{100}} = \frac{1}{1+\frac{a}{100}}\left(\frac{E}{N}\right)$$

$$= \frac{1}{1+\frac{a}{100}} \text{ (Actual average)}$$

Table IV below gives the "real" average cost as compared with the actual average for the B. G. Railways.

TABLE IV

Railway	*a.*	$\left(1+\frac{a}{100}\right)^{-1}$	*Actual average in 1954-55*	*Real average*
Central	2.5	$\frac{1}{1.025}$	1.51	1.47
Eastern	36	$\frac{1}{1.36}$	2.56	1.88
Northern	.6	$\frac{1}{1.006}$	1.85	1.85
Southern	.6	$\frac{1}{1.006}$	1.82	1.82
Western	.7	$\frac{1}{1.007}$	1.44	1.44

This shows that the "real" cost on the Eastern Railway is of about the same order as on Northern and Southern Railways though slightly higher than on Central and Western Railways. It will thus be seen that the comparatively higher cost of train staff on the Eastern Railway is due to a state of affairs that is unalterable.

RECORD PRODUCTION AND EXPORT OF U. K. DIESEL LOCOS.

The production and export of Diesel locomotives built in the United Kingdom have broken all records this year.

In the first half of this year, the combined output of British firms making Diesel and Diesel-electric locomotives was 501. This is a rise of 50 per cent. compared with the same period in 1955.

The English Electric Co. recently completed delivery of 23 2,000-h.p. Diesel locomotives for Rhodesian Railways and 42 mixed-traffic units for New Zealand. These orders are in addition to those for Netherlands Railways, British Railways, and others. Diesel locomotives built by English Electric are also operating in the Calcutta area.

At present, British builders of Diesel locomotives are executing orders from Malayan Railways, East African Railways, Netherlands Railways and Irish State Transport, as well as from the British Transport Commission.

THE EVOLUTION OF DWELLINGS

By Gurdial Singh, A. M. I. E., A. M. I. Struct. E.

THE three primary needs of human beings are food, clothing and shelter and the whole struggle of life is primarily based on obtaining these. In prehistoric times primitive man sought shelter in caves like his forbears the apes. As he developed implements for procuring his food through cultivation and hunting, and as the numbers increased, the need of some other type of shelter came to be felt. In those early times, the materials readily available were the branches of trees, straws of various types and the skins of animals. A hut made of cut tree branches and covered with straw or skins of animals was, therefore, the first natural habitation developed by early man, who was essentially a nomad and moved about in search of food and water.

This type of shelter continues to be common amongst the primitive people to this day. The nomadic tribes inhabiting the snowy wastes of Central Asia are almost entirely dependent on the yak for their sustenance. Its milk and meat is their staple diet, its dung their fuel and its skin serves them both for clothing and shelter. It is also the chief means of transport for them. The Eskimos of Tundras similarly mainly depend for their living on the reindeer. They have, however, contributed to the development of another dwelling in its primeval state viz., the Igloo shown in Figure 1. This is a dome-shaped structure built of snow, which hardens into ice and is the predecessor of our load bearing wall buildings. We must therefore, clearly distinguish between the two types of buildings, which followed as a logical consequence of the building materials available to primitive man.

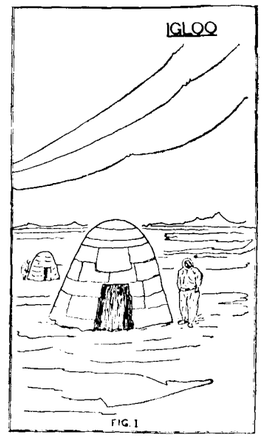


FIG. 1

(i) The point loaded structure developed from the basic conception of a hut and tent.

(ii) The bearing wall structure based on the igloo.

Till recent times, these two basic conceptions governed our constructions from a lowly hovel to a palace. In the present age, however, man has come across materials, which possess a very important property in which the materials known to early man were deficient viz., the tremendous capacity to resist a pull. This has enabled the present day builders to develop the idea of an umbrella, where the structure is spread out from a central support. This has led to the adoption of slender and graceful lines observed in the structures put up for our sports pavilions, gymnasia, platform shelters and residential buildings. Typical sketches of such designs are shown in Figures 2 and 3.

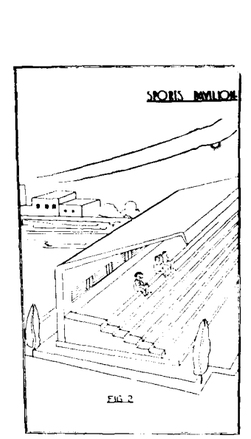


FIG. 2

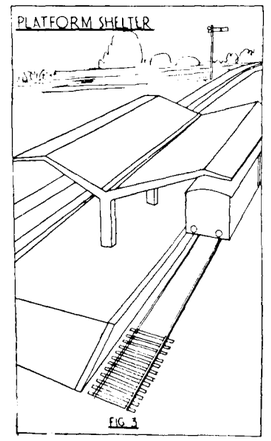


FIG. 3

In course of time, man discovered that he could span across two walls by laying a log of wood across. The natural development of the frame of the hut was a timber frame with pillars and beams both of this material. These were filled in with pieces of stone laid in mud mortar. With the discovery of lime, walls were laid in this material. Such constructions are still common in our hilly districts. The development of roofing has been greatly influenced by weather conditions. In hills of India, where both rainfall and snowfall are heavy, sloping roofs are common. Similarly in

countries in the Northern latitudes, sloping roofs are in vogue. The fundamental idea behind the sloping roof is the primitive hut and, therefore, the original form of this type of roof was with the gable walls, as shown in Figure 4. From the very beginning, however, man has been fond of beautifying his surroundings. Even early man tried to decorate his caves with crude drawings of animals and plants. The gable roof, therefore, was modified to a pent roof shown in Figure 5, which lends itself to graceful outlines of structures. Some other types in the sloping roof e. g., the Mansard Figure 6 were also developed. The material for covering the roofs was varied. Wooden shingles are still widely used especially in Kashmir and other hill stations, where

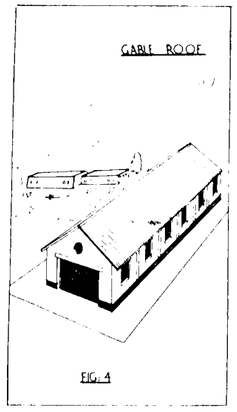
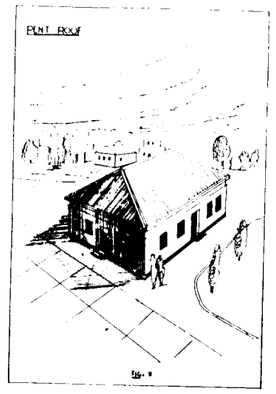


FIG. 4



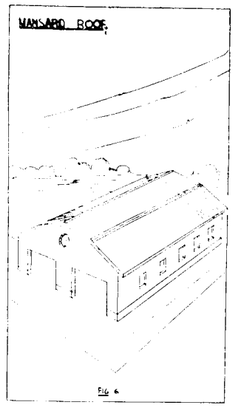


FIG. 6

timber is plentiful. Slates, tiles, corrugated iron and asbestos sheets are the other materials commonly used.

The other type is the flat roof obtained originally by putting timber balks across the supports. On these beams were laid battens, which in their crudest form were merely thick branches looped off from trees. On these were laid thatch, which was covered with earth. In modern design with the advent of steel and concrete, flat roofs are made of brick or reinforced concrete slabs, while steel or reinforced concrete beams span over long spans. Our point supported construction now consists of steel or reinforced concrete columns spaced widely apart, while the floor space is divided into rooms by light partitions of brick, concrete or other suitable material. This gives us great latitude in designs. Large glazed windows admitting plenty of light and sun shine are now a general rule. The sizes of rooms have become quite elastic and can be varied at will.

While speaking of roofs, we should not forget the dome, which has played a very prominent part in the architecture of all ages. The idea of a dome appears to be a continuation of the arch. Some ingenious early people spanned small openings by placing stone slabs together in a rectangular formation, so that the thrust from one was communicated to the other and thence to the walls. This gave rise to the construction of arches in brick and stone for buildings and bridges. Various forms for the arch were adopted to give grace and elegance to the buildings. Later on the vault of the arch was made to spring from all the supporting walls and a domed roof was the result.

The dome has played a very important part especially in religious buildings. The ancient Egyptians started with a grand entrance to the temple flanked by massive

masonry and from this one proceeded to smaller buildings till he was in the presence of the Holy of Holies enshrined in the smallest of them all. In most other countries especially India, one entered through smaller buildings and marched through continuously increasing masses till he entered the holy Presence in a massive building overtopped by a high conical dome.

The dome is the central feature in Church buildings and mosques also. The domes of St. Paul's London & St. Peter's at Rome are amongst the finest specimens and famous for their elegance and beauty. Man has thus endeavoured to put his most delicate feelings in the form of brick, stone and stucco. Who fails to admire the fine architecture of the Taj at Agra! This building built by Emperor ShahJehan as a monument of his extreme devotion and love to his wife Mumtaz Mahal is said to be a pœm in marble. Tourists from far and near visit it and admire its grace and beauty, which is especially enchanting on moonlit nights. The dome has thus given concrete expression to the most exquisite feelings of human race—of devotion and love.

With the advent of concrete and steel, it has been possible to design domes of much larger size and different shapes. Large open spaces even upto spans of 350 ft. are now being covered by shell construction in concrete. This idea has been borrowed from the egg, which is Nature's supreme handicraft in shell construction and demonstrates how very thin membranes can be made to give effective covering. The hen however, produces her perfect shell without the knowledge of Fourier's series and solution of intricate differential equations. The shell construction has made rapid advances in Europe and America and its technique is being perfected. The result is buildings of slender and graceful outlines, which are a distinguishing feature of the modern age.

A revolution has been occurring in town planning of house building with the advance of civilization. In early times men lived in villages with houses clustered round along narrow lanes, the chief consideration being defence as a community against marauders, who were numerous due to lax law and order situation. Proper town planning and sanitation was practically unknown. In Western Countries, which are so materially advanced and prosperous now, there were reeking slums, grimy streets and stinking cess-pools. It was common for gentlemen and ladies of quality to go about mounted on ponies and horses for fear of soiling their dresses with mud and grime of the streets. In London itself conditions were extremely bad so far as general sanitation was concerned. The Thames was a stream badly polluted with sewage of the city, whose major portion consisted of filthy streets. It was only after the great fire that devastated the town in the reign of Charles II after the great plague epidemic that schemes of town planning were put through. With the advance of Science, it became clear that the various ailments and diseases were not a scourge sent by God, as punishment for the misdeeds of the human beings, but were produced by tiny germs invisible to the naked eye, which flourished in filthy surroundings. Various insects e. g. the common house fly, mosquitœs and fleas were found to be the major carriers of such deadly bacteria. The importance of clean surroundings, food and water were realised and it dawned on man that it was not merely sufficient to have a roof over his head but also procure wholesome food and water for his consumption and to have tidy surroundings with plenty of fresh air and free from the harmful insects, which thrive on dirt and filth. All ideas of town planning have sprung from the primary need of making life cheerful and worth living. The main considerations in layouts have been scientific design of streets so as to ensure smooth flow of traffic, the introduction of a central feature e. g. a large park or a garden surrounded by business centres or public buildings on which all main streets converge, open spaces and parks for purposes of recreation, ample wholesome water supply, sewage systems for carrying away animal wastes and last but not least controlled planning of buildings with well ventilated and airy rooms. In the field of water supply absolute safety against disease has been ensured by purification of water through decantation, filteration and sterilization so as to destroy all bacteria. In the field of disposal of animal wastes great progress has been made in the disposal of sewage through various forms of treatment so as to produce a harmless by product. Sewage gas has been collected and used for working the machinery in sewage farms and for supply to the public for use as fuel. Large quantities of useful manure are produced and sold to the farmers. The garbage collected from towns is processed by machines and converted into rich manure, which produces best crops.

Further additions to human comfort have been made by the introduction of air-conditioning. This consists in controlling the temperature and humidity of air before introducing it into the rooms, thus controlling the weather. This results in improvement in health, efficiency and larger output of work. The days when human beings laboured in sweltering heat or shivering cold will soon be over, as air-conditioning is introduced on larger scales.

The original ideas in house and town-planning were what we call the horizontal planning. The population

being not very heavy, single storeyed buildings covering large areas were the rule. As the pressure of population increased, it became necessary to arrange for the concentration of larger populations in smaller areas. In most cases the pressure of business became so great as to necessitate the provision of larger room volumes on a limited horizontal area. The obvious answer to this problem was the provision of multi-storey buildings extending up vertically thus giving rise to what we call vertical planning. In the U. S. A. and some other Western countries buildings several storeys high, called sky-scrapers have been built. Electric escalators are installed for quick communication between different floors. Thus vertical planning has solved the problem of population and business pressures in particular areas. Living quarters are also planned vertically. A design most economical in space was evolved by Le-Corbusier for flats in Marseilles. In these flats, living room, dining room and kitchen are located at the landing levels of stair-cases in various storeys, while the bed rooms are located above these and provided with independent stair-cases inside. The idea behind the design is to let an individual get into his living room as soon as he returns from work tired and in need of rest. The bed room is used at a later stage in the night and by that time one is well refreshed for undertaking the ascent of a small stair-case.

In India efforts in town planning date back to the hoary past, as has been shown by the excavations at Mohenjodaro and Harappa and Taxila. In medieval times, however, due to frequent invasions and wars, no serious efforts were made in this direction. The best planned town of the Moghal period is Jaipur, which owes its existence to Maharaja Jai Singh, a noted mathematician and astronomer. The observatory built by him at Delhi and known as Jantar-Mantar bears testimony to his great skill as an astronomer. Generally, however, even during the British rule barring a few exceptions our towns have grown in haphazard fashion with dead lanes and alleys, narrow-dark streets and ill-ventilated houses. The most notable example of modern town planning is Chandigarh, the new capital of the Punjab. The planning of this city was done by Mr. Mayer, an American town-planner. The idea has been to divide the city into self-contained units called super blocks, each having its own shopping centre, school, dispensary and recreation facilities. These units are then artistically blended into a complete town. A team of architects under the guidance of Le-Corbusier has been responsible for designing its buildings. In this case, however, Le-Corbusier noted for vertical planning had to plan horizontally. The buildings are designed to suit the trophical climate. The orientation of the houses and windows is such as to catch the low winter sun and concentrate it inside the rooms to give them warmth, while the high summer sun is kept out. Le-Corbusier has achieved economy in doing away with the verandahs by the provision of horizontal and vertical projecting ribs called the sun-breakers, which protect the windows against direct rays of the sun during summer. The grilles (a modern version of the ancient jharoka) designed for the houses in Chandigarh have been universally appreciated. These ensure privacy, afford good ventilation but keep out the sun during the hot months.

The modern trends in house building are simplicity, gracefulness and economy. These features were brought out in the various designs put up in the low cost housing exhibition held at New Delhi. For Indian conditions, the traditional brick-work in mud walls, with reinforced brick slab roof, continues generally to be the cheapest and dependable house. The architects of future will have to concentrate more on the simple house for common man rather than on palaces, with the passing of power from the aristocracy into the hands of the people. Improvements in design and further economies in the use of material can therefore be expected.

In foreign countries especially the U. S. A. prefabricated houses are being increasingly put up. These are mass produced in factories and are, therefore, cheap. Their erection is very speedy and one can so to say order a house off the peg. The simple two bed room house is 28½ ft. × 24½ ft. consisting of a living room 16½′ × 12′, two bed rooms 10′ × 12′, & 8′ × 12′, a kitchen, utility area bath and water closet and cost approximately 6350 dollars exclusive of the price of site and carriage charges. The prices for three and four bed room houses with living room range from 8375 to 12500 dollars respectively. These figures are exclusive of the cost of site and carriage. The cost of two-room houses displayed at the low cost housing exhibition ranged between Rs. 2650 & Rs. 4678 exclusive of the cost of site and for three-room houses from Rs. 4673 to Rs. 5600. These houses are of course not prefabricated but make use of the local materials easily available and are suited to Indian conditions. Further research on cheap houses is being carried on at Roorkee and it is hoped that designs using indigenous materials suitably processed will be evolved to make the owning of a house within the reach of common man.

Another innovation in housing in U. S. A. is a house on wheels called a trailer. Such houses are mounted on trucks and can be moved from one place to another.

They are well suited to people with *roving instincts* or those who move about from place to place selling their goods. Special sites are set apart in towns for parking these mobile houses on payment of tax. Various service connections are available at site. Such houses do away with the necessity of a person requiring accommodation at a number of places for his business. They also provide change and thus add to the enjoyment of life. There are some 9000 trailer parks in the U. S. A. and their number is growing. Retired people appear to have a great liking for such houses.

In the pre-war period the average length of a trailer was only 22 ft.; it has, however, gone up to 30 ft. now and there are 35 ft., 40 ft. & 45 ft. models. The width of a trailer is limited by the maximum moving dimension on the highways. Ingenious attempts are being made to provide more accommodation by the addition of a second storey or the provision of additional space when the trailer is parked.

Even luxury trailers are being manufactured, which have sun-decks and beautiful roof gardens. Refrigerators, dishwashers, air-conditioning equipment and television sets are provided on some of them. The price of a de-luxe model is in the neighbourhood of £ 3600. An air-conditioned coach with mahagony panelling, luxuriously furnished throne room and a bed room was supplied to King Ibn Saud of Saudi Arabia at a cost of £ 18000.

Business is being built up for hauling peoples' trailers from one place to another. These firms employ a large number of drivers and have moved people's homes all over the U. S. A. and even into Canada, Mexico and Alaska.

The trailer housing business saw a great boom after the war, when thousands of ex-servicemen who married after their return were not in a position to find satisfactory accommodation and purchased these homes on wheels, which they could easily attach to their cars. Many of them became so fascinated by the gipsy type of life, which became thus possible, as to make the trailers, their permanent homes.

Another landmark has thus been achieved in the evolution of a dwelling satisfying to the full the wanderlust in man.

COUNTRYWIDE DRIVE TO INCREASE RAIL TRANSPORT CAPACITY

THE main lines of a countrywide drive to secure the most intensive utilisation of Railway rolling stock in the country were finalised at a four-day conference of the Chief Operating Superintendents of all the Indian Railways with the Railway Board, which concluded in New Delhi last month.

Top-level Railway Operating Executives present at the meeting decided on a series of far-reaching measures designed to tackle the problem on an emergency basis, with a view to closing, to the largest practical extent, the present uncovered gap between freight traffic likely to develop during the second Plan period and the resources available for carrying it.

The Railway Board emphasised that in view of the shortage of funds, it was of the utmost importance that the Railways should through superior organisation effect economy on new capital expenditure.

The Railway Board also reviewed the past operational results of each Railway, and set new higher targets of performance for the ensuing busy season (November 1956 to April 1957) in regard to the wagon loading and wagon engine usage.

The conference attached the greatest importance to co-operation from the staff. It was decided that frequent meetings of Railwaymen at all levels should be arranged to explain to them the revised targets of performance; so that all classes of workers, including even shunting porters and pointsmen, may have a clearer perception of their respective duties and their share in the fulfilment of the targets.

The conference decided that a systematic and persistent campaign should be initiated immediately to streamline all aspects of operation, particularly in regard to faster loading and release of wagons at terminal points, expeditious disposal and proper marshalling of Goods trains and punctual running of trains from terminal yards. There should be greater supervision at focal points like Moghalsarai, Bezawada, Ratlam, Baroda, Waltair, Agra etc. to remove any deficiences which may exist.

An important decision related to the establishment of a number of "traffic control" areas to maintain constant touch over the telephone with the various points which handle wagons, so that individual wagon movement and specific traffic movements could be closely watched with a view to ensuring better output from the existing yards and wagons. Telecommunications facilities should be strengthened in accordance with individual requirements.

TELEPRINTER LINKS

It was also decided that teleprinter services should be introduced between important marshalling yard to convey full particulars of wagons despatched on different trains, thereby facilitating advance planning of further movement and disposal of wagons.

Among the other decisions taken at the meeting were the following:

The "wagon-chasing" organisation should be strengthened by posting selected senior and experienced personnel, and their retention in these jobs should solely depend upon the results they produce.

Loading Inspectors should be appointed to introduce scientific loading of wagons, particularly in big sheds and transhipment sheds so as to ensure better wagon loadings.

ADDITIONAL EXPRESS GOODS TRAINS

Additional Express Goods trains should be introduced, and these should be run like scheduled Passenger trains, providing a minimum of a weekly fast service on all the important trunk routes to enable transport of all commodities essential to the life of the community. It is proposed not to apply ordinary operational restrictions to the running of these trains.

Under this scheme some of the additional important Goods services from North Bihar to Assam, Madras to Cochin, Bombay to Kanpur, Bikaner to Rajkot etc. will be introduced.

Punctuality of Passenger trains was also discussed and various measures for ensuring better punctuality were decided upon.

HUNGARIAN ROLLING STOCK INDUSTRY

By Our Engineering Correspondent

BACKWARD GLANCE TO THE LAST DECADES

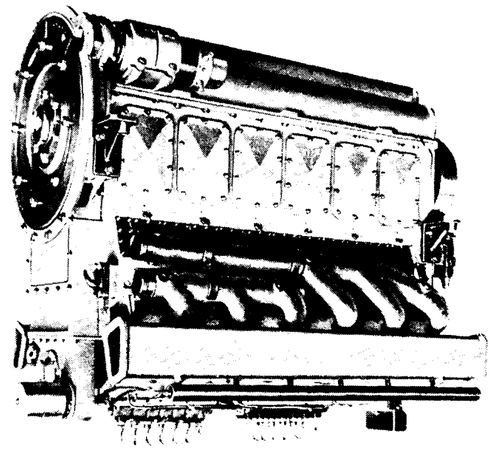
IN the twenties of present century a considerable impetus has been given to the Hungarian diesel engine construction by developing at the Ganz Wagon & Machine Works, Budapest an original type of diesel engines. Around 1925 have been started the first experiments with solid-injection diesels. The trials led by Mr. G. Jendrassik a mechanical engineer of the Ganz Co., have soon led to success. Up to 1929 about 100 diesel engines have been built and many of them have been incorporated into railway vehicles. After 1929 the existing models have been substantially redesigned and a number of new types has been developed. In the following years engines of 135, 240, and 320 b. h. p. respectively have been constructed, chiefly for railcar operation. All the models have been modernised at 1939 and the new types/rated one at 450 b. h. p. and the other at 600 b. h. p./were added. During the last war, in the years 1944–45, the Ganz factory could not be saved from war devastations, most of the shops and other buildings were left in ruins. After the war first and most important was to rebuild the factory.

From the second world war to the last year generally speaking the prewar types have been built by Ganz, while of course minor improvement have been constantly applied but they were not of a nature touching the general design of the diesel engines. Most important was the introduction of pressure charging. Trials to this effect have been conducted before the world war but without coming to a definite close.

MAIN FEATURES OF GANZ DIESEL ENGINES

The wide popularity of Ganz diesel engines may be attributed to a number of excellent properties. Characteristical feature of Ganz engines are:

Fuel injection system, which is perhaps the most important individual feature of these diesels. The working principles underlying to its design are as follows: fuel injection is effected during the whole stroke of the injection pump plunger. The stroke may be regulated from zero to a maximum length and simultaneously the dosing of fuel is undergoing a corresponding. The injection plunger is during the fuel-admission-stroke, pulled back by a cam and



simultaneously a strong helical spring located under the plunger is compressed. At the start of injection retaining effect of the cam is terminated and injection starts to a sudden shocklike manner under action of above mentioned compressed helical spring. After injection is finished, at the end of the stroke of the plunger, motion of the plunger is stopped by the insert between spring and plunger being caught by hitting the fuel pump casing. Thus the stroke is terminated in a very positive and sharply accentuated manner. The method of fuel injection possesses a few very important advantages, namely:

1. Injection is started by the impact of a compressed spring. The pressure above the injection plunger is dependent only and alone on the elastic force of the helical spring. Consequently there is no need for a closed atomizer, for a spring-loaded needle-value as uniformity of the injection pressure is ascertained by the elastic force of the helical spring, from the beginning of the injection stroke to its end.
2. Perfect atomizing is made sure independently from engine speed. In this way good atomizing is assured even at a very low speed, namely when starting the engine. This fact is leading to very easy starting of the Ganz engine.

3. The Ganz fuel injection pump has the advantage of allowing an extremely simple design of the atomizer. The atomizer is simply a conical blow-pipe. For preventing combustion-gas entering into the atomizer, a check valve provided with a soft spring is applied. Atomizers of this simple design are very long lived.

4. The movement of fluid oil under high-pressure is not controlled by the injection plunger or its admission and delivery valves, with other words: there are no control edges which could be worn out by erosion caused by movement of fuel oil containing impurities. Maximum stroke of the injection plunger is comparatively very small, in smaller engines it is about one mm., in the biggest diesels not more than four mm. Consequently the life of an injection plunger is very long, even after repeated general repairs, there is no need for exchange of the plunger.

5. Maximum stroke of a Ganz-type fuel injection plunger may be adjusted with a micrometer gauge and in this way the quantity of the injected fuel is precisely determined. The spring-force required can be adjusted by using a spring scale or a pressure gauge and no other measuring instruments are for this purpose required.

The stroke of the injection plunger may be varied by shifting the centre of rotation of the lever which serves for compressing the helical spring. When shifting the rotational centre of the lever, the stroke of the injection plunger will change accordingly. The moving wedge is shifted by the elastically coupled draw-bar in unloaded state of the wedges i. e. after the injection has been finished and compressing the helical spring has not yet started. Thus the power required for regulation is small and the wedges may be shifted easily, either manually or from the governor.

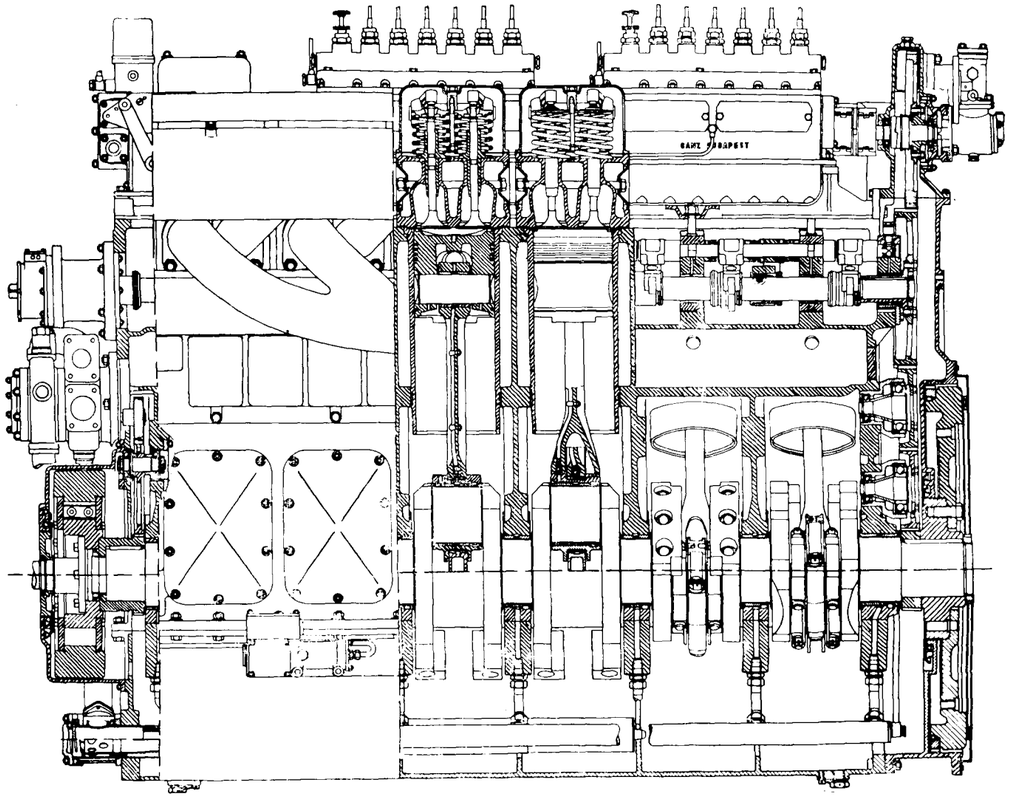
COMBUSTION SPACE

The Ganz engines are fitted with an antischamber if cylindrical shape with comparatively big openings. The fuel oil jet injected through the one-bore atomizer passes along the axis of the cylindrical antischamber and in atomized state rapidly evaporates and ignition is started. The fuel-jet, after such preparation, leaves the antischamber through the large-diameter openings in the bottom of the antischamber and it gets mixed with the compressed air in the cylinder space. It may be seen from above said that the antischamber is a transition between precumbustion-chamber and direct injection.

Characteristical for the combustion space of Ganz engines is that, aided by a suitable injection-system, good efficiency and easy starting are attained inspite of the comparatively low compression rate of 1 : 13.

STARTING

An individual feature of Ganz diesel engines is the fact that they can be easily started even in severe cold. Principle of the starting system is as follows: The design of the camshaft controlling the movement of the valves is such that it can be axially shifted until in its starting position the motion of the air inlet valve is controlled by another cam. This starting air inlet cam is designed to open the air inlet valve towards the end of the inlet stroke. Until the inlet opens a certain degree of vacuum is generated in cylinder. After the air inlet valve being opened,



the air streaming with high velocity into the cylinder will raise the temperature of the cylinder as the kinetic energy of the air will be transformed into heat. At the end of the air-inlet stroke the temperature of the air admitted into the cylinder will be consequently considerably higher than it was before entering the inlet pipe. As we mentioned before, the engine is a typically easily starting diesel but, with the starting device described above starts at an ambient temperature of 20° C below freezing point, can be performed with ease.

MODERNIZATION OF GANZ DIESEL ENGINES

What were the reasons for modernization?

In 1953 management of the Ganz Wagon and Machine Works decided to redesign and standardize the different types of diesel engines. The reasons for this decision have been manifold. Further improvements on the existing types would be difficult. The general layout of the old types does not admit substantial weight reduction. There are also great difficulties in the way of increasing the output of the old models. In course of long years of operation it turned out that assembly work and maintenance of the engines should be made simpler. The number of common component parts of engines with the same bore and stroke but of different number of cylinders should be as high as possible and in any case higher than up to now.

The engine designing office came to the conclusion that all above requirements can be satisfied if the Ganz engines are going to be entirely newly designed. It is self-evident that the well-proved fuel injection-system, combustion-space layout and starting device will be retained in basically unchanged but in some details modernized form.

THE NEW TYPES

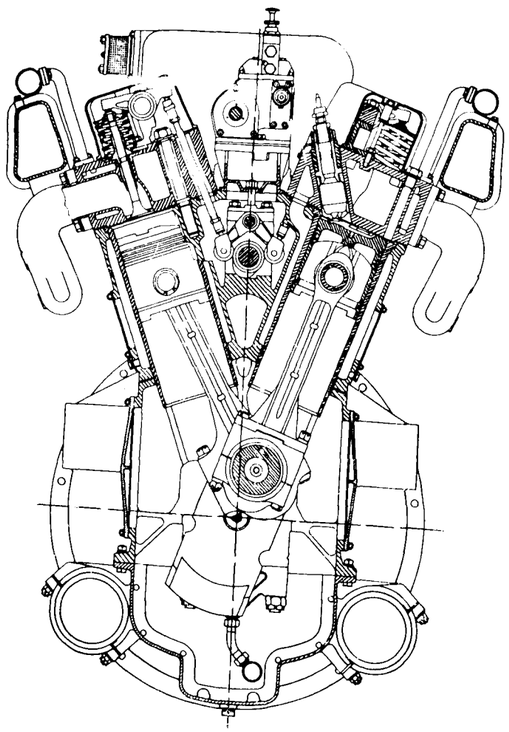
The new types should cover a range of from 7 b. h. p. to 2000 b. h. p. rating including diesel engines, for

railway traction, stationary and ships, engines. The new types of railway diesels are as follows :

27 cm. cylinder bore engines executed at six or twelve-cylinder units with ratings of 1000 and 2000 b. h. p. respectively at 850 r. p. m. Both engines are pressure charged.

17 cm. cylinder bore engines. The 6-cylinder model is rated at 250 b. h. p. at 1250 r. p. m., naturally aspirated, while pressure charged the rating increases to 400 b. h. p. The twelve-cylinder model of the same group is rated at 500 b. h. p. when n. a. or at 800 b. h. p. when p. ch.

Of the 13.5 cm. bore engines the six-cylinder type is a one-bank horizontal engine, with a rating of 150 b. h. p. at 1650 r. p. m. When naturally aspirated or 200 b. h. p. if pressure charged. The twelve-cylinder two-bank horizontally arranged engine is rated at 300 b. h. p. at its n. a. version and at 400 b. h. p. at the p. ch. execution. This group is intended for railcars, but a six-cylinder engine with one bank of vertically arranged



cylinders is provided too for smaller locomotives and railcars.

FEATURES OF THE NEW TYPES

Although the outputs of the new type engines as enumerated above vary between wide limits, their design is based on a uniform base.

A common feature of all models is that the cylinder banks are one-piece castings with exchangeable cylinder liners which are of the wet liner type being in contact with the cooling water. Each cylinder is provided with its own individual cylinder head. The antischambers are designed with inclined centre-line and they can be dismounted while the cylinder head is left in its place. Each cylinder head contains one air inlet and one exhaust valve. With the one-bank engines the camshaft is located on the lower part of the cylinder block. The two banks of the V-engines are provided with one common shaft mounted between the two-cylinder blocks and actuating the valves of both banks; this common camshaft is in the longitudinal centre-plane of the engine. As we mentioned above, the camshaft can be axially shifted and three positions of same exist: working-[illegible] and decompression-position. The camshaft is longitudinally shifted by a manually actuated device; the handlever can be dismounted if the lever is in a working position. The valve-actuating push rods may be fitted with a valve-clearance equalizing device.

In the 17 cm. and 27 cm.-bore engines the connecting rods with the pistons can be dismounted through windows located in the side walls of the crank-case. The connecting rods of the V-engines are of the fork- and blade-type. In course of dismounting the connecting rods and the pistons through the openings in the crankcase will no part of the engine needs to be dismantling the lids of the windows. Thus bearing bushes and piston rings may be inspected and exchanged without major mounting work being necessary. Pistons and connecting rods of the 13.5 cm. bore engines can be extracted and removed identically.

The crankshafts of the one-bank vertical engines with 17 cm. cylinder bore and of all types of the 27 cm. bore diesels are supported in bearings located in the crankcase. Division of the crankcase is in the bottom-plane of the cylinder-block; the crankcase is of U-section. This layout is resulting in a very rigid and yet light construction. The cylinder block and crankcase are connected with long bolts and this construction allows the force being transmitted on the shortest possible way

from the main bearings of the crankshaft to the cylinder heads. A similar layout was adopted for the vertical-cylinder bank model of the 13.5 cm. bore engines.

An interesting feature of the group with 13.5 cm. cylinder-bore is that the 12-cylinder model with two banks of horizontal cylinders is derived from the 6-cylinder horizontal engine by mounting to its crankcase the cylinder block of the vertical 6-cylinder model.

AUXILIARY EQUIPMENT TO THE NEW TYPES

Cooling water pump, lubricating oil pump and the camshaft shifting device are located on the front end of the engines. Fuel injection pump and governor are mounted on one side of the vertical one-bank engines, while the same machines are put between the shanks of the V-engines, in the simmetry plane. Each of the auxiliary machines can be dismounted without touching other parts of the engine.

FUEL INJECTION PUMP

As we mentioned above, the system Ganz-Jendrassik fuel injection pump has proved to be a very successful construction, its basic idea being fuel injection effected by the elastic force of a compressed helical spring. In the new types of diesel engines two important modifications have been effected.

First of all the pump has been redesigned to be suitable for fuel injection in two stages, after exchange of a few component parts. Aim of the two-stage injection is to stop the characteristically sharp, knocking sound of diesel combustion and pressure, a feature having very favourable effect on the life of piston rings and bearings.

The second alteration was that a safety quick-cut out device is built in into every fuel oil pump. The aim of this device is to automatically prevent increase of engine speed above the admitted speed limit.

GOVERNOR

The engine speed regulating device of governor is with all new types of Ganz engines mounted on the exterior of the diesel engine. According to the operational requirements, the functional performance expected from the governor of a diesel engine may be very different. The governors of railway traction diesel engines are hydraulic servoregulators as this type of control mechanism can be adapted in the most satisfactory manner to the complex requirements araising in railway power vehicles. The governor incorporates the remote control systems too, which is of the electro-pneumatic type.

An automatic device is incorporated into the governor with the aim of stopping the engine in the case that lubricating oil pressure should drop below a predetermined limit.

LUBRICATION

All engines belonging to the 17 cm. and 27 cm.-bore groups have the "dry crankcase type" lubricating system. A lubricating oil reservoir is located close to the engine and from this tank is sucked the oil by the oil pump and driven through the filter into the lubricating oil ducts of the engine. Another oil pump is permanently removing the oil from the crankcase. This clearing oil presses the oil through a filter into the oil cooler and from there to the oil tank. Thus the lubricating oil system consists of a high-pressure circuit and low-pressure circuit. The oil cooler is put into the low-pressure circuit which arrangement enables the use of air-cooled radiators for oil cooling.

The 13.5 cm.-bore engine possess similarly two oil circuits of higher and lower pressure respectively. But there is no separate oil tank in these engines, the crankcase serving as oil tank.

COOLING WATER CIRCULATION

Water circulation is effected in all new engines by a single centrifugal pump. The water pump is of a special design without buffing boxes which latter circumstance means considerable simplification of maintenance work.

CLOSING REMARKS

Although there are many types of Ganz engines not intended for railway operation yet in the production programme of Ganz Wagon and Machine Works the railway diesel engines are the most important sector. This can be explained by the fact that railcar building is the traditional domain of Ganz's activity and that this factory has been and is presently too in the rows of the pioneers of the constructors of railway rolling stock and machinery. Above described types of railway diesel engines are able to satisfy all requirements of railcar building but in each category can be found engines to be used as locomotive diesels.

There is also a complete range of stationary diesel engines from 7 to 1600 b.h.p. rating. The same engines are used in river and seagoing motorboats.

BRITISH RAILWAYS ELECTRIFICATION

THE British Transport Commission have announced the award of contracts to British Insulated Callender's Cables Limited and British Insulated Callender's Construction Company Limited for the design, supply and installation of overhead conductor equipment for Britain's first 25kV single-phase A C. railway electrification schemes. These contracts form part of the extensive modernization programme of British Railways which will restore national supremacy in the field of railway traction.

The first two routes to be electrified under this bold programme are between Manchester and Crewe, and between Colchester, Clacton and Walton. The former route involves 220 track miles of main line of the London Midland Region and includes the electrification of the main lines at Crewe Station a vital junction for many of the routes to be electrified in the future. The latter route consists of fifty track miles of the Eastern Region of British Railways.

The BICC Group is well equipped to undertake this important task in view of its outstanding experience in electrifying the World's railways. It has been engaged in this type of work for over 40 years, particularly overseas, and has carried out extensive research into the problems associated with modern high-voltage A. C. railway electrification practice.

At Rye Hey, Prescot, the Group has built a special proving ground where experimental installations have been erected for research and field trials. These facilities have provided, and should continue to provide, much useful data on many aspects of overhead conductor equipment. In addition, during 1953, the Group—in collaboration with British Railways—installed equipment suitable for high voltage A. C. operation over a route mile of double track on the Lancaster-Morecambe-Heysham electrified lines. The experience gained from studying the performance of this equipment under commercial conditions was of great benefit to the design finally decided upon for these contracts.

Alternating current at this high voltage and at standard mains frequency was chosen by the British Transport Commission as its ultimate aim after very thorough examinations of all other systems of railway traction, including D. C., lower frequency A. C., diesel-electric and diesel. A feature of the new scheme, which will form the basis of future overhead work on British Railways, is the use of much lighter overhead equipment than would have been possible with any other system of overhead electrification.

USE OF A PORTABLE BANDSAW ON DIE HANDLER SPEEDS, EASES STOCK CUTTING

IN a large toolroom or job shop there often is a need for some blanks to be cut from round stock or square bars in storage on racks. This means that the bar must be removed from the rack, transferred to the saw for cutting, and returned to the rack, which necessitates extra help and handling time. One shop solved this problem like this :

The floor in the stock-storage area was levelled off and a new stock rack built, with extra care being taken to insure that all members of the rack were square and parallel to the floor. The legs from a horizontal bandsaw were removed and the machine was mounted on a hand-powered shop elevator of the type generally used for handling dies. This unit, was altered by replacing the front wheels with castors.

In order to cut off a piece of stock, pull the bar out of the rack by hand or with the help of a hoist. To provide a grip, a C-clamp is secured to the end of the bar. This clamp has a V-notch cut in the solid jaw, to provide a sure hold on flat or round stock. The vise is locked to the stock and the floor lock is used to hold the elevator in place.

An extension on the edge of the plate catches the piece cut off. The saw will not cut stock placed in the lowest section of the rack, so this part is used for light pieces.

" Portable Bandsaw on Die Handler Speeds, Eases Stock Cutting," *American Machinist*, 21 November 1955, p. 157.

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