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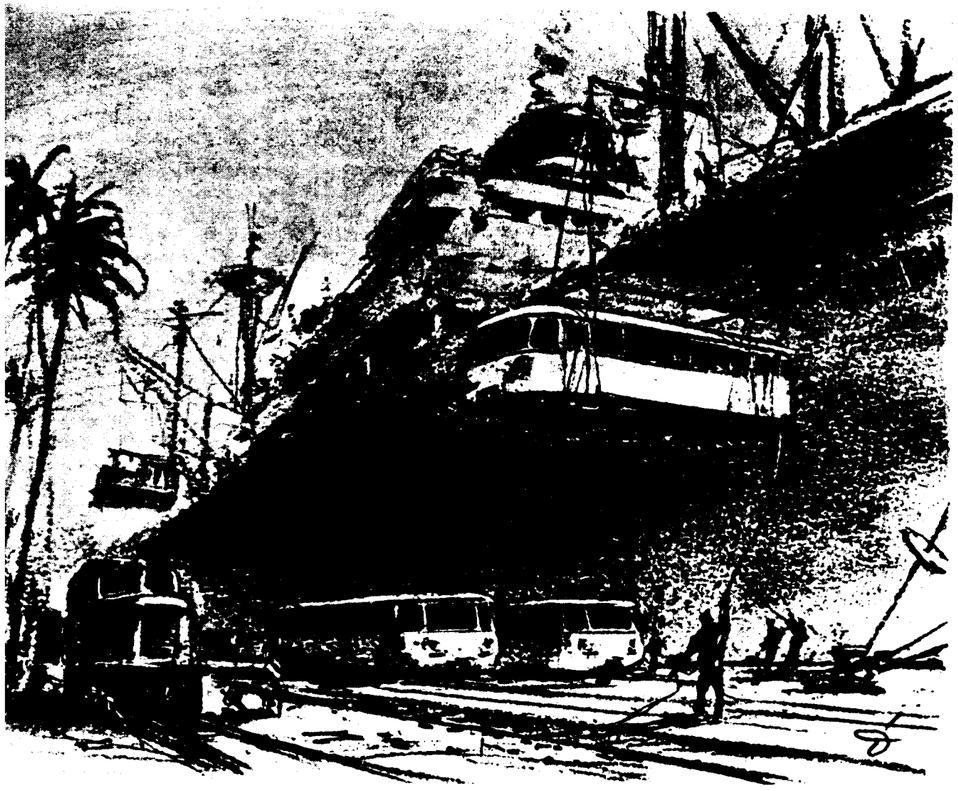

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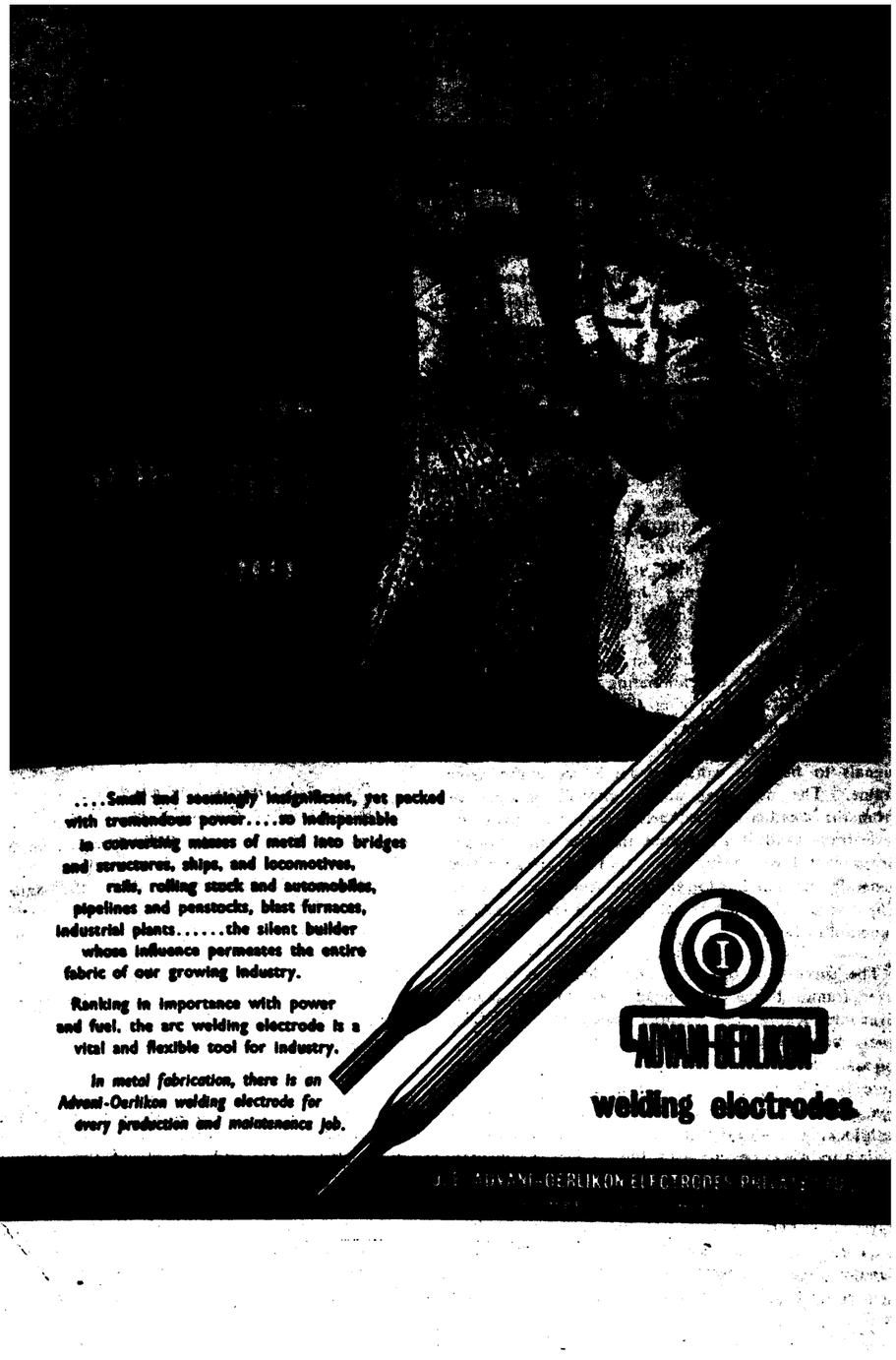


SIGNALLING SUPPLEMENT

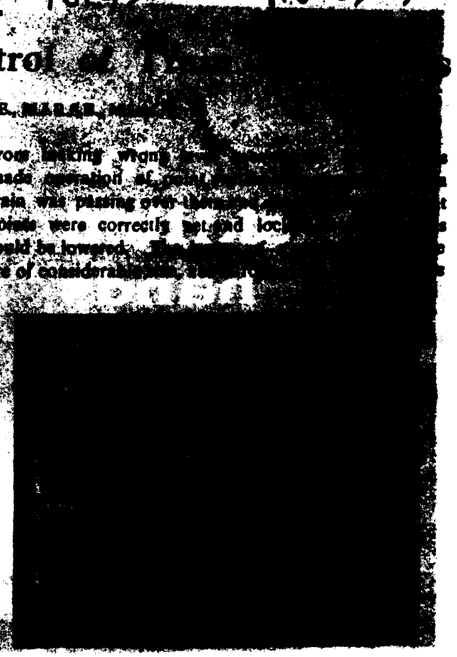
The Geographical system for the control of [illegible]

By H. C. Towers, M.I.E.E., M.I.R.S.E., [illegible]

In the very early days of railways movement was slow and even after steam traction was introduced extreme caution had to be observed. This condition applied equally to railway signalling when considerable time had to be taken to ensure that points were properly set for train reception. Today, these operations can be affected swiftly and accurately, by the movement of a push button or switch.

Railways had been in operation some 45 years before the first signal box was constructed. The points were of crude construction and hand signals, exhibited by the men working the points, were used to work the trains. At large stations there were many points and several men had to move over a considerably distance. In bad weather the work was performed with risk. Gregory Hutton, Chief Engineer of the then London & Croydon Railway, thought of a way of eliminating this unsatisfactory state of affairs by moving the point switches by rodding attached to the tails of levers assembled together in a frame. He also arranged for the signals to be wire worked from levers in the same frame. The next step was to protect the operator from the weather and a shelter was built over the lever frame and it is possible that the term "Box" arose from this development. In India, "cabin" is generally used and "tower" on American railways. The first installation was set up at Bricklayers Arms Junction in 1846.

The success of this experiment led to many other lever frames being constructed and in due course lever interlocking was invented which prevents wrong levers being manipulated perhaps leading to conflicting and dangerous movements. Facing point locks were introduced, worked from levers in the signal box, and these were made to function in conjunction with locking bars so that points could not be unlocked while a train was passing over them. In the course of [illegible] frames, interlocking, and signal and point [illegible] may be considered as the completion of the first stage in the story of signalling and interlocking. Signalmen could operate points and signals within their control in comfort, interlocking prevented them from [illegible] made operation of [illegible] train was passing over [illegible] points were correctly set and loc[illegible] could be lowered. [illegible] are of considerable [illegible]



Route Relay Interlocking panel in Temple Mills West signalbox, British Railways, Eastern Region.

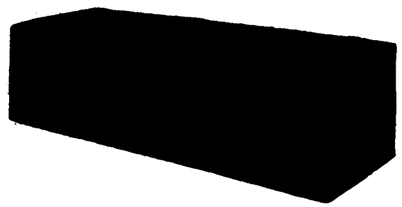
(Photograph by courtesy of British Rlys., Eastern Region)

is necessary in order to multiply the signalman's physical effort and develop sufficient force to drive the point rodding and point switches. At a large station, in order to set up a route for a train, often a dozen or more levers have to be worked. This takes time and also the expenditure of considerable energy. At the end of a signalman's spell of duty, the speed of lever operations must decrease.

The disadvantage was soon appreciated by George Westinghouse, the inventor of the air brake, who turned the principle of this invention to the operation of railway points and signals by compressed air and the first installation of this kind [illegible] only necessary for controlling the agency w[illegible] the points and signals, miniature levers or[illegible] required and from this stage developed [illegible] signal frame as used today. The first pow[illegible]

appear in Great Britain was put down at Granary Junction, Bishopgate, on the former Great Eastern Railway and this installation dates from January 15th, 1899.

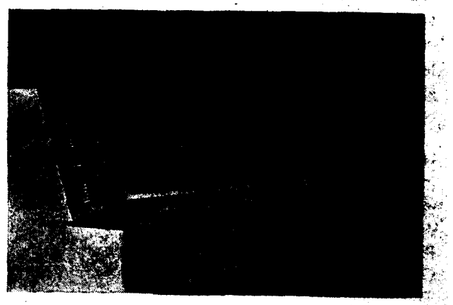
Miniature levers for power frames have been manufactured in various styles. The first frame made by Westinghouse has the handles fixed at right angles to the contact shaft with a knob at the end giving the appearance of a large clock key. The frame at Granary Junction is of this type. In another type of power frame the contact shaft does not rotate but moves backwards and forwards being operated by a moulded handle. The size of this type of power frame is reduced by staggering the position of the operating handles every other one being fixed underneath the shaft instead of above it. Generally other types of frames have miniature levers which are replicas in shape and operation of the full size mechanical levers.



Type 'NX' Route Relay Interlocking panel in Brunswick signalbox, British Railways, L.M. Region. Installed in February 1937 this was the first instance of geographical route setting in the world.

The introduction of power signalling not only permitted many points and signals to be operated in a very short time but also extended the distance over which they could be worked. Mechanical operation of points is strictly limited but with power operation there is no restriction. It is not necessary to be able to observe these units from the signal box for the position of all trains is indicated on an illuminated diagram, signal and point positions are electrically repeated on the power frame and electrical interlocking circuits prevent point operation while trains are passing over them or signals being [illegible]turely operated before routes are clear. Earlier [illegible]frames were fitted with mechanical interlocking [illegible]their levers but later, in larger installations, [illegible]terlocking was introduced.

Although the miniature levers of a power frame require hardly any effort for operation, the constructional details of the various connections for working circuit controllers, attachments for electric locks, framework and casing is very considerable. About 1920, in order to dispense with this elaborate construction, the railways of the U. S. A. adopted a switch panel arrangement wherein signals and points were controlled from miniature switches mounted on the illuminated diagram. In these installations the miniature switches controlled relays which operated points and signals and also provided the necessary interlocking features. From that date the use of panel interlocking in that country has progressed rapidly.



Type 'NX' Route Relay Interlocking panel at Faversham signalbox, British Railways, Southern Region. Brought into use June 1959.

(Photograph by courtesy of British Rlys., Southern Region.)

Great Britain has always been conservative in making any change in safety appliances for railways and except for the London Underground Railways, where power frames were introduced almost from their inception, at the beginning of the century, the main line railways were reluctant to adopt them except for a few isolated cases. The extensive electrification of the then Southern Railway brought the introduction of power signalling as a collateral development. With the exception to the London Transport Railways, this system now has more power frames in operation than any other region. The first panel interlockings were introduced on the former London & North Eastern Railway in 1933, at Goole Bridge and later in the year at Thirsk. These panels had individual switches for the operation of points and signals.

Power frames reduce the number of lever operations essential for the setting up of a route. In mechanical operation more lever movements have to be carried out. Before point positions can be changed they have to be unlocked and then re-locked by working the facing point lock lever. There are also many additional signals per route which are used for securing the route ahead of the approaching train. In power signalling fewer signals are necessary because the routes are locked through the agency of track and other circuits. The signalman therefore has less levers to operate and these without physical exertion. He is nor, however, relieved from the responsibility of thinking out his various movements and which levers have to be operated for a particular route and which levers require other levers to be operated first in order to release them. In a busy signal box the expenditure of mental energy for this part of the work is considerable and this led to the development of route setting on the geographical principle, a system developed in the U. S. A. in the nineteen thirties by S. N. Wight of the General Railway Signal Company who also invented the first Centralised Traffic Control system for railways. This is called the 'NX' system. The technical press is today the medium for advertisements displaying the advantages of the geographical method of route setting and some of these systems are supplied by countries outside the Commonwealth. It is necessary to point out that Britain was the first country in the world to install geographical signalling called the "NX" system and this installation was brought into use in February 1937 at Brunswick on the then Cheshire Lines Joint Committee. The same system was installed at Girard Junction, Pennsylvania, U. S. A. in September of the same year and quickly followed by many other installations of identical type.

The geographical method of route setting eliminates all mental strain and concentration. The routes are set up by the operation of buttons or knobs at the entrance and exit ends of the desired route, as depicted on the panel, and not by the operations of individual miniature levers controlling points and signals. Generally operation of one or two switches is necessary for setting up a complete route which, in a power frame, would require the movement of many levers. The working of points and signals and the interlocking with conflicting routes is all accomplished by relay interlocking. All track circuits are electrically repeated on the control panel together with signal aspects.

Apart from rapidity in operation, the geographical method of route setting is readily understood by new signalmen. With mechanical and power operation new men took several weeks to "Learn the box". The geographical way has a switch at the signal position and a button at the part of the track layout where the signal reads to and operation of these two units sets all the necessary points and clears the signals.

The modernisation plan for British Railways includes a very large programme for power signalling and in this route relay interlocking panels form a very prominent part some 145 of these now being in operation or are under construction. In some installations the control switches have been placed on a console underneath the illuminated track diagram and control desks with push buttons have been developed for the latest signal boxes on the railways of London Transport. No doubt these variations may be considered more suitable in their particular application but the advantages claimed by the geographical route setting method is the absolute simplicity in selecting the required route and the minimum operation necessary in setting it up; Removal of the control units from their geographical position on the panel reinstates the visual connection between these units and the panel or diagram and this condition existed between power frame and illuminated diagram and was the source of mental fatigue in a busy signal box.

PLATFORM WEIGHING MACHINES

The Indian Standard Specification for Platform Weighing Machines (IS: 1435-1960) is the latest addition to a series of Indian Standards on commercial weights and instruments being prepared by ISI at the instance of the Standing Metric Committee, Government of India. Standards covering general requirements for weighing instruments and specifications for counter machines, beam scale, weigh-bridge, crane machines, steelyards, etc., have already been published.

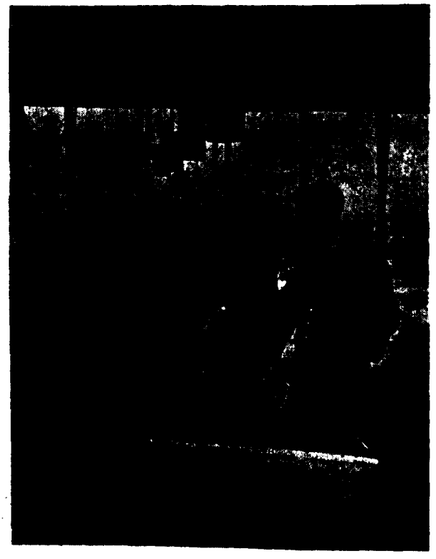
Automatic Control at Margam Marshalling Yard

Computer techniques are used in this installation to derive voltages corresponding to the retarder pressures required for checking the speed of wagons running off the hump, and the release from the retarders is governed similarly as the sidings fill up, with provision for injecting certain modifying factors.

A new railway marshalling yard covering 170 acres of what was formerly a tract of sand dunes at Margam (Glamorganshire) was officially opened on April 11 by Mr. K. W. C. grand, member of the British Transport Commission. The yard, one of the major work in the modernisation programme of the Western Region, British Railways, is on the east side of Port Talbot and was designed in close co-operation with the Steel Company of Wales, to whom fifteen sidings have been allocated. In all there are twelve reception sidings, fifty double-ended sorting sidings, ten single-ended holding sidings, and seven single-ended tranship and cripple sidings. The extent of the sorting sidings is seen in the accompanying night view from near the hump summit, with the control tower visible on the left.

Sorting sidings at Margam seen from near the hump summit.

Margam yard is stated to be more fully automatic in operation than any similar installation in Europe. Computer control is applied both to primary and secondary retarders. The system provides a voltage analogue of required exit speed from the secondary retarders, and compares this with a voltage analogue of actual speed, the error voltage then controlling the retarder pressure. The main contractor for the signalling and control equipment and retarders was A.E.I.-G.R.S., Ltd. (formerly Metropolitan-Vickers-G.R.S., Ltd.). Improved procedures introduced in this installation begin with the punched tape programming for operating the sorting siding points. The tape is produced in the traffic office at the control tower on a reperforating teleprinter, from information transmitted by portable radio telephone by the shunter who divides arriving trains into cuts according to the wagon destinations. When a train is about to be humped, the corresponding tape is fed into a tape reader. Operation of a push-button on the control room panel (seen in the second illustration) starts the tape, which initiates control signals for setting the points as necessary to direct the cuts into the appropriate sidings. The control signals, in the form of destination codes, pass in succession through an



Signalling and humping control panel in control tower operating room.

indication store, where four destinations at a time are displayed to the operator, and then through a series of relay stores, one for each track circuit. They are not accepted by a store associated with an occupied track circuit so that there is no interference with the control of the points for a preceding cut.

The driver of the locomotive propelling the train over the hump has a continuous indication in his cab of the humping instructions (" hump normal," " hump slow," or " stop "). This is a light signal with horizontal and inclined rows of lamps, and is operated by an alternating current in the rails with alternative frequencies of the order of several hundred cycles. One or other frequencies, according to the indication required, is superimposed on the normal d.c. track circuit and is picked up inductively. Absence of code is arranged to signal " stop." Any change of aspect is accompanied by an audible warning.

The automatic control of the electro-pneumatic retarders takes account of standage space in the sidings as well as weight, speed and " rollability " of wagons, and provision is made for manual biasing of wagon release speeds from the retarders to allow for the effects of strong adverse or following winds, and for the slightly higher pressures required when rails are wet.

Measurement of " rollability " is effected by two pairs of inductive wheel detectors operating at supersonic frequency, preceding each retarder. The signal from each pair is used to operate a high-speed binary counter giving a count inversely proportional to the speed of the cut. As the distance between the pairs of detectors and the gradient are known, the count is computed electronically to produce a voltage representing the rolling resistance of the cut. This voltage is transformed into a digital code and passed forward to the release speed computer.

Other inputs to the release speed computer are derived from voltages proportional to distance-to-run and curvature, the latter being constant for each siding and selected automatically when the route is set up. Distance-to-run is taken from a standage store for each siding, consisting of a potentiometer controlled by the state of the siding track circuits. As wagons enter the siding, the potentiometer is stepped by an amount corresponding to the length of each cut. The output voltage is thus reduced as the siding fills up.

Actual speed of wagons approaching retarders is measured by v.h.f. equipment utilising the Doppler frequency-shift effect, and a proportional voltage is produced. This measured-speed voltage and the required exit-speed voltage, together with information from a weight detector preceding each primary retarder, are then fed to the pressure computer, which produces a voltage output defining the pressure required in the retarder cylinders to remove the excess energy from the cut. At the retarder this voltage is compared with

Pull-out drawer of control panel, housing telephone and microphone equipment.

that from a pressure transducer mounted on the air manifold, providing the means to operate the inlet and exhaust air valves so as to maintain the pressure in the cylinders equal to that demanded.

Primary retarders are controlled similarly to the secondaries except that distance-to-run is not involved at this stage. The weight-deducting device preceding these retarders consists of a group of micro-switches which are mounted in a short length of slotted rail.

The control panel in the control tower is in two portions, that on the right operating the signalling of the reception sidings and associated tracks on the entry-exit route setting system, while the left-hand portion controls all equipment associated with humping

operations. Each retarder has two switches. One switch has an automatic position and three manual positions for selecting retarder pressures by hand if necessary; the other has a "computer" position for fully automatic control of release speeds, as described earlier, and five manual positions, enabling present speeds to be selected. Provision is also made for manual operation of points as an alternative to the normal route-storage system.

The panel is a "Domino" panel constructed on the "Integra" system, for which the British licensee and manufacturer is Henry Williams, Ltd., Tolpits Lane, Watford. It is built up of units 40 mm. square arranged to form a combined track diagram and operating panel with push-button or rotary switches and repeater lamps. Certain units are "blanks," containing no operating elements but being engraved with a portion of the track diagram so that continuity of presentation is preserved where no controls or indication are required. Units and "blanks" are supported in a grid. Each unit comprises a lower insulated portion with the contact pins and connections, an upper moulded part carrying the optical parts and push-buttons, and a cover plate forming part of the panel diagram. Twelve contact points are provided in each unit, enabling up to twelve lamps or six single-contact push-buttons to be accommodated, or various combinations of these accessories. All lamp bulbs are of clear glass, the required colours for different indications being provided in the inorganic glass optics of the "Domino" unit. These principles are embodied in the Margam control desk, which also has certain special features, including the pull-out drawers (one of which is illustrated) containing dial telephones and microphones for v.h.f. radio or loudspeaker communication with shunting locomotives and various parts of the yard. The radio equipment was supplied by Pye Telecommunications, Ltd., and the sixty-line automatic telephone exchange, which also gives access to the main railway trunk network, by the Reliance Telephone Company, Ltd.

Main lighting in the yard is provided by 216 Benjamin "Duoflux" floodlights with 1000W filament lamps, mounted 55 ft. above ground level on tubular steel tower with triangular bases having 2 ft. 6 in. sides, on square bases with 1 ft. 6 in. sides, according to the space available between tracks. Lights distribution from the "Duoflux" fittings is controlled so that the main illumination is directed towards movement along the yard while shunting and glare is avoided. The lighting is controlled from two mimic diagram consoles supplied by The General Electric Company, Ltd.

The whole scheme has been developed and directed by Mr. M. G. R. Smith, M. I. C. E., Chief Civil Engineer, and Mr. A. A. A. Cardani, A.M.I.E.E., M.I.R. S.E., Signal Engineer, Western Region.

In addition to those named in the text, the following contractors were responsible for work as shown.

PRINCIPAL CONTRACTORS

Main contractor (earthworks, permanent way, bridgework, drainage, fencing, amenity blocks), Sir Robert MacAlpine (South Wales), Ltd.; control tower, John Morgan, Ltd.; earthworks and permanent way, Robert M. Douglas, Ltd.; main electrical contractor, British Insulated Callender's Cables, Ltd.; signalling cables, British Insulated Callender's Construction Company, Ltd.; internal electrical installation in control tower and yard buildings, Lee Beesley and Co., Ltd.

[Courtesy: THE ENGINEER]

UTILISATION OF WORLD BANK LOAN BY INDIAN RAILWAYS

The Deputy Minister of Railways, Shri Shah Nawaz Khan told the Lok Sabha during question hour that a fresh loan of $ 70 million had recently been negotiated with the International Bank for Reconstruction and Development to finance the acquisition from abroad of diesel and electric locomotives, rolling stock spare parts and other railway materials and equipment and services connected therewith.

Asked to state the extent to which the Railway administration had been able to utilise the sum of $ 50 million made available to it by the Bank, Shri Shah Nawaz Khan replied that the loan had been fully utilised. The railway equipment acquired for the value of $ 50 million had been fully utilised for the railway's modernisation and development programme.

The Deputy Minister gave this information in reply to a question by Shri Narayan Das and three other members.

EDITORIAL NOTICE

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

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

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

All published contributions are paid for at our usual rates.

Editor

Primary Batteries for Signalling Applications

By D. Krishnamurty

Asst. Development Engineer, Consumer Products Sales Division,
Union Carbide India Limited, Calcutta

IN the early days of railways when only one or two trains were running on a track each day, the primary concern was just to move the trains. There were no signals and no movement controls because there were hardly two trains simultaneously moving on the same track. With the increase in the number of trains, signalling systems were introduced to regulate the movement of trains so that any two trains are kept at a reasonable distance from each other when they are running on the same track. Today, the number of trains and their speed have increased tremendously and the job of present-day signalling systems, therefore, does not stop at making the railways safe, but at maintaining this safety at maximum speed.

For this purpose modern signalling systems have two definite functions. Firstly to set tracks and signals to direct the train movement, and secondly to control or supervise the setting. Or, in other words, to make the signalling system fool-proof and failure-proof. Setting the signals is mostly a manual job and has been in operation for a long time. The supervisory and controlling function of the signal systems in the key note for the safe and speedy working of modern railways. This is made possible by the imposition of an automatic control on the operation of signals by electric and electronic instrument which sense the presence of trains on the lines, the setting of the track and the signal indications given to train drivers.

This supervisory operation in signalling—distinguished from the manual or power driven track setting, lowering of signal arms, etc.—consists of the modern block system, track circuits, train indicators, slot circuits etc. The mode of power chosen for this operation is electricity, because of its amenability to instantaneous communication and remote control. Three sources of electric power can be used for the control of signals—electric mains, secondary batteries and primary batteries. Electric mains power is not desirable for "supervisory" signalling circuits due to its restricted availability, unpredictable failure and consequent unreliability. Secondary batteries are generally used only where mains power is available to recharge the batteries either continuously (trickle-chargers) or at pre-determined intervals. The ideal power source for the control equipment of signals is the primary battery. This article aims to discuss the various types of primary batteries and standardisation of the primary battery requirements of Indian Railways.

Analysing the electric energy required for operation of the signal control equipment, three broad categories of batteries are essential for the railways—small batteries for portable equipment such as the emergency field telephone sets carried on trunk route trains; medium size batteries for signal supervision; and heavy duty batteries for track circuit and physical management of signal and points. In the ultimate analysis, the total battery requirement of the Indian railways thus consists of three types of primary batteries.

However, for various reasons, largely historical, the Indian railways at present are using more than a dozen types of primary batteries. In the initial stages the railways imported all their battery requirements. Prior to the amalgamation, the railways in India were run by independent companies using different types of equipment. Each of the railways imported batteries from different countries and consequently more than one type of battery was being used for the same kind of operation. Thus the total number of types of batteries used by all the railways increased considerably.

The uncertainty of imports resulted in the need to maintain large stocks of batteries in railway stores. Due to the semi-perishable nature of regular batteries

the railways preferred the more expensive "inert" type of cells which can be stored for long periods and need be activated only when required. The present Indian Railways, which combined the entire railway system of India, generally had to continue the same systems as were in use before nationalisation.

For efficient operation of battery power supplies four conditions should be fulfilled—(1) the battery should give maximum performance per unit first cost, (2) the battery should not require any maintenance (3) the stores inventory cost of the battery should be minimum and (4) the battery should be readily available. To fulfil the first requirement, different types of batteries with different capacities have to be designed so that in each application the performance per unit cost is maximum. However, the number of types of batteries should be restricted to reduce the stores inventory. For example if 10 types of batteries are used and the stores has to keep a minimum inventory of 2 units of each type, the total stores to be maintained will be 20 units. If, however, the types of batteries are reduced to three sizes by using them on more than one circuit, the minimum stores inventory will reduce to six or a little more. Reducing the number of types of batteries automatically increases their availability because each battery can be used on more than one application. The battery should be manufactured for ready use in order to eliminate maintenance.

Efficiency of operation can therefore be greatly facilitated by standardisation of stores items. The Indian railways have realised this and established the Central Standards Organization to reduce the number of stores to an optimum level. The Indian dry battery Industry has also realised the advantages of standardization and has been working on the development of efficient batteries for the Indian railways.

The Indian dry battery Industry has been developing more and more dry batteries for the Railways to make India self-sufficient in this respect. The import of batteries was practically stopped during wartime and Indian dry battery industry supplied most of the many types of batteries required by the then separate Indian railways. At present all types of dry batteries, inerts and sac types cells are manufactured in India and the industry is approaching the stage of self-sufficiency with respect to materials and processes.

The Indian dry battery industry does not stop at merely manufacturing all the types of batteries used by the Railways. It also works closely with the Railways in the standardisation of primary battery requirements for efficient operation. Investigation of the relative economies offered by inert and sac type cells and the dry cells has shown that the performance obtainable from inert type of cells per unit cost is comparatively very low. This is because the cost of manufacture of inert cells is more than regular round cells. The sac type of cells are also expensive overall, because they require regular maintenance. On the whole, it is now generally accepted that economy can be realised from using regular dry cells only.

The industry has now succeeded in developing two types of dry celles each with a wide range of application in its field. A small type of dry cell is developed for portable instruments like the portable emergency telephone set used in the mail trains. The second type of dry cell, the Railroad and Industrial Cell (Indian Standard Institution Specification IS 586 : 1959 type R 401) can be used in all supervisory circuits of the signal equipment; The dry cell, which is designed to give long service in applications involving either heavy discharge for short periods or light discharge for long periods, has already been tried successfully by the Indian Railways and is rapidly becoming established as the standard battery in these applications.

These two types of dry batteries give efficient service in all signal applications except for the signal and point movement and in track circuits. These two circuits require very heavy current and can be handled efficiently only by the Air Depolarised cell. These cells, which are imported at present, are not easy to manufacture indigenously, and offer the dry cell Industry its greatest challenge at present.

The Indian industry by virtue of its past performance will certainly manufacture the air Depolarised cells and will complete the range of primary battries required by railways. The co-operative spirit existing between the Indian railways and the dry battery industry will surely result in the standardisation and efficient use of primary batteries in the Indian railways.

(Courtesy: "The Indian Railway Engineer," Bombay)

METALS SUPPLEMENT

"Alloys for High Temperature Service"

By Dr. D. Swarup, B.Sc. (Met), Ph.D. (Sheffield), F.I.M.
Principal and Professor, College of Mining & Metallurgy, Banaras Hindu University

THE phenomenal development witnessed in recent years, in the production of jet engines, gas turbines and the various types of rockets has exerted a tremendous influence in the evolution of many alloys suitable for service at high temperatures. The efficiency of a gas turbine is, among other factors, a function of operating temperature and so is the case with the internal combustion engine components which are subjected severe service conditions—particularly alternating stresses at elevated temperatures. It has been said that the possibility of jet propulsion arises mainly out of the development of alloys capable of functioning at high temperatures. It is proposed to deal with some of these developments briefly in this paper.

HIGH TEMPERATURE ALLOYS

It may be admitted at once that the theoretical principles of alloy making have not advanced to that stage at which, given the requirements, one can prescribe a suitable composition and a thermal treatment. Constitutional diagrams of binary alloys are available for almost all the useful metallic elements, as well as a few ternary diagrams. These and the properties of the pure metals offer some guidance, but the majority of industrial alloys are complex systems and the behaviour of these under a set of conditions cannot be reliably forecast. The development of alloys, therefore, is largely empirical and suitability has often to be decided by service tests. Inspite of these difficulties, quite a number of alloys have been developed. It has been said that "alloys and steels used in modern jet engines (which are of course only one application of the gas turbine engine) have to withstand stresses equivalent to hanging two saloon cars from a red hot piece of metal about the thickness of a fountain pen, without stretching or distorting it. They have in fact, to withstand 10 tons per sq. in. at 850 deg. C. Moreover, conditions in the engine are such that the fountain pen might have to be red hot at each end and comparatively cool at the centre. The necessity for meeting demands of this sort has led the steel industry's scientists into some unusual paths."

The high temperature alloys for use above 600-650° C have an austenitic matrix and several types are found. A few of these are:—

(i) Stainless steel type, which are essentially of Fe-Cr-Ni base. Timken 16—25—6 and 19—9 DL belong to this class.

(ii) Stellite type alloys, which are essentially Co-Cr-Mo or Co-Cr-W base. Vitallium and Jessop G-32 are representatives of this class.

(iii) Inconel or chromel or nichrome type. These are essentially Ni-Cr alloys made hardenable by alloys additions such as Ti. Inconel-X, Nimonic 80 etc. typify this class.

There are other types which are modifications of the above. The evolution of a creep resisting alloy 'Cromadur' in place of 'Tinidur' is a notable development of the last war. Tinidur is an austenitic alloy containing 30% nickel. Shortage of nickel in Germany necessitated its replacement by manganese and the alloy 'Cromadur' was developed. The composition of some these alloys is given in Table I.

The use of non-metallic materials (Ceramics) along with creep-resistant metallic powders which are pressed and sintered under appropriate conditions, is yet another field of research. These ceramic—bonded metal parts are more resistant to thermal and mechanical shock than ceramic materials, but they present many new problems as they are relatively brittle and the method of bonding is far from satisfactory.

In high-temperature operation, the behaviour of metallic parts depends more upon their plastic properties than upon the elastic properties which dominate their behaviour at low temperatures. The plastic properties are more difficult to characterize, since the plastic deformations are not proportional to the applied loads. In the high temperature range, a part may creep under constant load so that in time

TABLE I - HEAT RESISTING ALLOYS

Sl. No.	Type	Chemical composition							Remarks
		Ni	Cr	Mo	W	Cb	Ti	Other Elements	
1	Cr-Ni-Fe	8	18	0.4 to 3.0	1 to 3	0.3	0.2 to 1.5	Balance Fe	
2	Ni-Cr-Fe	20 to 50	14 to 25	4 to 14	Upto 4	Upto 4.2		Balance Fe	e. g., Timken Cr/Ni/Mo : 16/25/6
	Refractaloy A	50	20	14	—	—	—	Balance Fe	
3	Ni-Cr-Co-Fe	15 to 33	14 to 27	3 to 10	Upto 4	Upto 4		Co 13 to 45 N_8, B, Ta Balance Fe	
4	Ni-base : Hastelloy B	65	—	29	—	—	—	Fe 5	Forged buckets for use under 1400°F
5	Ni-Cr & Ni-Cr-Co	37 to 75,	14 to 22	—	—	—	—	Co Upto 22	Hardened by Al or Ti
	"Nimonic 80"	74	22	—	—	—	2.5	Al 0.6	
6	Co-Cr :-Vitallium	—	28	5.6	—	—	—	Balance Co	Precision cast buckets
7	Co-Cr-Ni	10 to 32,	23 to 25	Upto 6	Upto 12	—	—	Balance Co	
8	Cromadur	—	12	—	—	—	—	Mn-18 V-o. 7	

the plastic deformation much exceeds the elastic strain. The tendency of the part to flow, the deformation continuously increasing in time, is a high temperature property of immediate concern to design engineers. Metallurgists recognize additional properties necessary to successful operation at high temperature. These properties are listed in Table II.

Table II. High Temperature Properties

1. Chemical composition
2. Processing data.
3. Room temperature properties compared to high temperature properties.
4. Short time tensile strength.
5. Stress rupture strength.
6. Creep strength.
7. Design data.
8. Hot impact strength.
9. Hot fatigue strength.
10. Change in the elastic constants with temperature.
11. Change in the coefficients of thermal expansion.
12. Change in the thermal conductivity.
13. Hot hardness.
14. Relaxation tests.
15. Influence of combined stresses.

HIGH TEMPERATURE TESTS

The testing of these alloys includes high temperature creep and rupture tests. Some figures of the former are given in Table III which is self-explanatory.

Table III—Stress-Rupture Tests at 1500°F

S. No.	Material	Stress for rupture in thousands of lbs. per sq. inch in		
		10 hours	100 hours	500 hours
1	Cr-Ni-Fe	12.5 to 22	11 to 16	10 to 11
2	Ni-Cr-Fe	17 to 22.5	10.5 to 18	8.5 to 12.5
3	Ni-Cr-Co-Fe	20.5 to 34	16 to 25	12.5 to 20
4	Ni-base	25	15 to 17	11.7
5	Ni-Cr & N Ni-Cr-Co-Fe (Ti & Al hardened)	21 to 40	13 to 29	17 to 21
6	Co-Cr	21	11 to 28	14 to 25
7	Co-Cr-Ni	25 to 33	27 to 30	24 to 27

Since most of the components out of these alloys are to be manufactured to very close tolerances for interchangeability, as well as for considerations of high operating efficiency, dimensional changes under working conditions and during the working life have to be known before hand. Creep tests are used for this assessment which measure the deformation in terms of the stress in lbs. per sq. in. required at a particular temperature to cause a creep rate of one-ten millionth of an inch per hour for every inch of the length of the specimen. It may be mentioned that the average working life of an aero-engine is about 300 hrs. and that of an industrial unit is about 100,000 hrs. (11 years). The figures given in Table IV are indicative only of the magnitude of the creep.

Table IV—Some Creep Data of High Temperature Alloys.

Temp. 1350° F. : Stress 15,000 lbs./Sq. in.

Sl. No.	Material and Treatment	Creep rate per hr. @ 1000 hrs.
1.	Cr-Ni-Fe: C. O. 26, Cr. 18, Ni. 8. (Oil-quenched & aged)	0.00004
2.	Ni-Cr-Fe: C. O. 4, Cr. 13, Ni. 19, Mo. 4.28, W. 3.87, Cb. 4.2. (Water-quenched and aged)	0.000101
3.	Ni.-Cr-Co-Fe : Refractaloy M 284 C. O. 11, Cr. 20, Ni. 20, Co. 30, Mo. 8, W. 4 (Oil-quenched and aged)	0.000052
4.	Ni-Cr-Co-Fe: (Ti and Al hardened) Refractaloy 26. C. O. 03, Cr. 18, Ni. 37, Co. 20, Mo. 3, Ti. 3, Al. O. 25. (Oil-quenched & aged)	0.00001
5.	Co-Cr :—Vitallium C. O. 2, Cr. 28, Mo. 5.6, Co. Bal. (Cast and aged)	0.000440

Similar data for other values of stress and duration have been investigated and reported in the literature, on the basis of which design data have been arrived at which are helpful in deciding the suitability of an alloy for a particular application.

POSSIBILITIES IN INDIA

A large majority of the high temperature alloys are face—centred cubic at the service temperatures and the main elements present form solid solutions. The solid solutions being non-creep—resistant, alloy constituents such as carbon, molybdenum, tungsten, columbium, tantalum, titanium, nitrogen are added to strengthen the matrix by forming carbides, nitrides or intermetallic compounds. Their dispersion in the metallic matrix help in retarding creep.

A characteristic draw back of these alloys is that they lose their creep resistance rapidly above 800°C. The future largely depends upon developing alloys which will be creep resistant at higher temperatures. Among the alloys known, metals such as nickel, cobalt and iron have been, more or less, completely investigated as alloy—bases. Low melting metals such as aluminium, magnesium, silver, copper, tin and zinc are obviously unsuitable as alloy—bases for service at high temperatures, since melting points of the metals which make the alloy base is a criterion. Prohibitive cost stands in the way of metals such as platinum, rhodium, osmium, palladium etc. from being used. Therefore, comparatively only a small number of metals are primarily suited for high temperature range. As far as this country is concerned, the available metals are titanium, zirconium, beryllium, and hafnium. These are distributed in various parts of the country. Occurrences of cobalt and nickel are negligible. Chromium as a base has been found to be ineffective owing to the brittle nature of the alloys made and molybdenum and tungsten (which exist in the country to a minor extent) have their two fold disadvantages of high density and susceptibility to oxidation. Amongst the four metals titanium, zirconium, beryllium and hafnium beryllium because of its low melting point and hafnium because of its scarcity and high density are precluded. It is evident, therefore, that in a programme for development of high temperature alloys in this country, titanium and zirconium are bound to play a major role.

HUNGARIAN TRAINS ON TIME

More than 97 per cent of Hungarian trains now run to time, compared to 89.6 per cent three years ago, Mr. Jozsef Soproni, General Secretary of the Hungarian Railway Workers Union, told 313 delegates representing 150,000 members at the union's annual conference in Budapest. In the same period, the quantity of freight carried by the railways had increased by 36 per cent, said Mr. Soproni. The Railway wages bill increased by £ 1 million as a result of wage increases, and 2,000 workers in unhealthy jobs had their working hours reduced. Present at the conference was Hungary's Minister of Transport, Mr. Istvan Kossa.

Whiter Non-Ferrous Metals in Railways

By M. R. Sreenivasan

Bombay Metal & Alloys Manufacturing Co., Private Ltd., Bombay

THE main stay of the Non-Ferrous metal manufacturing units in India is the Railways, who are the major consumers of Non-Ferrous Metals and Alloys in this country. In the absence of sufficient encouragement from the Indian Railways the Non-Ferrous Industries in India will be affected to a very great extent in as much as it cannot use its installed capacity at least partly.

The Indian Railways have an obligation in this respect to help the Non-Ferrous Industries in keep-going. It is but natural that the railways will as far as possible not only keep the Industries going but also will not themselves undertake the manufacture of any Non-Ferrous Metals and Alloys in their shops.

Broadly the requirements of Indian Railways fall under the following categories:

1. *Regular Demands:*
   - (a) Copper Based Alloys conforming to I. R. S. Specn. N6/49 Class I, Class II, Class III & Class IV.
   - (b) Antifriction Bearing Metal I. R. S. Specn. N10/54 Class I, Class II, Class III & Class IV.
2. *Occasional Demands:*
   - (a) Railways also require Phosphor Copper Tor de-oxidising purposes and also
   - (b) Soft Solder for Soldering purposes.

Outright purchases of these Alloys are channelled through the Director General of Supplies & Disposals, New Delhi, while the conversion of Non-Ferrous Arisings out of machining operation of the respective Railways are handled by the purchasing branch of the Railways. The exact figures of consumption of the above Railways are not available but experience shows that the requirements of the Indian Railways fall between 4,000 to 5,000 Tons per year. This does not take into account the two Locomotive manufacturing units in India.

1. The Tata Locomotive and Engineering Works Ltd.
2. The Chittaranjan Locomotive Works.

The main stay of the Non-Ferrous manufacturing units in the country are the Railways in as much as at present there is no other industrial undertaking requiring Non-Ferrous Metals in such large quantities as these units can produce and supply basing on their installed capacity.

Baring the small percentage of copper ingots manufactured by the Indian Copper Corporation in West Bengal. India has to look to foreign sources for the supply of balance quantity of Copper and the entire requirements of Lead, Tin and Zinc. This being the situation whatever arisings the Railways obtain from the machining operation of the castings they produce out of the Alloys made available to them assume greater importance. The Non-Ferrous Borings offered by the different Railways from time to time cannot be used for the grade of Alloys they specify against such accumulations, the reason being the Railways are not taking proper care to have the different grades of Borings stored separately taking care to have the foreign matters, such as Iron, etc., do not get into these accumulations. It will be more profitable for the Railway to exercise proper care to have these accumulations of different grades of Alloys separately, in that they would be able to obtain more favourable quotation for conversion of these arisings into that particular grades.

At times it is found that the scrap lot offered for conversion is to be simply traded in for as the manufacturers have to provide their own raw material, in which case, naturally, the conversion charges are bound to be higher.

It is observed from the tenders and orders issued by the DGS & D that large quantities of virgin metals are procured on behalf of railways presumably for the manufacture of different grades of alloys in their own workshops. This procedure is not conducive to the satisfactory working of the Non-Ferrous units of this country since they are deprived of that much of quantity of Non-Ferrous Alloys made by the Railways themselves. It is also doubtful whether the Railways can manufacture these Alloys as economically as the Smelters and Refiners can do, in as much as the latter is specialised in handling such production.

There are instances where some Railways are disposing of their accumulations of Non-Ferrous Borings, whereas looking to the present tight foreign exchange position of the Indian Government it would be more advantageous for them to invite tenders and have these accumulations converted into grades of Alloys they require.

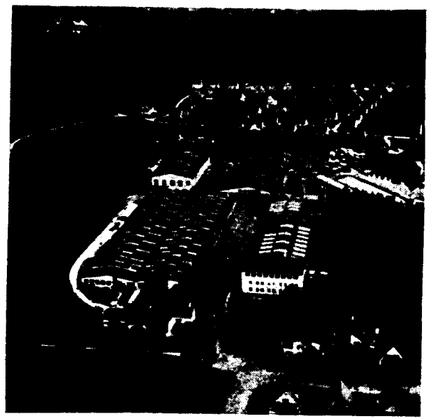
(Courtesy: The Indian Railway Engineer)

MECHANICAL HANDLING EQUIPMENTS SUPPLEMENT

Mechanical Handling Equipment on German Railways

By An Engineering Correspondent

STEINBOCK GMBH of Moosburg is not only one of the oldest but also one of the biggest European factories producting Mechanical handling Equipment. This company deals exclusively in machinery designed for lifting and lowering and transporting.

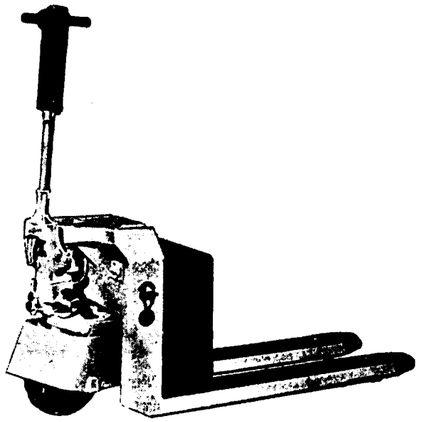


Steinbock Factory in Moosburg
Birdseye View

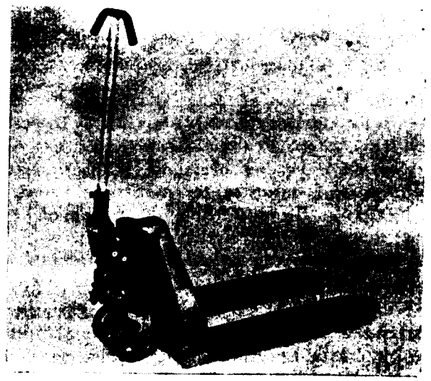
It is certainly no exaggeration to state that STEINBOCK GMBH, Moosburg, as far as the mechanical handling field is concerned, is the factory having the most versatile line of mechanical handling equipment in Europe. To this line belongs quite a range of fork lift trucks, walkies and hand lift trucks.

Fork lift trucks are produced from 0.4 to 3.5 tons of load capacity. The equipment is available either with electric or internal combustion engine. In the later case, Steinbock supplies Petrol, Diesel or LBG powered Fork Lift Trucks.

As far as walkies are concerned, there are available walkies for handling stillages and walkies for handling pallets.



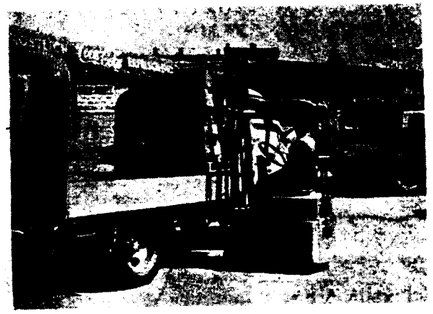
Steinbock Electric Pallet Truck



Steinbock Pallet Truck
most exported pallet truck all over the world

STEINBOCK is very well known for its hand-lift truck line, including a complete range of hand-lift trucks for handling stillages, and a complete line of

Steinbock Diesel Fork Lift Truck "SYNCHROLIFT" loading a railroad car

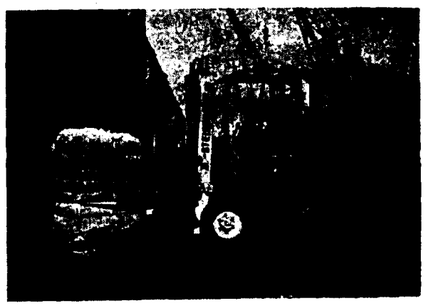


The tiny Steinbock PICCOLIFT loading Coca Cola cases

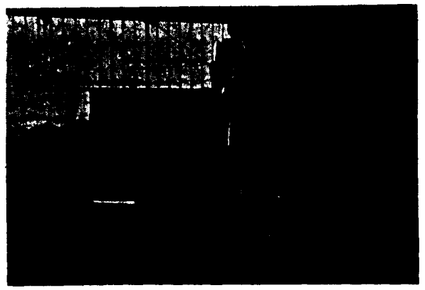
pallet trucks. For special purposes, e.g. for repair works of railway cars, there are supplied the famous Steinbock Universal lift trucks.

In the railway field, Steinbock is very strong as far as the supply of pallet trucks is concerned. They have been supplied many thousands of pallet trucks to the German Railways and other railways in Europe. The Steinbock pallet truck is as famous as any similar

Steinbock PICCOLIFT loading export cases into railroad car



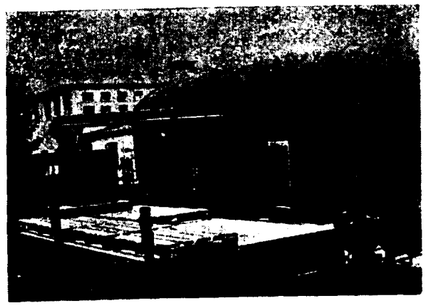
Steinbock Diesel Fork Lift Truck handling cottton bales by means of a special hydraulic clamp fork



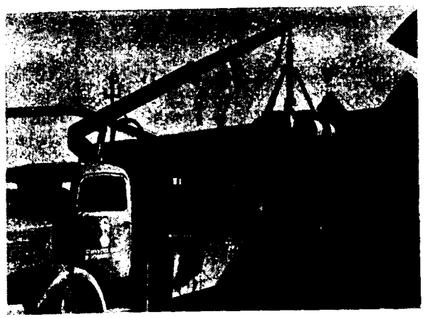
Steinbock Diesel Fork Truck SYNCHROLIFT handling cotton bales by means of a special fork clamp

product throughout the world and Steinbock can be considered in this field to be the biggest exporter all over the world, perhaps even the biggest producer of pallet trucks.

Diesel Fork Lift Trucks are used in large numbers by the German Railways for handling materials of any



Steinbock Lorry Loading Crane loading goods directly from lorry into railroad car



Steinbock Loading Crane for lorries, showing how to load scrap in a Metal Working Plant

kind. Also in the field of repair works, railway shops frequently use Steinbock Diesel Fork Lift Trucks for their very heavy repair works.

To load and unload open railway cars with unwieldy pieces of equipment, Steinbock has developed especially for railways a fork lift truck with hydraulic crane. This equipment facilitates the loading and unloading of railway cars considerably.

A specific creation for the railways has been the Steinbock PICCOLIFT, i.e. a small-sized fork lift truck of 0.6 to load capacity. This small sized truck is so manoeuvrable that it can enter without difficulty into railway cars, can turn in cars and load and unload goods.

In England and Ireland, the Steinbock Universal lift truck has been used very successfully. It might be of interest to mention here that Steinbock is producing its own hydraulic rams. This is not common to other European manufacturers of such types of equipment. It is further to be mentioned that Steinbock also produces its own ancillary equipment to be attached to fork lift trucks as shovel attachment, clamps for cotton bales, clamps for drums, clamps for cases and so on.

One of the latest types of equipment is the Steinbock lorry crane. This crane can be mounted onto any ordinary lorry exceeding 3.5 tons of load capacity. Then the crane serves to load and unload the lorry. This crane is fully hydraulically operated and gives much assistance and saving of time to the driver of the lorry.

The importance of Steinbock is still increasing in the past year. This results from the fact that Steinbock is now going to establish two new factories, another one in Germany and one in Ireland. This will enable Steinbock to deliver the famous Steinbock equipment to all countries throughout the world and to give maximum benefit to the users of the equipment.

Worthington International Operations Executive Visits India

Mr. S. R. Williams, Vice President, International Operations, Worthington Corporation (U. S. A.), recently visited India to explore the possibility of establishing a manufacturing unit in conjunction with the Blue Star Engineering Group of companies.

The Blue Star Engineering group is exclusive distributor of Worthington air conditioning and refrigeration products in India.

Mr. Williams was accompanied by Mr. Charles H. Thaw, his Assistant.

Taking part in the discussions with Worthington were Mr. Mohan T. Advani, Chairman of the Blue Star Engineering group, and Mr. Ram, D. Malani, Managing Director of Blue Star's Air Conditioning and Refrigeration Division.

Mr. Advani recently returned from a visit to Worthington headquarters in the United States. During his trip, the Indian executive was presented with a plaque marking Blue Star's long and loyal service as Worthington distributor in India for air conditioning and refrigeration equipment.

RAILWAY WORKSHOP MACHINE TOOLS SUPPLEMENT

Technical Progress in Rolling Stock Exported from Poland

By K. Kamienobrodzki, M. Sc., Eng.

ONE of the most effective stimulants in foreign trade is international competition. Obtaining an export order depends not only on keeping pace with the ever growing requirements on the part of buyers, but also on the ability of demonstrating own initiative in following most up-to-date designing trends.

The first few post-war years marked the period of rehabilitation and rapid filling of gaps as to quantitative requirements. To-day, however, and this is markedly the case for some years now, the rolling stock export is confronted by ever growing requirements as to the modernisation of design.

Continents to which Polish-made rolling stock is exported, i. e. Europe, Asia and Africa, contrary to the American continent, show a constantly growing demand as regards railway transport. The motorcar, the motorcoach and the plane do not, as yet, outrival in those regions the railway coach. In order to cope with the growing demands of railway transport, it has been decided not only to increase the number of cars but also their capacity. It appeared, however, that the most effective means of increasing transport capacity is to increase the operational speed of trains.

While, until recently, the construction of railway cars was adapted to the speed of 100 km./ h., the speed of 140, and even 160 km./ h., is to-day required of rolling stock, which is rendered possible due to the introduction of electric or diesel traction.

In order to ensure that the railway cars should withstand such speeds, it was imperative to follow more modern design trends, since this called for moving the gravity centre downwards and for excellent bearings. In connection with this latter requirement slide bearings in practically all types of railway cars built in Poland have been replaced by antifriction bearings; this has not only enabled speed increase, but also reduced running costs. Railway cars built in Poland are equipped with rolling bearings produced by the Polish industry.

It was also necessary, in order to ensure traffic safety at high speeds, to introduce powerful brakes. In 1959, the Polish industry entered into a license contract with the Swiss firm Oerlikon Werkzeugmaschinenfabrik, Buehrle and Co. of Oerlikon, Zurich and launched the production of "Oerlikon" brakes in Chrzanow. In the near future, all railway cars built in Poland will be equipped either with Matrosow brakes manufactured on the Soviet license or with Oerlikon brakes—depending on the buyers' requirements. Besides pneumatic systems, electro-pneumatic brakes will also be installed, the latter being particularly useful when putting to stop extremely long express goods trains. Brake block will be replaced by disc brakes enabling a train moving at a speed of 160 km./h. to be stopped over a distance of 1000 m.

High travelling speeds of passenger trains confront chassis designers with problems extremely hard to solve. Bogie suspension must be developed to perfection in order to prevent any unpleasant rolling of railway cars at high speeds.

Being anxious to keep pace with current technical achievements, the Polish industry decided to purchase a licence covering forkless bogies for passenger cars, in order to utilise experience already acquired by other designers, by way of applying either individual elements or complete designs according to the licence. In talks concerning the purchase of such a licence, either German or Swiss designs are being considered.

Designing problems pertaining to speed increase are, however, not limited to bearings, bogies, and brakes; passenger coaches call for more technical improvements.

High speeds which until quite recently were the province of aircraft, and to-day are demanded of trains, call for streamlined coaches; protruding running boards, railings, etc., are becoming outdated. The demands of aerodynamics decide as to the shapes of locomotives and cars.

It has been proved in practice that a train passing, in a dry, rainless season, over sandy regions or those with poor vegetation, at a speed of 140 km./h., causes enormous clouds of dust to rise, making it impossible to air the coaches by opening the windows. Therefore, coaches built for high speeds are equipped with a draft ventilating system: air forced inside passes through filters which eliminate the dust.

Draft installations are connected with the heating system which enables draft heating during cold seasons.

The next step in advance is the air conditioning equipment, enabling both air temperature and humidity control at any time.

A prototype railway car equipped with the air conditioning system, built by the "H. Cegielski" Works of Poznan was released for trials in 1959; towards the end of 1960 decision will be reached as to the type of air conditioning system to be installed in railway cars built in Poland.

The windows in modern coaches are double-pane, made of shatter-proof glass, similarly as in motorcars. Double-pane windows protect the coach interior against the penetration of dust, against excessive cooling, and they act as sound-proof insulation. Due to the introduction, in between the panes, of special materials absorbing, atmospheric humidity, the windows do not become frosted in temperatures to –40°C.

Body sheeting is coated on the inside with a thick layer of sound damping material preventing corrosion.

The soundproof quality of a railway coach is one of the superior requirements with regard to travel comfort. Most comfortable seats, together with luxury interior finish will not secure the feeling of comfort if the coach is noisy. Silence inside the coach is a basic condition in rendering travel a pleasure instead of a hardship. Designers are therefore aiming at developing a coach in which the sound level of noises due to travel would not exceed 65 decibels with frequencies of 0.35 to 0.8 kilocycles per second and 60 decibels with frequencies exceeding 0.8 kilocycles per second.

Until recently, a considerable number of cars exported from Poland were equipped with hard or semi-soft seats. This years marks the turning point in this respect. The production of coaches equipped with hard seats is being stopped, and only coaches with upholstered or at least semi-soft seats will be manufactured from now on.

The adaptation of passenger train coaches to high speeds calls further-more for changes in the design of seats. Since most passengers prefer to sit during the travel, facing the engine, the seats will be revolving in order to ensure maximum comfort. Thus, all passengers will be able to face in the same direction, as this is to-day the case, e.g., in airplanes. Moreover, the construction of Ist class carriage seats will follow the trends applied in air transportation, i.e. the back rests, inclination angle will be adjusted individually. The interior lighting will be much brighter in future than heretofore, since light bulbs will be replaced by fluorescent tubes.

In connection with steam traction being replaced by electric or diesel traction, coach interior heating will be of either steam or electric type. Coaches equipped with individual heating, will have liquid fuel fired boilers.

In order to reduce coach weight while retaining the same bearing strength, alloy steels, light alloys and plastics will be applied in the construction of chassis and bodies. Coach weight reduction will enable coupling more cars in a single train.

In order to increase passenger coach capacity, the construction has been initiated, already in 1958 of extra long cars (of over 26 m. length) containing a larger number of compartments than the conventional car types formerly built.

Technical advancement is evident not only in the construction of passenger cars, but also finds its expression in freight car designs. Freight cars are to-day, similarly as passenger cars, equipped throughout with antifriction bearings and a modern brake system. Furthermore, special efforts are noted on the part of designers, aiming at increasing the freight car capacity-to-weight ratio. The same applies to the relation between the space volume and carrying capacity. Special attention is paid to the application of devices enabling rapid loading and unloading.

Increase in the relation of freight car carrying capacity to its weight is obtained, in the first place, by eliminating small two-axle freight cars and replacing them by four-axle ones: six- and even eight-axle freight cars are already in preparation. While in two-axle box cars the carrying capacity is only slightly over

twice their weight, in four-axle cars it is three times their weight.

In order to ensure maximum possible utilisation of the freight car loading capacity, even when transporting bulk goods of low specific gravity (such as hay, cotton, etc.), modern designs aim at increased loading space. Freight cars built to-day have loading space of 2 cu.m. per every 1 ton of carrying capacity, while until recently this ratio was 1.5 : 1. The loading space of four-axle freight cars is planned for approximately 140 cu. m. with a carrying capacity of 60—70 tons. In order to increase the carrying capacity of freight cars, the application of alloy steels and light alloys is planned, similarly as in passenger cars. Pine and oak wood representing until recently one of the basic construction materials, is to-day widely superseded by sheet steel and fibre-boards.

Self-discharge freight cars enabling extremely rapid unloading of bulk goods are to-day moving upwards in the lists of the polish freight car exports. In the past years, Poland exported two types of self-discharge freight cars, while scheduled for 1961 is the export of three novel types of self-discharge freight cars, two of which incorporating four-axle, the third one six-axle design.

Rapid loading and discharge of goods which must be transported in box cars is facilitated by sliding roofs enabling crane operation from the top. In order to speed up the discharge of bulk goods, unloading hatches are provided in the floor, for mechanised discharge.

If technical advancement in railway car designing can be characterised as bearing the features of a constant evolution, in the field of traction it should be rated as revolutionary. The building of steam locomotives is nearing its end, the last units to be exported from Poland by 1961. Their position is taken over by electric and diesel locomotives, rail diesel cars and multiple unit electric trains. The "Pafawag" Works in Wroclaw has been manufacturing, for some years now, 3E type electric locomotives according to documentation supplied by the U.S.S.R. In 1959, a licence was purchased in England, covering the production of a new type of electric locomotives.

Diesel locomotives powered below 800 HP are being produced by the "Fablok" Works of Chrzanow, according to Polish documentation. Diesel rail car prototypes are also in construction. All three types of power transmission are used in Diesel traction, i.e.: mechanical, hydraulic and electrical, the last named being most widely used.

The industry plans to purchase in 1960 licences covering the production of diesel locomotives powered 850 and 1700 HP, equipped with electrical transmission. Thus, the traditional export of steam locomotives will be superseded by that of diesel and electric units.

Type Testing of Internal Combustion Engines

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

(a) Compression ignition engines,

(b) Carburettor type engines, and

(c) Gas engines.

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

When major modications are made in the design or materials or both of an existing type of engine, or when an entirely new design is evolved and is to be introduced in the market, it is necessary to type test the new or modified design under rigorous operating conditions in order to prove its reliability. This Indian Standard is intended to serve as a guide in carrying out such type tests.

SCHAERER—LATHES

By An Engineering Correspondent

SCHAERER-Lathes are built since about 60 years. Today the programme includes Universal Lathes, Production Lathes with automatic working process, Semi-Automatic Copying Lathes, and special attachments for non-circular copying, particularly glass-molds and cam-shafts of Diesel-Engines and similar machines.

The special feature of the SCHAERER-Lathe are the underslang saddle guideways, arranged in such a

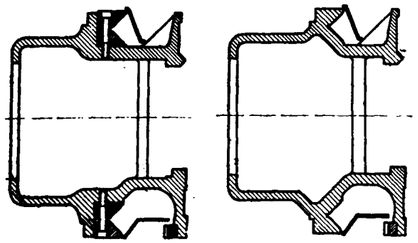
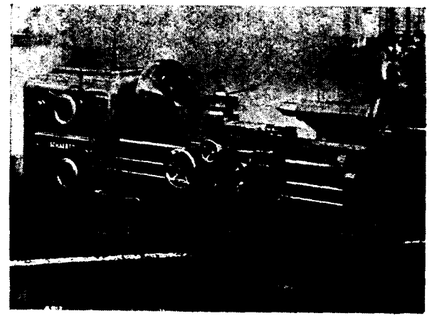


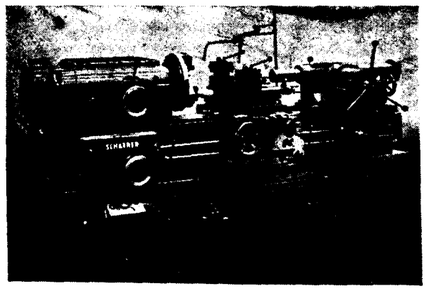
Illustration of SCHAERER-Guideways. At the top normal execution, at the bottom hard-chrome gibs.

way that they are well protected against damage by swarf. Their Vee shape guarantees that a permanent oil film is maintained. This ensures a long life for guideways and extra-ordinary resistance against warping. If high pretensions are made, these guideways even may be supplied as hard-chrome steel gibs.

Furthermore the SCHAERER-Lathes are characterised by their large drive capacity in comparison to the height of centres, by their important speed range (universal lathe = 1 : 200), and by their various special equipments. Regarding the SCHAERER Lathe Programme, it's easily possible to choose production lathes being particularly economic and suitable for special operations. As to the universal cutting, the SCHAERER Universal Lathe is fitted with all equipments, capable to execute a great range of work. As shown on the photos, the machines possess but some control elements in order to facilitate their operation. The quick change control lever is used for the rapid setting of all standard metric, inch and module threads as well as for the feeds. Settings can be read instantaneously from the control drum. Neither tables nor calculations for machine regulation are necessary.



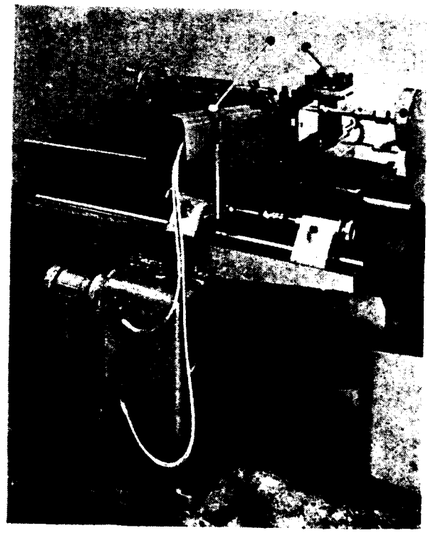
SCHAERER-Lathe in standard execution, centre height 320 mm. drive capacity 20 to 30 H.P.



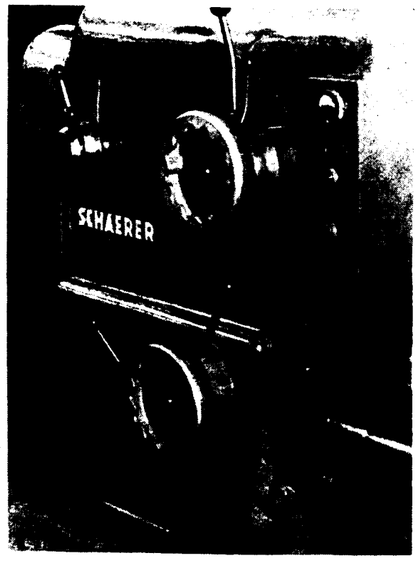
SCHAERER-Lathe, 320 mm. centre height, with twin slide and one independent front and rear cross slide, boring tailstock, and pneumatic chucking attachment.

Today SCHAERER-Lathes are installed in leading factories throughout the world, where high precision and great cutting capacity is required.

The Hydraulic Copying Unit "SCHAERER-PROFILE D9", suitable for fitting to lathes of all



Copying Unit " SCHAERER-PROFILE D 9 " suitable for fitting to lathes of different types.



View of main drive and feed box. Setting of speed, feeds, and threads by hand wheels.

types, is remarkable, too. This copying unit distinguishes itself by its high accuracy. In all cases, where special copying lathes will not pay—because of the low output capacity—SCHAERER-Lathes with hydraulic copying attachment are prefered.

The blocks illustrated will give an impression of large manufacturing programme and the variety of application possibilities of SCHAERER-Lathes. They are well-known in the whole world.

PELS Straight Sided Crank Presses

Satisfy all claims for technical perfection. They are built in three different series, i. e.

type PIKs mainly for stamping, cutting, and shearing purposes, of small operational capacity and high speed,

type PIK for a wide range of operations and small table area,

type P2K for a wide range of operations and big table area, for press powers of from 100 or 125 tons respectively up to about 1000 tons.

Presses of types PIK and PIKs have single point suspension, those of type P2K double point suspension.

The press frame consists of bed, header, and uprights fabricated of heavy steel plate and stress relieved after welding. These components are joint by welding to form a single-piece body, or, in the case of presses above 250 tons and with large table area, by preloaded steel tie rods. The boxshaped components are properly stiffened by ribbings to increase their strength against dynamic stresses. Both the uprights are made of folded plate sections with welded-on tension plates and allow to provide openings to make the tooling accessible from 4 sides.

The ram slide is also welded of heavy steel plate and its boxlike shape stiffened by adequate ribbings. It is guided by long adjustable prismatic gibs along the 4 inside borders of the uprights. The vee gibs of the small size crank presses are abjustable and fitted to the ram slide, while those of the bigger size presses are mounted to the uprights. The adjustable gibs are armed with plastic foil, the

opposite ones of special quality cast iron. The weight of the ram slide and partly that of the tooling is balanced by compressed air cylinders. A reversible electric motor actuates the ram slide adjustment transmitting its power through a gear to one or two threaded spindles which are guided in cylinders. Accordingly, only axial pressure stress is put on these spindles. The ram slide adjustment way is limited in

Copying of cams of a Diesel engine camshaft with 2 hydraulic copying slides.

both directions by limit switches. In case the ram sets on tool parts during the adjustment operation, the drive of the regulating gear will be automatically stopped by a safety device.

To protect the tooling and to safeguard the press against overload, an oilhydraulic overload safety device can be fitted. A pressure pad below the small ends of the connecting rod can be adjusted by preloading to any desired load within the admissible range of pressing force. A pilot lamp mounted on the control panel flashes immediately the adjusted press power has been reached. When the predetermined pressing force has been exceeded by 20%, the overload security cuts off the press automatically.

In case overloading takes place within the range of before 40° before lower dead center, the press drive will be automatically declutched. The ram slide is then to be brought to top position in the reverse direction. Will the press, however, be overloaded in a position closer to the lower dead center, the crank drive will continue its way through the bottom center with blocked ram slide. Only during the return of the connecting rod, the ram slide will again be carried along and stopped in the topmost position.

Sometimes, a mechanical overload security in the place of the hydraulic one may be sufficient. It works on the principle of measuring the elongation of the press frame or of two tie rods diagonally opposite to one another.

The press is fitted with a detachable bolster plate, which will get Tee slots for tool fixing. In accordance with conception adopted on principle for all PELS Straight Sided Crank Presses, the press has cross shaft drive. The crankshaft liable to bending and breakage, has been omitted. In its place, gear wheels with cast-on eccentric hubs running on fixed wheel pins in closely mounted gearings form the crank drive.

The complete drive is arranged inside the head of the press. The flywheel and the first driving shaft run in roller bearings, all the high speed wheels have helical gearing assuring an almost noiseless operation of the complete drive. By mounting the flywheel on a hollow shaft bearing flanged to the press body, the driving shaft rotating inside the hollow shaft bearing is completely relieved from flywheel weight and belt pull.

The single disk friction clutch has given full satisfaction for a good number of years. It is electromagnetically controlled and actuated by compressed air. The friction blocks can be exchanged without any considerable dismantling work. Also, the single disk friction brake is electromagnetically controlled, released by compressed air and rapidly and dependably engaged by spring pressure. It is designed for very high operating frequencies, the renewal of the friction blocks takes little time.

The press is controlled by an electromagnetic two-hand safety engaging gear. A selector switch allows three settings :

1. *inching,*

   by pressing down the push button, the ram slide can be moved up or down over short bits of the stroke, the ram remains in motion as long as the key is kept pressed.

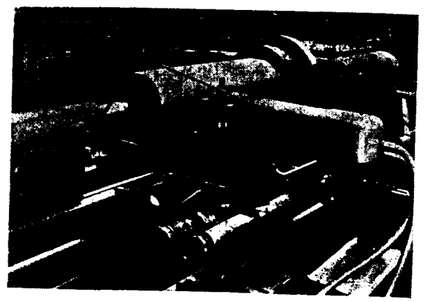
2. *single stroke,*

   by actuating the switch-on key during the down stroking of the ram slide, the latter performs a full stroke cycle and remains stopped in top position.

3. *continuous run,*

   after engaging the press works till it is stopped by pressing a switch-off key, the ram slide returns to top position.

During "single stroke" and "continuous run", the ram slide can be stopped in any position by pressing an emergency key. The ram slide movement is indicated by the hand of a dial in the control panel. In the right side upright, a cam shaft with 10 cam disks will be installed, out of which 6 cams are available for the synchronous control of the transport and working movements, when the press is inserted in a production train.

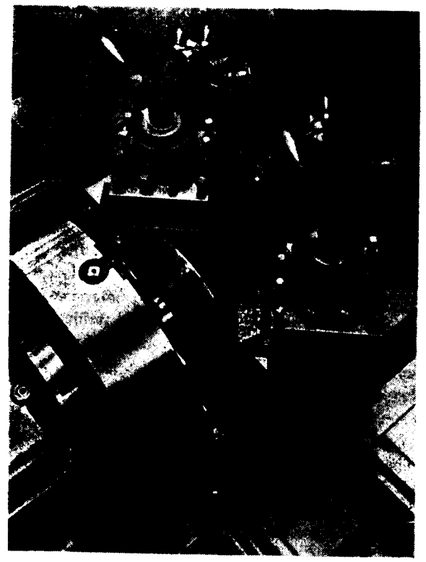


Copying of a four-edge mold with the hydraulic non-circular copying unit.

In the ram slide a number of knock-out bars are incorporated brought into action by adjustable stops on both sides of the press headpiece.

A flywheel brake stops the flywheel within abt. 15 secs. after switching off the motor.

The press is equipped with the so-called cascade circulation lubricating system. Thereby, the lubricant is pumped from a tank in the press bed through filters and two pressure adjustable distribution lines to the sliding faces, bearings and gear wheels. The quantities can be regulated by time switches with impulsing device. The oil flowing from the lubricating



Machining of a taper with twin slide and power traverse.

points is caught in the headpiece, the overflow is conducted over connecting rods and ram slide back to the collecting tank. In case of failure of the lubrication, the press is automatically stopped, while a pilot lamp flashes on the control panel.

Particularly marked lubricating points are fed in the usual way by hand guns.

To avoid accidents during continuous run of the press, we recommend to instal light barriers in the front and at the rear of the press. Strip lights are fitted inside the press opening on both uprights to improve working conditions. The headpiece with the press drive can be made accessible by inspection platforms and ladders.

It is also possible to instal a pneumatic drawing cushion in the press bed, either of the uncontrolled type, or of the controlled type with control slide and electrically regulated stroke adjustment.

IWK Hydraulic Self-contained Straight Sided Plate Shaping and Deep Drawing Presses

These presses are built with a maximum press power of from 160 up to 1000 tons. They are either single acting, for ordinary shaping, stamping, flanging, beading and pressing work, if necessary equipped with hydraulic cushion or ejector, or double acting with downstroking blankholder.

The press body consists of bed, header and uprights, these parts fabricated of heavy steel plate are stress relieved after welding. They are joint by welding to form a monobloc press frame, or in the case of presses above 315 tons and with large table area, by preloaded tie rods of steel. To make the uprights specially resistant against transversal and torsional forces and dynamic stress, they are made of folded steel plate reinforced by ribbings and welded to form box shaped bodies. The bolster plate of forged steel is screwed on to the bed and has Tee-grooves for tool fixing, a centering hole and an arrangement of holes for the drawing cushion pins.

The ram slide being rigidly fixed to the piston shaft is a welded boxlike structure and extremely resistant against bending and twisting forces. It is guided by 4 prismatic gibs along the 4 inner borders of the uprights. The guide gibs are adjustable, they allow to work with the smallest possible clearances guaranteeing a high degree of accuracy. Its bottom surface bears Tee-grooves and a centering hole. In accordance with capacity and table breadth of the press, a number of knock-out bars are fitted inside the ram slide, their movement can be regulated by spindle stops on both sides of the press frame. The press power is exercised on the ram slide by one or two pistons, their cylinders are mounted inside the header. Oil pressure below the piston disk effects the return movement of the ram slide.

Moving below the ram slide and guided along the same 4 gibs as the ram slide, the blankholder is pressed down by 2, or, in big size presses, by 4 cylinders, the return movement being effected either by 4 adjustable spindles or by 2 separate push back cylinders. The blankholder can be coupled to the ram slide by bolts, the press power of all downstroking cylinders acting jointly.

The blankholder satisfies all demands in regard to self-adaptable downholding. The central opening is reduced by annular plates forming part of the tooling. The guide gibs are adjustable. During the drawing operation the downholing pressure is maintained by oil escaping from the annular space below the main piston and can be infinitely varied.

All the cylinders for ram and blankholder are made of cast steel and have a polished interior surface. Long guide bushes for the piston shafts are fitted, the cylinders are sealed by multiple packings with bilabial rings of wear resisting synthetic material.

The pistons, whether of the disk type or the plunger type, are made of chilled cast iron of high surface hardness or high quality steel. All differential disk type pistons bear bronze guide rings and packings to prevent leakage from one cylinder room to the other and dropping of the ram during a standstill of the press.

Below the bolster plate the hydraulic cushion is fitted. Piston or pistons and pressure platen are rigidly fixed to one another. The pins standing on the pressure platen and penetrating the bolster bear the drawing cushion ring clamping the rim of the blank during the drawing operation against the annular face of the die. A special pressure regulating valve is fitted to the cushion. Generally, the cushion works as a passive one, during the downstroking of the ram it is pressed down by means of the pressure pins and follows the ram again on its way upwards till its upper adjusted position is reached and the top of drawing cushion ring and drawing stamp lie in the same plane. During active work the drawing cushion is controlled by a slide connected to the electromagnetic controls, it can then be used as ejector or for reverse drawing.

The operative oil pressure is produced by a multi-piston axial pump with dependable capacity regulator. In the place of the formerly common slide valve for distribution, a reversing control system is employed offering the advantage of a smooth reversal of the ram movements in the stroke end positions.

The capacity regulator varies the stroke of the pump plungers in relation to the pressing resistance. Rising resistance reduces the pump output, the motor input remains thus practically constant. The motor drives the pump by a flexible coupling. The pump works without valves or packings and owns its convenient lubricating system regulating the lubricating

pressure in accordance with the load put on the press.

The press power of ram, blankholder and drawing cushions can be varied within wide limits. All adjusted pressures are to be read off on the gauges jointly fitted to the manoeuvring board. The pressure regulating valves we employ have an uncommonly wide range of adjustment.

In accordance with the respective height of tooling and drawing depth, the ram slide stroke can be confined at liberty in chosen top and bottom positions. In this way, it is possible to realize for every stroke cycle the shortest and most economic lengths of stroke. Any exceeding of the maximum stroke length is impeded by solid stops.

When performing punching or trimming operations intermediate pieces are put on stops making the ram slide or blankholder to set on them immediately the punch has broken through the material and avoiding any percussion in the hydraulic system.

On the manoeuvring board fitted to the right side upright are arranged, beside the pressure gauges, the push buttons and an emergency switch, up to 3 selection switches, one for selecting the desired operation cycle: "inching", "single stroke" or "continuous run", one for switching on and off the drawing cushion or putting it on active or passive operation, and one for connecting or disconnecting the backside control panel.

"Inching" is mainly used when setting or trying out tooling. When "single stroke" has been selected, one complete stroke cycle will be released. By a time-log relay the ram slide can be kept for a short predetermined period in the bottom position. This is particularly important for coining work. Once the press has been regulated for "continuous run", the succession of stroke cycles will go on till the press is stopped. The duration of the feeding will be determined by the time-lag relay for the top position of the ram.

To protect the operator against accidents, we recommend to instal two hand; two men or four men safety controls, light screens or electric interlock guards. Light screens are automatically switched off during ram return and feed periods.

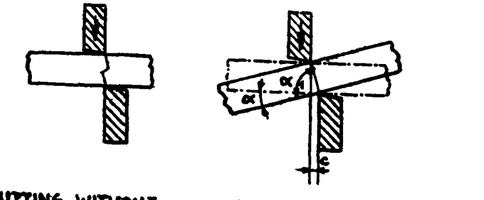
In order to catch the ram and blankholder slides while downstroking in rapid motion, before they set down on the material, an electromagnetic guide motion slide is closed and the descending slides braked by turning the pump back to its central position. At the end of the return stroke, the ram slide is braked too.

Oil filters are provided to keep the circulating lubricant clean and to protect it against the effects of deterioration by ageing. If operating conditions demand it, oil cooling or oil heating can be fitted. These are thermostatically controlled.

Due to the excellent finish of all components, the minute deflection of the press frame and the perfect parallelity of bed, ram slide and blankholder, work-piece sizes can be most accurately held and maintained. Owing to this fact, to the rigidity of the press and to its oscillation-free working, tool life is uncommonly long.

PELS Billet and Slab Shears

Billet shears are wanted for high numbers of cuts and uniform evenly cut surfaces on the sections as they can be obtained by sawing. Billet Shears which cut on the diamond, usually do not allow to achieve uniform cuts with perfect rectangularity and free of burrs and core protrusion, without blade changing when cutting steel of different composition and a tensile strength of from 55 to 140 tons/sq. in. The reason for it lies in the bending of the off-cuts during cutting which produces obliquely cut faces. The smaller the tensile strength, the more oblique the cutting plane. This inconvenience was tried to be removed, already in former years, employing so-called up-clamping devices, they did, however, not give full satisfaction, as the up-clamping forces were too small.



CUTTING WITHOUT CLEARANCE

CUTTING WITH CLEARANCE ANDANGULAR FEED

At this new PELS billet shears, blade beam and up-clamping device form one pincer-like system. The design is protected to IWK by patent rights in Germany and foreign countries. Due to the high

downholding pressure and an up-clamping power proportional to the cutting force, the face of the off-cuts shows the properties mentioned below. No supplementary mechanical power or working capacity is needed for up-clamping.

This new type billet shears works with simple rectangular blades. They produce almost square off-cuts with negligible deformation and without core protrusion. The shears is designed in such a way that the up-clamping device cannot impede the cutting operation. The big number of cuts to be obtained with this shears gives a comparatively high efficiency.

The advantages of the newly developed PELS Billet Shears are focussed and explained below :

(1) High production figure by automatic working. The working cycle is automatically performed by the new PELS billet shears. Having engaged the roller table drive, the inserted billet is fed into the machine, knocks against the back stop and releases the cutting cycle, causing in quick succession clamping down by the downholder, withdrawal of the back stop and cutting. After throwing out the off-cut and stopping the blade beam in the upper dead center, the cutting cycle is repeated. It is not necessary to engage the shears by hand each time the material is put against the back stop. Hand operating will unavoidably cause time losses and rejects when the wanted exact length of the off-cuts has not been maintained.

While the idling speed of the shears of 315 and 630 tons shearing force are 28 and 26 per minute, the production figures vary with the off-cut length. Considering idling times, the number of cuts will be abt. 12—15 with an off-cut length of say 4"—5", and 5—7 per minute when the off-cut length is 20" approximately. The output figure in tons per hour is consequently increasing with the length of the cut pieces.

When cutting on the diamond, loss of time occurs owing to bent billets which impede the performance of the cutting operation and require readjustment of the downholder. Such disturbances are unknown for shears with horizontal blades, because the billet can be turned on the roller table and put on that one of its four faces on which it lies almost flat.

(2) Outstanding quality of cut. The excellence of the cuts depends on a conveniently big upclamping force, on the correct selection of the clearance between upper and lower blade and on the predetermined cutting rake, i. e. the angle between blades and severing plane vertical to the billet axis. If upclamping force is lacking or insufficient, the material when cut will be bent, torn or curved. The horizontal clearance between upper and lower blade edges must be regulated in accordance with the height of the section and the quality of the material, as a rule the clearance amounts to some 7 to 10% of the height of the section.

A sketch shows the actual conditions. Cutting without clearance gives a broken face. If the billet, when being cut with the required clearance, is fed horizontally, the cutting plane in the billet runs obliquely, as shown by the dotted line. In order to achieve a square cutting face, the billet is to be introduced with a slight inclination.

Experience teaches that proper cuts can be obtained, when cutting on the diamond, provided.

(a) the blade is relief-ground over the full breadth of the material, what is obviously feasible for one section only.

(b) the Vee-shaped edges of the blades must have an angle of more than 90°, the correct size of the angle depending on the elongation of the material. This means cutting on the diamond can be achieved just for one section of material of a certain quality. Already slight deviations from that section or differences as to the elongation cause improper cuts. In case, the rounding-off radii of blade and billet do not coordinate, a burr or even a core projection will be squeezed out which is rather an unwanted impediment during a further transport. This formation of

proper and square cuts will be achieved. Extreme core projection and forming of a nose on the cut face by the upper blade—as mentioned above—will certainly not occur.

(5) relatively rapid blade exchange by effective measures. The backstop and the down-holder of the PELS Billet Shears are pivoted on hinged in order to change the blades with ease and to change the shears from smaller to bigger billet sections. Once the personnel have got accustomed to this work, they will take 20 to 30 minutes to perform it.

The blade clearance, too, can be rapidly set, owing to the special design as described above, simply by inserting or removing shims under the lower blade.

The obvious advantages of the new PELS Billet Shears lie in the high quality cuts that can be obtained, the accuracy of the length of the off-cuts, the high effective output and the easy maintenance.

STEEL SMELTED IN RECORD SPEED

The local iron and steel mill named after Lenin has reported a record speed for steel smelting in small tonnage furnaces in the USSR — 5 hours 20 minutes. At the same time it obtained 13 tons 100 kilograms of steel per square metre of the furnace floor, which is 100 per cent above norm.

The Uzbek iron and steel mill was built after World War II and is a firstling of the Soviet Central Asian Steel Industry.

The record feat was carried out by steel-makers Shirali Khamrakulov and Nikolai Krasi.

DIESEL & ELECTRIC TRACTION SUPPLEMENT

Bagnall's Contribution to World's Railways

By An Engineering Correspondent

Messrs. W. G. Bagnall Limited of Stafford, England are one of the old locomotive builders and railway engineers.

The business was first started in 1875 and the company has concentrated on manufacturing locomotives, wagons, turntables and all kinds of light railway rolling stock for every conceivable purpose and in the early years built an enormous amount of smaller type steam locomotives for use in quarries, tea and sugar plantations and such light services at home and abroad.

During the last twenty-five years, however the works have been considerably extended and the plant made of suitable capacity to handle the large locomotives now running on the British main-line systems and the main Indian Railways and all railways of other countries abroad.

For the last six years they have designed and built diesel mechanical and diesel hydraulic locomotives as well as building diesel electric locomotives.

Connection with diesel locomotives, however, dates back to 1933 when an order was received for a 22 h.p. double-bogie mine locomotive. This was fitted with a two-cylinder DEUTZ two-stroke engine of 22/24 b.h.p. at 700 r.p.m. It was completed in 1934 and delivered for underground working at a colliery in North Wales.

Another order was received in June 1934 for a larger machine. This time a locomotive powered by a 45/50 b.h.p. DEUTZ engine running at 1000 r.p.m. for working underground in conditions involving fire-damp. Complete elimination of harmful gases from the exhaust was effected and there was no danger from fire. The locomotive weighed eight tons in working order and had four speeds. It was delivered in January 1935 for service in Scotland at King's Hill Colliery, owned at that time by Coltness Iron Company Limited, New Mains, Lannark.

Prior to the last war and for several years following about 60% of all orders were for export to India.

Numerous steam locomotives were designed and built for Indian Railways and the leaflet illustrates many types and gives details of them.

A number of fireless steam locomotives have also been designed and manufactured for use where there is a danger of fire and in all locations where adequate supplies of steam are available from stationary boiler plant. They can be built for very much less than the cost of diesel shunters of equivalent power, while the absence of a boiler and firebox make them cheap to maintain and operate. They also have a very high availability for traffic.

Many other steam locomotives were designed and built for use in this country and in other countries throughout the world.

When design and manufacture of diesel locomotives was re-started after the war the first order was for Ten 240–H. P. 0–6–0 shunters of 3′ 6″ gauge for the New Zealand Government Railways and one 240 h. p. 0–6–0 shunter for Tasman Pulp and Paper Company Limited, New Zealand.

Since then diesel mechanical locomotives have been designed and built for service in The Middle East, South Africa, and for the National Coal Board and other industrial concerns in England.

On the diesel mechanical locomotives the transmission consisted of Fluid Coupling, Cardan Shaft, Air Operated Change Speed Gearbox, Flexible Coupling, Air Operated Reverse and Final Drive Gearbox, Jack-shaft and Coupling Rods.

At present diesel hydraulic locomotives are being produced and on this type the transmission consists of Torque Converter, Cardan Shaft, Air Operated Frame-mounted or Axle-Mounted Reverse and final drive gearbox and coupling rods.

The complete range of hydraulic locomotives cover H. P.'s of 30–700 and are divided into the following groups :

30— 60 H. P. with chain drive from the final drive gearbox to the rail wheels.

70—100 H. P. with single stage torque converter and chain drive.

70—100 H. P. with three-stage torque converter and chain drive.

150 H. P. with three-stage torque converter and chain drive.

150—300 H. P. 0-4-0 type with rod drive.

232—456 H. P. 0-6-0 type with rod drive.

Leaflet No. B1 gives the leading particulars of the standard 0-6-0 diesel hydraulic locomotives for Metre Gauge upwards.

Leaflets Nos. B16 and B17 give details of the 70-100 H. P. standard 0-4-0 chain driven diesel hydraulic locomotives for Narrow Gauge and Standard Gauge respectively.

In 1951—2 Underframes, Bogies and Mechanical Parts were manufactured for 25 main line diesel electric locomotives of 1,000 h. p. for the Ceylon Government Railways. These locomotives were AIA-AIA type 5' 6" gauge and weighed 87 tons in working order. They had a maximum speed of 55 m.p h., a starting tractive effort at 26% Adhesion of 33,700 lbs., a tractive effort (1 hour rating) of 30,000 lbs. at 9.2 m.p.h. and a tractive effort (continuous) of 24,000 lbs. at 11.7 m.p.h. The locomotives were powered by a Mirlees engine type JS12VT developing a continuous power at site of 1,000 h.p. at 850 r. p. m.

Since then the following diesel electric locomotives have been built for operation in steel works and at collieries in Great Britain.

0-4-0 type of 300 H. P., 0-6-0 type of 366 h. p. and Bo-Bo type of 515 b.h.p. In addition mechanical parts up to deck plate level have been produced for the 300 h. p. 0-4-0 type, 400 h.p. 0-6-0 type and 875 h.p. Bo-Bo type diesel electric locomotive. Further more mechanical parts up to deck plate level have been manufactured for British Railways type 2 diesel electric locomotives.

It will therefore be seen that the company by the construction of locomotives of varying size have given a demonstration of the capacity of their works and also of their ability as a firm to produce locomotives of the highest standard.

Designing Locomotives to meet widely varying needs

By D. R. Meier

Locomotive & Car Equipment Department
General Electric Company (U.S.A.)

THE transportation system of a nation is as vital to its economic well-being as the circulation of blood is to the health of the human body. It is closely connected with every phase of economic life, from the production of raw materials to the distribution of finished products. It also provides the means for the free and rapid movement of people so essential to social, economic and political progress. Hence, it is evident that industrial and social advances can only be made when they are accompanied by a corresponding development of the transportation system.

As the economic progress of nations throughout the world continues, it is logical to expect that further improvements in transportation will take place. In many instances this will most likely include major emphasis on the improvement and expansion of railways. One aspect of such a program will be the replacement, where economically justified, of the steam locomotive with the diesel-electric or electric locomotive. Apparently the pattern will be generally similar to that followed in the United States over the past 20 years. Where oil supply is adequate, diesel-electric locomotives will probably be used. Their potential field is expanding with the oil developments now under way in many countries. In some localities the presence of abundant hydroelectric power may favor electrification for heavy-traffic main lines, with the diesel-electric locomotive serving the branch lines.

A valuable and illuminating comparison may be drawn between conditions existing in other countries and those in the United States.

STANDARDIZATION OF MOTIVE POWER

The replacement of the "iron horse" with the diesel-electric locomotive is virtually complete in the United States. This is clearly indicated by Chart 1. Although this shows an appreciable number of steam locomotives still in service at the beginning of 1959, they were confined almost entirely to light traffic lines. A more accurate picture is given by locomotive performance statistics. During 1958 diesel-electric locomotives performed 96 per cent of the total freight gross ton-miles, 94 per cent of the total passenger-train car-miles, and 98 per cent of the total locomotive hours in yard switching service on the railways of the United States.

This motive power revolution has been accomplished largely with well-developed standard types of locomotives. These all have the following outstanding features :

1. One standard gage : 1435 mm (56 1/2 in.)

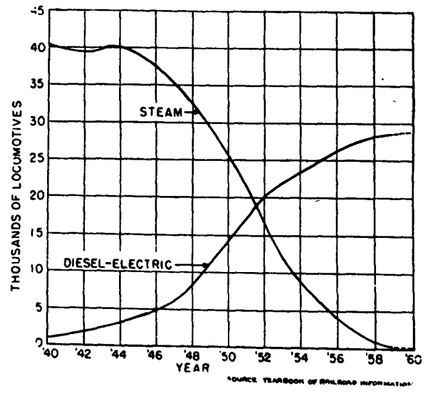


Chart 1.

Number of steam and diesel-electric locomotives in use in the United States from 1940 to 1960. Steam units are now completely replaced with more economical diesel-electrics. Note that there are about 30 percent fewer diesel-electrics at present than there were steam locomotives in 1940. In spite of this unit decrease, U. S. diesel-electrics haul approximately 35 percent more freight than steam locomotives did twenty years ago. (2.3 billion ton miles in 1959 compared to 1.7 billion in the 1940 period).

2. Essentially the same clearance diagram, based on a cab width of 3048 mm (10 ft.) and a height from rail to roof of 4420 mm (14 ft. 6 in.)

3. Practically all axle loads within the range of 24.9 to 29.4 metric tons (55,000 to 65,000 lb.) per axle.

4. Diesel engine power output for traction ranging from 1521 to 2434 cv (1500 to 2400 hp) horsepower for road units, and 608 to 1216 cv (600 to 1200 hp) for switching locomotives.

This standardization of motive power was possible because practically all railway track and structures in the United States are designed to permit operation of locomotives having the weights and dimensions given above. Both builders and users of locomotives reap benefits from so high a degree of standardization. These include lower first cost, shorter shipments from builders, lower maintenance costs, and simplification of servicing problems.

The standardization of locomotives for use outside the United States is a different problem. The data in Table I indicate some of the major differences encountered in permissible weight per axle, clearance limitations, coupler height and track gage. This selection is representative and does not by any means present a complete picture of all the variations that must be dealt with.

Some railways may find it feasible to make changes in permanent way and structures to permit taking fuller advantage of standardization, although large-scale moves in this direction may be difficult. Understandably, in a preponderant majority of the situations encountered there will be a natural inclination to obtain locomotives to fit the railway rather than remake the railway to fit a standard locomotive. Naturally, the locomotive purchased will represent some degree of compromise between complete individuality of design and complete standardization. Every step toward standardization that can reasonably be taken will prove beneficial to all concerned.

A " BASIC " LOCOMOTIVE DESIGN

Careful analysis of data accumulated from world-wide applications of electric and diesel-electric locomotives indicated the possibility of designing a basic locomotive type, from which variations could be built within certain limits.

In seeking to promote standardization in the diesel-electric locomotive field, studies and experience indicate that best results can be achieved by creating a flexible basic locomotive design readily adaptable to the majority of the requirements encountered. Such a basic design should meet the following requirements :

1. Adaptability to various gages, the gage requirement to be determined before manufacture.

2. Adaptability to various coupler heights and types.

3. Ability to meet composite clearance diagram which will permit operation on a majority of railroads.

4. Cab design to permit operation under a wide variety of conditions, such as switching and road service with either end leading. The cab that has found wide acceptance in the United States for this purpose is known as the " road-switcher " or " hood " type.

5. Over-all design for minimum weight consistent with adequate mechanical strength.

6. Ability to maintain low weight per axle. The design will have greater adaptability if the superstructure is arranged so that it can accept either 2-axle or 3-axle trucks, as conditions require, without modification.

7. All weight to be on driving axles (no idle axles) in order to achieve maximum use of power and weight.

8. Utilization of standard electrical and mechanical components wherever possible.

9. Provision of certain options (with minimum disturbance of basic design) to suit differences in the requirements of individual railways. These options should include 2-station control, multiple-unit control, dynamic braking, train-heating steam generators, combined air and vacuum brake systems, and numerous other items.

10. Emphasis should be placed on a simplicity and reliability of components.

With these requirements in mind, a line of basic locomotives covering a range of 608 to 1824 cv (600 to 1800 hp), has been designed and built.

The type F engine used on most of these locomotives is described in more detail in the section of this paper headed " Recent Developments ". The engine used on the 912 cv (900-hp) locomotives is a 6-cylinder, in-line engine. The one used on the 1216 cv (1200-hp) locomotives is a v-8, and that on the 1824 cv (1800-hp) locomotive is a V-12. The cylinder assembly, pistons, rings, valves, and many other components are common to all three engine sizes. The engine used on the 608 cv (600-hp) locomotive is a high-speed V-12 manufactured by the Caterpillar Company.

One traction motor model is used throughout the line on locomotives of meter gage and larger. A modified version of the same motor is available for use on 914-mm (36-inch) gage locomotives.

The same generator is used on the 1216 and 1824 cv (1200 and 1800-hp) locomotives, and the same exciter is used throughout the entire line from 912 to 1824 cv (900 to 1800 hp).

Many components of the control system are common to all of the locomotives.

In addition to equipment, many to the mechanical components, such as journal bearings, wheels and axles, brake rigging, etc. are alike.

This extensive use of similar components is of great benefit, particularly to a railway requiring locomotives of several different ratings, because it simplifies the matter of stocking spare parts and of training both operators and maintenance men.

The outline of the 1824 cv (1800-hp) locomotive in this line is shown in Fig. 1. The others are basically similar, and all except the 608 cv (600-hp) size are available with B or C type trucks. A photograph of one of the locomotives built for the Chilean State Railways is shown in Fig. 2.

Twenty-five 1824 cv (1800-hp) locomotives were built for the Argentine State Railways. They are generally similar to the 912 and 1216 cv (900 and 1200-hp) units described above. They differ, however, in that each unit is equipped with a 75-kw auxiliary generator to provide power for passenger car heating.

Locomotives of this design are applicable to a wide variety of railways with different permanent ways, structures and operating conditions. Because of their design and adaptability they can be used for all types of service, thus minimizing the total number of locomotives needed. For these reasons the name universal has been selected for this line of locomotives. The basic design also results in other economies stemming from standardization, such as reduced first cost, lower maintenance expense, and greater ease and economy of servicing.

SPECIAL LOCOMOTIVES

Where standard designs cannot possibly be used, locomotives can be designed and built to meet any reasonable special condition encountered. Examples of such conditions are extreme limitations on weight per axle, specially restricted clearances, odd track gage, unusual altitude conditions, coupler height

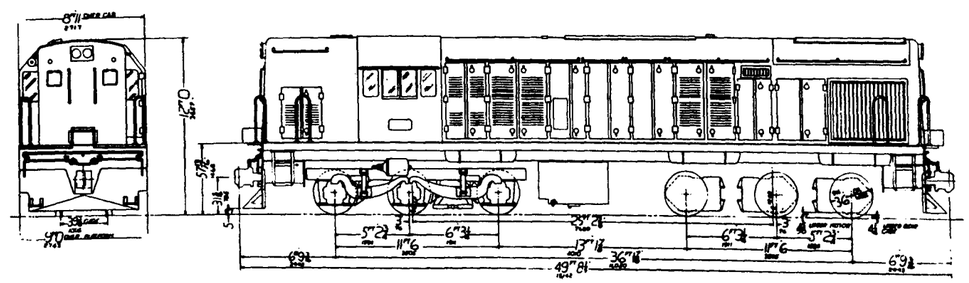


Fig. 1. Outline drawing of 1824 cv (1800-h.p.) universal type diesel-electric locomotive built by General Electric Company.

outside the ordinary range, etc. Of course, departures from standard designs will be reflected in some increase in costs. Extra costs can, however, be minimized through cooperation of the builder and the railway in three ways.

Fig. 2. General Electric universal type diesel-electric built for Chilean State Railways. This 86-ton, 900-h.p. unit is typical of the locomotives built by G.E. for use in many parts of the world. Horse-power range of the G.E. universal line is from 700 to 1980.

1. Co-ordinating specifications and designs with a view to using standard electrical and mechanical components wherever they are acceptable. This will permit full advantage to be taken of reduced cost through repetitive manufacture and elimination of extra design work. It will also give the railway the advantage of a minimum number of special parts to operate and maintain.

2. Arranging, when possible, to build a quantity of locomotives at the same time. As is well known, design costs, starting costs, etc., are independent of the number of units produced. Hence, the greater the quantity of locomotives the less effect such costs have on the unit price.

3. Taking full advantage of well-known design principles to attain the special objectives required.

The following locomotives built by General Electric for service in various parts of the world illustrate the wide variety of special conditions encountered and the means used to cope with them.

Indonesia : Twenty-seven 96 metric ton (106 short ton) 1622 cv (1600-hp) locomotives equipped with Alco 244 engines were delivered to the Indonesian Railways in 1953, for freight and passenger service on their 1067 mm (42-in) gauge lines. The streamlined type cab was used, with an operator's compartment at either end to eliminate the necessity of turning the locomotive. A special running gear with a C-2-C wheel arrangement was designed. This permits the locomotives to meet the currently light axle loadings. When contemplated improvements to track and structures allow heavier axle loads, the 2-axle truck can be removed and the locomotives operated with a C-C running gear.

Philippines : The thirty 1216 cv (1200-hp) road locomotives built for the Manila Railway in 1956 illustrate modifications of cab design. Basically of the universal line design, all of these locomotives have C-C running gear with fabricated trucks. Twenty were fitted with streamlined cabs, Fig. 3, for road freight and passenger service, and weighed 87 metric tons (96 short tons).

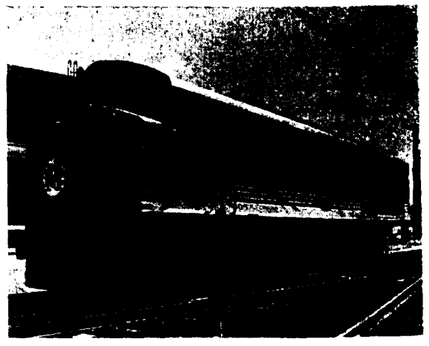


Fig. 3. One of 20 locomotives built by G.E. for the Manila Railway with Streamlined cabs instead of standard "box" cab. Weighing 87 metric tons, the locomotives developed 1200-h.p.

Ten were fitted with road-switcher type cabs, an weighed 82.5 metric tons (91 short tons).

Southwest Africa : A good example of modificatio of running gear is found in the 115 locomotives no under construction for the South African Railwa for operation on the 1067 mm (42-in) system Southwest Africa. Basically they are the 1824 (1800-hp) universal type design of the road-switch type, and weigh 95 metric tons (104.5 short tons To meet required wheel loads, an idle axle was adde at each end giving a 1C-C1 running gear, as show in Fig. 4. These locomotives are equipped wi

multiple-unit control, allowing two units to be operated together as a double-ended locomotive of twice the capacity of one unit.

RECENT DEVELOPMENTS

Developments have been under way for years looking toward continuing improvements in horsepower rating, reliability and maintenance of locomotives, whether of standard or special design. From 1954 to 1959 General Electric operated four specially constructed diesel-electric units of the box-cab type for developmental test purposes. These consisted of two leading or "A" units, one of 1216 cv (1200-hp) and the other of 1824 cv (1800-hp), and two trailing or "B" units, one of 1216 cv (1200-hp) and the other of 1824 cv (1800-hp). The 4-unit locomotive, having a total of 6084 cv (6000-hp) for traction, was operated in regular freight service on the Erie Railroad where it was assigned to runs 644 km (400 miles) in length over a rolling profile with grades up to 1.0 per cent.

This locomotive was really a "mobile laboratory"—designed and built for the express purpose of proving out new developments and stimulating further improvements in the motive power field. The operating agreement with the railroad permitted developments to be carried out under actual service conditions, and in a location convenient to the builder's factory and engineering staff. This method of developing new equipment has much to commend it, both from the point of view of the builder and the user alike.

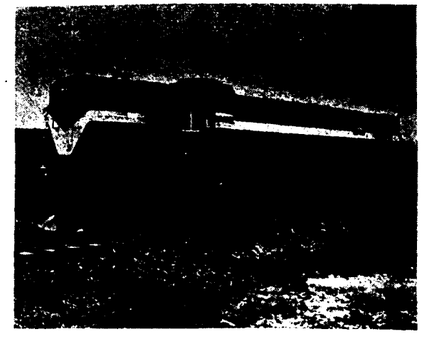


Fig 4. One of 115 1800-h.p., 95 metric ton diesel-electric universal type locomotives built by General Electric for South African Railways. Units will operate on 42-in. gauge system in South West Africa. To meet required wheel loads, an idle axle was added to each truck giving 1C-C1 running gear. Locomotives also fitted with multiple unit controls.

The diesel engines used in these units were of the V-type, 4-cycle, turbocharged. Cylinders were 228.6 mm (9-in) bore by 236.7 mm (10-in) stroke and fitted with removable liners. Engine combustion air was filtered through oil-bath air filters.

Dynamic braking circuits were arranged to provide greater maximum braking effort and better control of braking than was previously available. The reaction

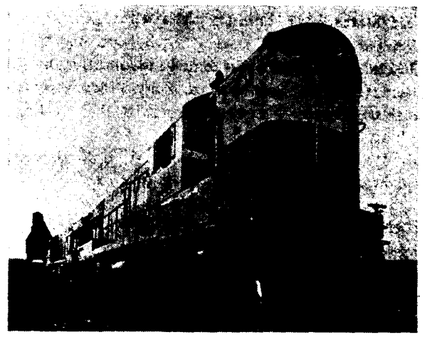


Fig. 5. Two thousand five hundred horsepower universal type locomotive recently introduced for use by U.S. railroads by General Electric. Unit has B-B running gear with axle load of 29.2 kg. Gross weight is only 118 metric tons. Lessons learned from experience with these locomotives will be incorporated in future locomotives designed for use outside the U.S., according to General Electric.

of railroad operation personnel to this feature was highly favourable.

As the equipment on these units was proved and evaluated much valuable information was gained that was applied to the design of the universal line of export locomotives.

After nearly five years of service, the four units were returned to the builder's plant for dismantling and thorough inspection. When this was completed, larger engines were installed in place of the two 1216 cv (1200-hp) engines. A measure of the developmental progress made up to that point is found in the fact that the rating of each unit of the locomotive was increased to 2028 cv (2000-hp). In addition to the increased horsepower, the engines were modified to burn residual fuel as well as diesel oil. The 4-unit, 8112 cv

(8000-hp) locomotive was sold to the Union Pacific Railroad, where it is being used in mainline freight service to study various aspects of dual-fuel operation.

As a further development step, in 1959 two prototype units fitted with 16-cylinder diesel engines were placed in mainline freight service on a U. S. railroad, for the purpose of evaluating components and design concepts. After more than 100,000 miles of actual operation the new locomotive was publicly announced in April 1960. Since then the two units have been demonstrated on numerous railroads in all parts of the United States.

Designated the U25B, the new locomotive develops 2540 cv (2500-hp) and weighs only 118 metric tons (130 short tons). The running gear is B-B, giving an axle load of 29.2 kg (65,000 lbs.). The cab is of the road-switcher type, as shown in Fig. 5, and the length between couplers is 18,350 mm (60 ft. 2 in.).

The U25B is specifically designed to enable U. S. railroads to haul freight faster and more economically, and represents a new concept in motive power. Lessons learned from experience with it will be incorporated in future locomotives designed for use outside the United States.

SUMMARY

The differences existing in permanent ways and structures of railways throughout the world preclude the possibility of locomotive standardization to the degree existing in the United States today. Nevertheless, the introduction of basic types of locomotives using standard components, which can be modified during construction to suit a variety of operating conditions, has proved to be of great help to both builder and user. Such basic type locomotives offer advantages from the standpoint of first cost, maintenance and service charges, and procurement time.

New developments under way will be of advantage in the design of all types of locomotives. They will make possible increased ratings, increased reliability, and decreased maintenance and operating costs.

TABLE I

SUMMARY OF DIFFERENCES IN MAJOR LOCOMOTIVE DESIGN CONSTANTS ON FOREIGN RAILWAYS

1. Track gage — 914 mm. (36 in.) to 1676 mm. (66 in.)
2. Coupler height — 750 mm. (29½ in.) to 1029 mm. (40½ in.)
3. Over-all height — 3683 mm. (12 ft. 1⅛ in.) to 4080 mm. (13 ft. 4⅝ in.)
4. Over-all width — 2642 mm. (8 ft. 8 in.) to 3073 mm. (10 ft. 1 in.)
5. Length over Couplers — 15011 mm. (49 ft. 3 in.) to 17323 mm. (56 ft. 10 in.)
6. Min. Wgt. per axle — 11.9 mt. (26.400 lb.) to 18.3 (40,500 lb.)
7. Brakes — Independent and automatic air on locomotive and train, independent air on locomotive and vacuum on train, or combined independent and automatic and vacuum brakes. Dynamic braking may be added to any of the above.
8. Couplers and Draft Gear — Either American or European type, or " multi " coupler arrangement.
9. Altitudes — From seal level to 4400 m. (14,000 ft.)
10. Ambient temperatures — up to 49°C (120°F) maximum.

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

By An Engineering Correspondent

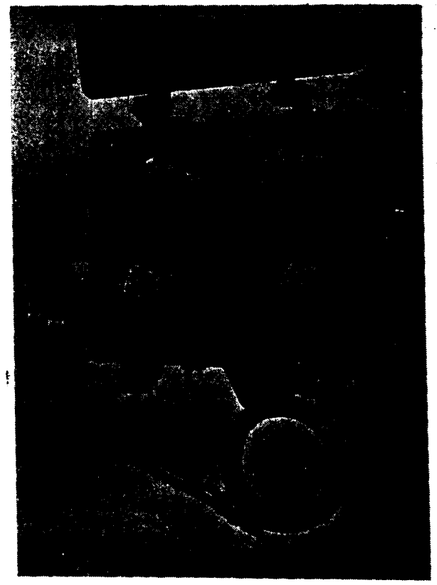
DURING recent years it has become increasingly evident of the expanding use being made of automatic warning and shut down devices to protect diesel engines from damage. No where is this more noticeable than in the marine and rail traction spheres, where it is felt that a great advantage of remote reading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

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

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

One of the foremost Company's specialising in the design of engine protection equipment is Teddington Industrial Equipment Limited of Sunbury-on-Thames, a visit to whose works vividly illustrates the extent of the business now done in this field. Teddington Pressure Controllers and Thermostates have been in use for over twenty years to protect all types of engines giving warning signals in the event of failure of oil pressure or excessive cooling water temperature.

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

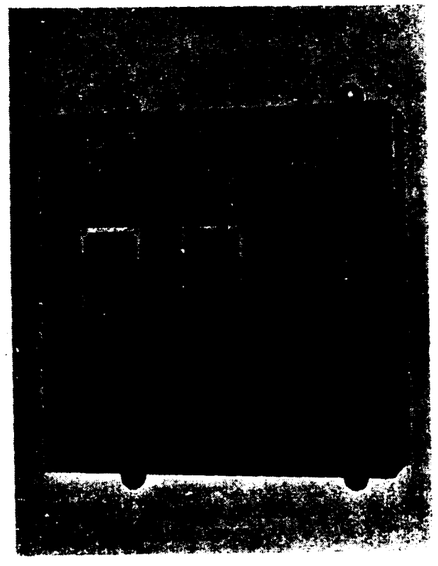


have British Admiralty approval. In addition, it will be appreciated that wherever engine protection is discussed, the question of resistance to shock and vibration has come very much to the fore and it is now regarded as essential that all equipment mounted on engines of every description, no matter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

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

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

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



The range mentioned comprises of oil and coolant pressure controls; thermostats for oil and coolant temperatures; dial indicating thermometers and gauges; warning lamps; solenoid operated fault indicators; engine mounted tachometers; transmitters; moving coil relays for over and under speed warning or shut down; secondary relays for use with the above. Solenoid operated engine trips for coupling to the fuel pump levers and solenoid

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

DESIGN DETAIL

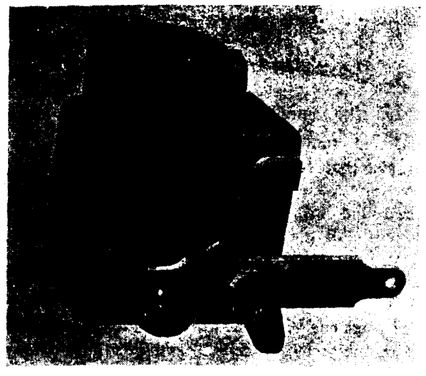
The temperature sensitive equipment developed by Teddington Industrial Equipment Limited for the general range of applications described above, is of the vapour pressure type consisting of an immersion bulb which is inserted into the lubricating oil cooling or other medium, the temperature of which is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

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

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

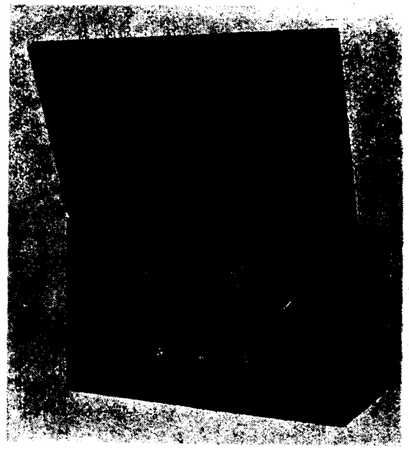
A special feature of Teddington panels is that by use of this compact light switch mechanism it is possible to combine two units on the same temperature bulb and capillary tube. It can be clearly seen that where pre-warning is required, one unit can be set to operate for example, a signal lamp or klaxon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

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



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

Certain special instrument combinations are available, it being possible to combine, for example, one switch and one thermometer on a common bulb if warning and indication is required but in shut down conditions. Alternatively, warning and indication can be combined with an additional bulb for shut down



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

INDICATION

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

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

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

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

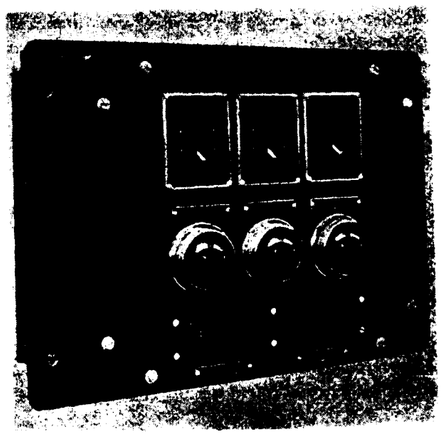
Besides the control panel system, Teddington have also covered a range of individual Teddington engine watchers for inclusion on any installation. It can be appreciated that in many engines loss of lubricating oil pressure will result in seized bearings if the engine is not stopped within thirty seconds.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

Loss of water arising from high cooling temperature is a menace which is frequently un-detected until the damage is done. It can occur for a number of reasons which again have nothing to do with the performance of the engine itself, i. e., blocked radiators; fractured hose connections; broken fan belts; water pump failure; failure to top up.

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

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

To summarize, their coverage besides those mentioned above include tank level watchers; coolant and pressure trip mechanisms and in every indication



visual and audible alarm components. It can be seen also that for the larger installations the engine protection panels as described previously can be utilized and will cater for any hazard combination required. All this equipment can be specified as original equipment or can be readily fitted to most existing installations.

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

A Survey of Current practices of U. S. Makers of Diesel Locomotive Engines

By J. C. Rhoads

Railroad Locomotive Engine Section, Locomotive and Car Equipment Department
General Electric Company (U. S. A.)

DURING the past generation the world's railways have entered a major evolutionary period. One by one railroads have been changing over from steam locomotives to diesel electrics. The changeover is now complete in the United States and is already a well established trend in other countries.

The changeover to diesel-electric drive has been prompted by its greater efficiency, as well as the economic benefits that are derived from the much lower operating costs of the diesel-electric locomotive.

At the present time, the U. S. A. is still the largest manufacturer of locomotives for the railways of the world, although there have many signs of increasing activity in other countries.

The purpose of this article is to survey the current practices of U. S. diesel-electric locomotive manufacturers with regard to the design of diesel engines in terms of over-all locomotive design criteria. In addition, points of difference between U. S. A. and European practices are noted.

The V-engine configuration is popular among U. S. manufacturers because it gives the best space utilization and maintenance accessibility. The high percentage of V-engine applications for diesel locomotives leaves little doubt that this configuration has world-wide preference. Top cylinder accessibility is excellent and space utilization ideal. Generally, 8 1/2 or 9-inch bore diameters can be accomodated in a 6-foot cab width with a 45° V angle. Larger bores can be accommodated only with difficulty; smaller bores do not fully utilize the space. In this connection it is of interest to note that all three of the engines most used for locomotives have 45° V angles and bores in the 8 1/2—9-inch range.

Maximum horsepower per cylinder is desired in order to provide the minimum number of cylinders and other engine parts. Maximum horsepower per cylinder comes from the maximum bore diameter that can be accommodated in a given locomotive cab width in the V configuration. Based on U. S. practice, a 9-inch bore appears to be about the maximum obtainable in 4-stroke cycle engines, and an 8 1/2-inch bore in 2-stroke cycle engines. Horsepower per cylinder ranges from about 140 for 2-stroke engines to 165 for 4-stroke engines.

Maximum crankshaft rotational speed is important to minimize engine and transmission weight. Some engine design practice outside the U. S. includes speeds up to 1500 or 1600 rpm, but even at this higher rpm, the horsepower per cylinder is appreciably less than American practice, since the bore and stroke are less. American practice is to run 4-stroke cycle engines in the neighbourhood of 1000 rpm, and 2-stroke cycle engines at 800 or 835 rpm. Piston speeds are about equal to those of the so-called " quick running " engines mentioned above.

Ratings of engines by U. S. makers are based on long-term field experience rather than laboratory tests. Deratings due to ambient temperatures or high altitudes are made only for extreme conditions. Under more normal conditions of moderate altitudes and temperatures, the ratings are quite conservative. This rating practice results in longer life of the engine wearing parts.

Ratings generally are most dependent on thermal considerations; that is, deterioration of the hot parts such as pistons, liners, rings, valves, heads, manifolds, and turbo-superchargers. For a given output per cylinder, the 4-stroke engine exhaust temperature is several hundred degrees higher than that of the 2-stroke engine. The mean cycle temperature, however, is lower because each alternate stroke is a cooling stroke. For this reason, the 4-stroke engine operates cooler internally and has less trouble from thermal problems.

Engine ratings vary with ambient air temperature, altitude, fuel temperature, fuel heating value, and

engine condition. All U. S. engines operate with fuel pumps measuring a given volume of fuel for each stroke. Condition of the fuel, therefore, has a greater effect on engine rating than any other of the above-mentioned factors. Heating value of the fuel varies with fuel density which, in turn, varies with fuel tank temperature. Proper engine output, therefore, must be carefully correlated with the condition of the fuel.

Turbo-supercharged engines maintain the air-fuel ratio with increased altitude so that engine smoke is not a problem. If the engine design will safely permit full output at high altitudes, greater ratings can safely be carried at sea level.

Two types of engine derating should be considered—inherent and controlled. Inherent derating follows a schedule where derating curves are plotted on turbo-supercharged engines and on non-turbo-supercharged engines. It is apparent that the turbo-supercharged engine is considerably better from this standpoint.

Power outputs are best measured by connecting the engine to a load absorbing device. Where electric drive is used, the generator can be readily connected to a water box. When power outputs are corrected for air and fuel conditions and for generator efficiency and auxiliary loads, gross output of the engine should be equal to the specified power of the unit. Operating time schedules are related closely to unit power outputs. Trends toward greater outputs per unit are to be expected as time goes on.

Locomotive manufacturers in the U. S. rate horsepower in terms of the amount actually going into the transmission. This is known as *horsepower for traction* and differs from the European practice of rating in terms of the gross horsepower developed by the diesel engine. Gross horsepower ratings obscure the losses that come from auxiliary equipment such as radiator fans, air compressors and the like. Actual horsepower at the rail is obtained from horsepower for traction ratings by multiplying them by the efficiency of the transmission.

Engine reliability comes from conservative rating on the one hand and a minimum of control items on the other. Experience indicates that the fewer the components on a locomotive, the fewer the opportunities for failure. The United States concept of simplicity, as compared to the European viewpoint, is definitely in the direction of reliability.

Fuel and lubricant consumption should be kept at the lowest level for economy of operation. Fuel consumption is minimized when the diesel engine produces power with maximum efficiency over its operating range. Fuel rates in the range of 0.36 to 0.42 pounds per bhp-hr are obtainable. On engines of the same size, 4-stroke engines generally have five to ten percent better economy than 2-stroke engines. Also, oil control problems are simpler on 4-stroke engines since they have no inlet air ports to traverse with the piston rings. Conformable oil control rings can readily be used on 4-stroke engines—reducing the oil consumption to considerably less than one gallon of lubricating oil for each 100 gallons of fuel burned.

Although diesel engines can be shut off and started readily, the customary practice on U. S. railroads is to leave engines idle, particularly in cold weather, to keep the engines warm and to prevent coolant freezing. Engines used in the United States are capable of idling for appreciable periods without distress and require a minimum warmup when being put into operation. Locomotive cooling systems controlling temperature within close limits under both extended idling and running conditions greatly assist in obtaining long engine life.

ENGINE DESIGN DETAILS

Diesel engines used in locomotives require several design considerations that greatly affect operating results.

Pistons: Two types of pistons are currently favored by United States builders of locomotive-type diesel engines: iron and aluminum. Two builders use iron, whereas another builder uses aluminum. Iron is considered superior from the standpoint of both sturdiness and wear, although iron pistons are sometimes heavier and add to the engine reciprocating weight. In the two American 4-stroke engines, however, the one with the aluminum piston, although the piston itself is lighter, has slightly more reciprocating weight than the engine with the iron piston. Hence it does not follow that aluminum pistons always reduce reciprocating weight.

Aluminum pistons require iron top ring groove inserts but, even so, have lower life than iron pistons. Also, in the infrequent case of valve failures, an aluminum piston quite often disintegrates, resulting in considerable engine damage. In most cases, iron pistons remain intact.

Piston Rings: Properly designed and applied oil control rings minimize lubricating oil consumption.

Conformable type rings consisting of thin sections, backed up by a spring, are universal on U. S. automobile engines and are used by some locomotive diesel engine builders. These rings give minimum lubricating oil consumption, consistent with good top ring life.

Cylinder Liners: Two types of liners are used in the United States: unplated iron or chrome-plated iron. From the wear standpoint, the chrome-plated liner is considerably superior although its replacement cost is higher than plain iron. But per unit of service its over-all cost is probably lower. One major factor in liner and ring life is the liner thickness. The thinner the liner, the cooler its surface, and, as a consequence, the better the lubricating properties of the oil film.

Connecting Rod Arrangement: Two of the three principal U. S. locomotive types engine builders use connecting rods arranged for maximum rod bearing area. They are of either fork and blade or articulated design. The other builder uses side-by-side rods which greatly reduces the available rod bearing area. Both builders using large bearings on the crankshaft end of the rod use a bolted piston pin arrangement, giving a great increase in bearing area over the conventional piston pin arrangement. Generally the lower the bearing pressures, the longer the life and the greater the potential for future growth.

Main Frame: Two principal U. S. engines use a weldment for the main frame construction, while the third uses an alloy iron casting. Virtues of cast main frames are maximum stiffness for minimum weight since the metal can be placed most advantageously, maximum damping of vibratory strsses, and extreme resistance to fatigue crack development. However, in case of an engine wreck, repairs of the cast frame are somewhat more difficult.

Valves and Valve Trains: All three principal U. S. engines have 4-valve heads. The 2-stroke engine, however, operating at 835 rpm, must have valves actuated 835 times a minute. Although 4-stroke engines run at 1000 rpm, the valves operate on alternate strokes only, or 500 times a minute. Since the valves in all three engines the nearly the same size, the valve train stresses on the 2-stroke engine are more severe.

Bearing Material: All U. S. builders of locomotive-type diesel engines use steel backed copper-lead bearing shells. Steel backed aluminum bearings have been tried and some experience has been obtained. An advantage of aluminum bearings is minimum pin damage in case of bearing failures, although aluminum bearings seem to be sensitive to break-in and to dirt. A preference exists for copper-lead bearings, which require hardened crankpins and main bearing journals for optimum shaft and bearing life.

Turbo-supercharging: Optimum engine output and maximum engine efficiency are obtained by using turbosuperchargers. All three principal U. S. builders of locomotive-type engines use turbosuperchargers.

Without turbosuperchargers, more cylinders are required to obtain a given output. One complication in the use of turbosuperchargers on 2-stroke engine is engine starting and part-load operation. Separate, mechanically-driven blowers or mechanical connections to the turbosupercharger must be used on such engines, increasing the complexity of the system. Four-storke engines need no mechanical connection to the turbosupercharger which is coupled only by the exhaust system. Optimum engine manifolding with turbosuperchargers is obtained with outboard inlet manifolds leaving all of the space in the engine "V" for exhaust manifolds.

Generator Mounting: All three of the principal engine builders in the United States use electric drive on all of their production locomotives. Two of the three mount the generator rigidly to the engine frame both torsionally and transversely without the use of flexible couplings. The combined engine-generator set is then mounted as a unit on the locomotive platform. The other builder mounts the engine to the locomotive platform separately from the generator. A disk-type, flexible coupling is then used between the engine crankshaft and the generator armature. The coupling is rigid torsionally, but flexible angularly. The former method is preferable because: the engine-generator set is lighter and the alignment problem is simpler and unaffected by locomotive platform deflections.

With the V-design diesel-electric locomotive engine continuing its gain in world-wide acceptance, the future will see further refinements and efficiency improvements with emphasis on interchangeability with existing components. Improved technology in transmission design is expected to keep pace with engine improvements, yielding even more useful diesel locomotives for the furture.

These changes will enable railroads to haul larger loads at lower costs. Such savings will be of direct benefit to the economies of all growing countries.

PERMANENT WAY ENGINEERING SUPPLEMENT

The Evolution of the Railway in a Road

By An Engineering Correspondent

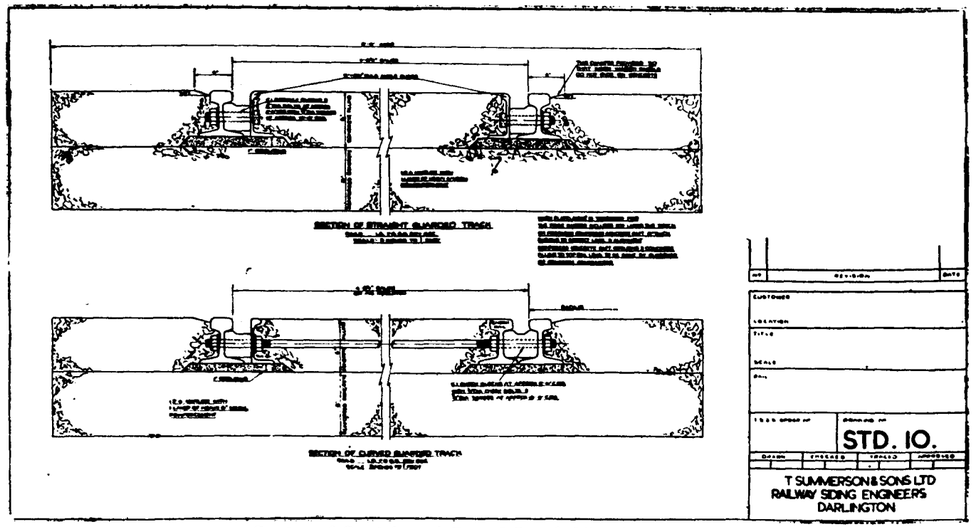
DUE to the growth of road transport many industries in Britain and on the Continent of Europe now receive some part of their raw materials, or despatch their finished products by road vehicles. This fact is specially accentuated in Docks and Harbours, and industrial sites where the quick inter-departmental handling of goods and products by means of small rubber tyred petrol trucks has necessitated the quays, or works yards being paved or being laced with roadways to carry this traffic.

These roadways are inevitably required to cross railway track systems and a design of railway track has evolved which caters for these needs.

The Railway must offer no obstruction to the road vehicle and is usually sunk into the roadway so that the road and rail top are at a common level. If the road is to be made of concrete then the timber sleepers and ballast must be eliminated as if the track is merely buried in concrete, the sleepers will quickly rot away and cause sinkage of the track.

The modern method applied to this problem is to lay a reinforced concrete raft of a thickness great enough to withstand the maximum load likely to be carried by the railway wagons. The top surface of this raft is at a level about 6" below finished road and rail level. The Rails are then laid on this raft, packed to correct level and alignment by the use of steel packers of varying thickness, at intervals along the length, and cement grout pressed beneath the rails to form a continuous seat. The surface concrete is then poured to finish level with the rail top, a chase being formed to accommodate the wagon wheel flanges.

To prevent the edges of this concrete chase breaking away it is usual to fit a steel kerb made from Bulb Angles. This is bolted to the rail web and held the required distance away from the running edge of the rail by cast iron blocks which fit between the rail and bulb angle webs and are holed to take the Bolts. The Track is held to gauge by Tie Rods which are fitted through every fourth or fifth block and span the gauge.



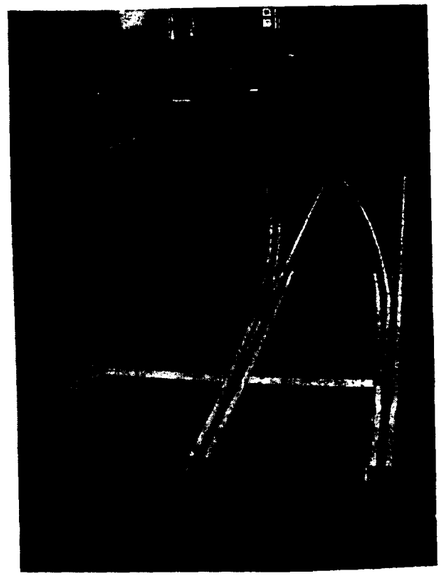
Section of Straight and Curved Guarded Track in concrete.

For curved Track a check or guard rail is substituted for the Bulb Angle Kerb which fit to the inner rail of the curve and this helps traffic to negotiate the curve without causing undue wear to the high side rail.

If Turnouts occur in the paved areas they are of similar construction to the Straight and Curved Tracks. The Switches of the Turnout are fitted with a guard rail or kerb which is specially cranked and planed to allow the Switch Tongue Rails to move, and thus divert the traffic to its respective track.

A design of Switch has been evolved which reduces the gap between the switch tongue rail and the switch guard rail to a minimum. The tongue rail being specially planed and reinforced to withstand buffeting from both rail and road traffic. The reduction of this gap reduces the risk of road vehicle wheels or pedestrian traffic from becoming trapped or wedged in the recess.

The Lever Box for this traffic is of the auto reversing type with an obstructionless lever which lies in a recess in the roadway and forms a flush surface for road traffic. The Rods are housed in cover boxes and are also obstructionless to road traffic.



Photograph of Fully Guarded Turnout for laying in flush paved concrete area.

This design of Guarded Track has been evolved by the designers of Thomas Summerson & Sons, Limited, Railway Sidings Engineers, Darlington, England.

Brazil's New Steel Mill Will Rank Second

Brazil's economy will be US $50,000,000 per year richer when the new COSIPA (Companhia Siderurgica Paulista) steel mill goes into operation in early 1962. This represents the savings in foreign exchange that will be realized when the privately-financed US $135,000,000 project begins making steel.

Located near its largest market, Sao Paulo, the new mill will be the second largest in Brazil. When it is producing its full capacity of 4,000,000 tons, it will increase Brazil's steel output 60 per cent.

The new mill will boost Brazil to 15th place among the world's steel makers. At present Brazil ranks 21st.

All of the raw material for steel-making will come from Brazil, except a portion of the coal, which is expected to be imported from the United States. Iron ore will come from Belo Horizonte, coal from Laguna, and limestone from Iguape.

To help speed the completion of the mill, COSIPA has purchased four universal-type diesel-electric locomotives from General Electric (U.S.A.). When the mill is ready to produce, the locomotives will pull freight cars loaded with raw materials and finished goods.

Hundreds of similar locomotives built by G-E have been put into use in Latin America. They can be used for switching, passenger and freight service. The COSIPA locomotives are of the U6B and U12C type and develop 700 and 1,300 gross horsepower, respectively.

The mill has been completely designed in the U.S. and incorporates all the latest technical advances in steel making machinery. It is expected to provide employment for several thousand Brazilians.

The Design and Development of Resilient Rail Mounting for Jointed and Long Welded Track

By O. H. Varga, M. Sc., A. M. I. Mech. E.

Great scope of systems employing rubber anchorage in all types of rail sleepers and rail foundations.

THE great success in recent years of resilient grip anchorage methods in concrete and other foundations for light and heavy industrial equipments by means of expanding sleeves of tough rubber and plastic materials, the Seetru Mounting Bolt being a particular example, has lead Seetru Ltd, of Bristol, England to undertake an extensive programme of design and development of rail mountings employing the same anchorage principle. The original purpose of this work was to provide a rail fastening for concrete sleepers, which are being used in ever increasing numbers all over the world, in which the inherent resilience of the fastening was to supply the essential degree of elasticity which is absent in concrete sleepers as compared with timber sleepers, and even steel sleepers. The work has lead to the establishment of a rail mounting principle, widely adaptable, and patented in many countries, which far beyond the original objective, is considered to provide a general solution for the many diverse requirements of technical performance and economy of installation and maintenance which a modern rail mounting system has to satisfy. The Seetru Rail Mounting principle is in fact applicable to every kind of rail foundation; concrete sleepers, timber sleepers and also steel sleepers, as well as to continuous concrete beds. One particular version of the system, the Wedge Clip Mounting has been designed to meet the very important special requirements of long welded track.

THE SEETRU RAIL MOUNTING PRINCIPLE

The Seetru principle is readily observed in the simple mounting employing steel sleeper type rail clips. This mounting was originally designed for 60 lb./yd. F. B. rail, but is applicable to other rail sections as well. A base plate is employed in one form or another in all rail fastenings according to the system, and is placed on the sleeper or other rail foundation with the interposition of a rubber pad. The base plate here is a simple forged steel slab with a centre portion sloping 1 : 20 to provide rail inclination when used on a horizontal sleeper surface. Where the sleeper surface is itself inclined, the base plate need only be plane. Two rectangular holes are pierced through the base plate on either side of the rail to allow the rail fixing bolts to pass through and to provide location and abutment for the tabs of the rail clips. The bolts are the so called Seetru Bolt 'M' type with threads uppermost, and it is to be noted that they perform the double function of tying the rail firmly to the base plate and anchoring the rail mounting assembly as a whole to the sleeper or rail foundation.

The shank of the bolt in the sleeper is surrounded by a tough rubber sleeve which in its uncompressed state can stop short of the bolthead, or may be moulded right over it. In any case, the bolt head is clear of the wall of the sleeper hole, and thus the rubber sleeves and the rubber pad between them effect complete mechanical and electrical insulation between the metal parts on the rail mounting and the sleeper. The bolt shank is seen to be formed with a shoulder which, when tightened, abuts against the bottom of the base plate, and thereby limits the amount of axial compression to which the rubber sleeve is subjected. This is a key feature of the Seetru principle and a number of important advantages flow from it. During the tightening down process, a positive stop is felt to the bolt movement when the abutment is reached, and the bolts is then given a final pull-up of arbitrary substantial force to tie the rail, base plate, bolts and clips firmly together into a comparatively rigid assembly. This assembly as a whole 'floats' in rubber, small vertical oscillations of the rail mounting relative to the sleeper being allowed under impact by deformation of the rubber pad and axial shear deformation of the rubber sleeves.

Above the shoulder the bolt is formed with a square on the shank where it passes through the base plate, and this prevents rotation.

The limitation of the compression of the rubber sleeve ensures that no excessive bursting stresses are set up in the sleeper, while the grip on the rail foot itself is in no way limited. The tightening down process is not subjected to any form of critical control and only requires straightforward robust hand pull-up. This is of obvious importance where there is little opportunity of long term training of large track laying gangs.

For economy of production the bolts are built up of two components, a stout forged shank with a head at the bottom and a female thread on the top, and a stud member with a central square to screw into the forged shank.

The firm "metal-to-metal" grip top and bottom of the rail foot ensures positive rail location, i. e. resistance against both creep and track gauge changes while the resilience of the mounting, as a whole, imparts to the track a great shock resistance. The freedom of the rail to undertake small undulatory movements relative to the sleepers is bound to reduce wear and abrasion of the sleepers, and disturbance of the ballast, and thereby to extend the maintenance free useful life of the track. This point is emphasised by the substantial track movements which are known to exist under moving trains, and which have been measured in the course of research work in Germany [1]. The elastic mounting of the rail reduces the accelerations which are imported to the sleeper, and therefore necessitates a comparatively gentle hold only in the sleeper, involving low stresses, while the location of the rail is assured by the firm, independent grip of the mounting on the rail foot.

The importance of the electrical insulation introduced by the rubber elements is obvious from the signalling point of view.

These results are achieved by the use of economical robust components and notably without the use of any carbon or alloy spring steel members.

DETAIL DEVELOPMENT OF COMPONENTS

The effectiveness of the Seetru Rail Mounting principle from both technical and endurance points of view has been established in the course of the last 6–7 years in extensive laboratory tests in Great Britain, Germany and Austria and on experimental tracks in Great Britain and Austria. It is clear that the principle of the system, i. e. rubber anchorage in the rail foundation and a statically separate 'hard' grip on the rail foot, can be achieved in a variety of ways with different types of components, and the work of the last 2–3 years has been devoted to establishing the best form of the various constructional elements of the system.

The limitation of the compression of the rubber sleeve is effected by a distance tube integral with, or spigoted into the nut member, and coming to rest against an abutment on the base plate after a predetermined compression travel.

It is the advantage of this arrangement that the thread is protected inside the sleeper, that the external contour of the fittings is very compact, and that standard industrial bolts can be used.

BOLTHEAD OR NUT CONTOUR MOULDED INTO RUBBER

The latest technique consist invariably of moulding (but not bonding) the rubber sleeve on to the metal part which it engages. Experiments carried out at the Civil Engineering Laboratory, Western Region, British Railways, by means of large Perspex models have shown that a special corrugated form of the bolt head or nut engages the rubber sleeve most smoothly, avoids localised high strains, and ensures ready extraction of the rubber sleeves after prolonged service, if so desired.

MOULDED FLANGES ON RUBBER SLEEVES

In the manufacturing cost of concrete sleepers the provisions which have to be made to take the rail fastenings play a very important part, and the plain cored through holes required for the resilient anchorages of the Seetru Mountings represent in fact the most economical provision of all the various methods under present consideration. To prevent the rubber sleeves from falling through the sleeper holes on assembly, they are often provided with moulded flanges on top, which can either be accommodated in moulded recesses in the rubber pads, or in shallow counterbores on the base plates.

RUBBER PADS

Pads of rubber or other resilient insulating material in one form or another are an essential part of the Seetru Rail Mounting System. Pads of numerous designs are being tried out at present in different parts of the world with the overall result that they are becoming more and more a standard part of the modern track. Again, the Civil Engineering Laboratory, Western Region, have constructed, according to a scheme of the authors, a comparatively simple

endurance testing machine for resilient track pads for the rapid evaluation of their long term service performance.

Also, the strides being made at present in rubber and polymer science ensure that satisfactory materials can be compounded for long service track pads in tropical countries.

THE WEDGE CLIP RAIL MOUNTING

While of general validity, it has been particularly developed for use with long welded track, the introduction of which represents one of the great advances of modern track engineering. Both theoretical analyses [2], as well as comprehensive scientific tests carried out at the Civil Engineering Laboratory, Western Region, have established a high torsional stiffness about a vertical axis to be one of the crucial requirements for a satisfactory rail mounting to be used in such track. The Wedge Clip Mounting possesses this property to a higher degree than any other.

While employing a resilient pad and sleeve as before, the rail foot is held in a powerful wedge grip between the sloping edges of the cast iron base plate and a long malleable cast iron wedge. There are thus no clearances whatever between the rail foot and the lateral faces of the base plate, and any torque about a vertical axis applied to the rail, is at once resisted resiliently by the sleeves in the sleeper, without any rotational rail slip, however minute. Also, for a given bolt load, the grip against creep exerted on the rail foot is more powerful than with any other system.

The distance tube inside the rubber sleeves enter and abut in jig drilled counterbores in the base plates.

SEETRU RAIL MOUNTINGS ON CONTINUOUS CONCRETE BASE

The principle of expanding resilient grip anchorage in concrete holes offers a reliable method of laying track direct on a continuous concrete bed. Apart from harbours, jetties, factory yards and bridges etc., this is of particular value in tunnels where the elimination of ballast reduces the headroom requirements. This can result in a very great saving in the cutting of new tunnels, while in existing tunnels it may make possible the introduction of overhead electrification for which there would be insufficient space otherwise.

Rubber pads lying direct on the concrete surface provide the essential resilience of the track, while two resilient anchorage sleeves are placed into drilled holes in the concrete surface. Rotary percussion pneumatic rock drills are used for this purpose in conjunction with vacuum disposal of the concrete dust. It has been found that a team of four men can drill 28 holes per hour, which is, of course, equivalent to seven sleeper positions.

A special base plate design is available which allows shimming up the rails by varying amounts to compensate for any irregularity of the concrete surface.

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Eisenbahntechnische Rundschau. July 1957.

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Civil Engineering and Public Works Review. No. 639, Volume No. 54. October, 1959.

HUNGARIAN MINERS BEAT PRODUCTION PLAN

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

WELDING SUPPLEMENT

Design and Manufacture of Oxygen Cutting Machines

By An Engineering Correspondent

HANCOCK & Co. (Engineers) Ltd. of Croydon, England have been designing and manufacturing oxygen cutting machines for over 40 years and the first photograph (Fig. 1) shows a profile cutting machine built in 1921. This machine operated from oxy-coal gas and was driven by a clockwork motor drawing a serrated wheel which was steered over the pencil line on a drawing twice the size of the job required; this gave the machine a high degree of accuracy but it also required skilled labour to operate it.

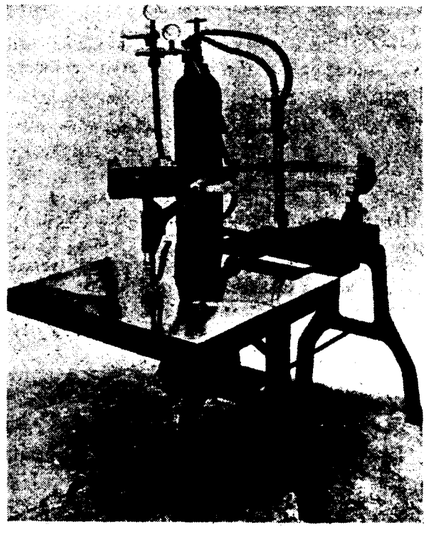


Fig. 1.

The second photograph (Fig. 2) shows the latest electronically controlled machine following a pencil line or a drawing the same size as the required cut out. This machine is fully automatic and allowance can be made on it for the width of cut so that one template of the correct size can be used on varying thicknesses. The dual carriage machines of this type vary in size from 40" square upto 10 ft. wide by 20, 30 or more feet long. One advantage to this type of machine is that a number of burners can be placed side by side along the burner bar thereby increasing the production of the machine on smaller jobs, whilst at the same time the same machine using one burner only can produce large jobs, thus the versatility of the machine is increased whilst the capital cost, floor space, and number of operators is kept to a minimum.

As can be seen in the photograph, the machine is of box type construction with a fabricated bottom carriage running on precisioned ground rils. On top of this is mounted the top carriage which has an aluminium casting on the smaller machines, and

Fig. 2.

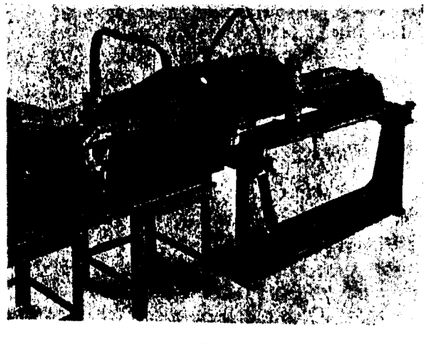


Fig. 3.

fabricated on the larger machines. Built into the top carriage are all the electrical controls, such as rectifiers for use with the magnet, and all switches are dual controlled at either end of the machine. For reasons of safety the electrically operated gas solenoid valves are mounted in the open in a recess at the back of the machine. One switch controls the fuel gas and preheat oxygen and the second switch controls the cutting oxygen, this valve is specially designed so that when it is switched off the oxygen in the pipe between the burner and the valve itself is exhausted to atmosphere giving an instant shut-off of cutting oxygen at the burner. Fig. No. 3 shows the Hancomatic Machine itself without the electronic control. In this case the roller drive which prevents any contact with the drawing when the electronic control is being used, has been removed and the standard tracer head which has five interchangeable drive heads is fitted in its place. This tracer head

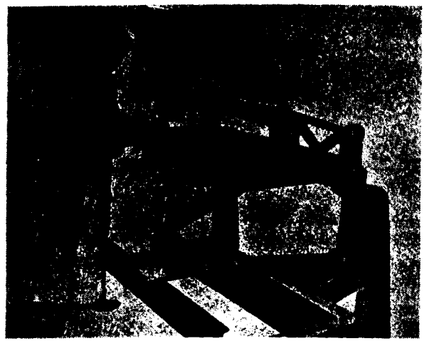


Fig. 4.

which is also used on the small Hancomaster Machine (Fig. 4) enables steel, wood or plain drawing templates to be used on the machine, circles and straight lines are cut automatically without the necessity of either templates or straight edges. All slides on the machine are fitted with slipper plates to enable any slight wear to be taken up so that the machine during the course of a lifetime can easily be kept in first-class condition as the running surfaces are hardened and ground, all ball races are grease packed and fitted with dust covers. To increase the versatility of the machine further, it is possible to fit a three burner compound head for flame planing for any type of double bevel and nose preparation, for single burner work a compact electronically controlled automatic height device will maintain the burner at a set distance above the plate.

For the smaller type of profiling work, the Hancomaster Machine shown in Fig. 4 is very popular. This cannot be fitted with the electronically controlled head but the standard tracer head with the various drives can be used. The main advantage of this machine is that the floor space requirements is very small as the work is directly underneath the template support arm. The main feature of this

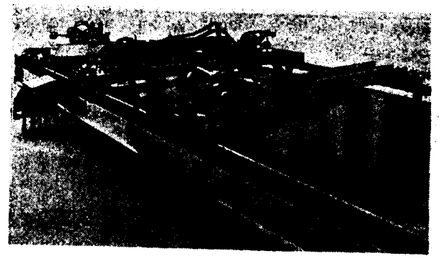


Fig. 5.

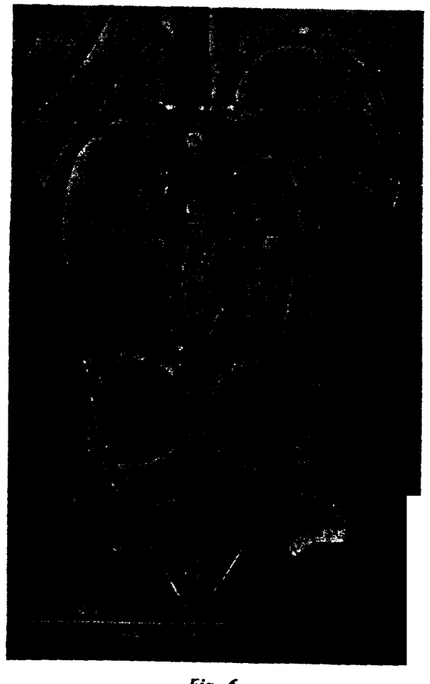


Fig. 6.

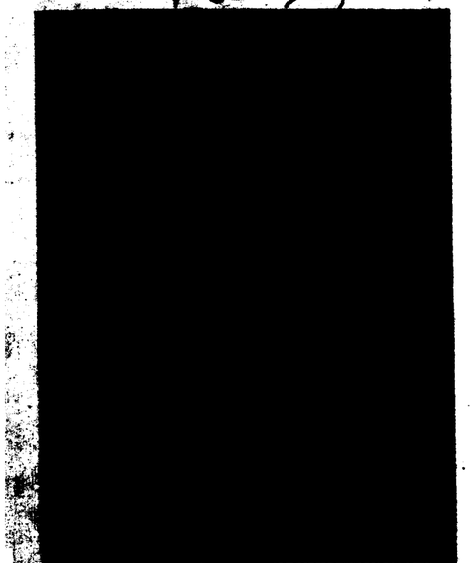
machines as with all other Hancock Machines is the robustness of construction. This is essentially to eliminate vibration and to obtain good cutting.

Plasma planing machines (Fig 5) are widely used in the ship-building industry and in various other engineering industries where any large rectangular plates are required with double bevel and nose weld preparation for subsequent welding operations. These machines are capable of taking plates approximately 12 ft. × 40 ft. and cutting all four sides simultaneously. The machine has many automatic controls which means that only one operator is required to control the whole machine, the correct depth of bevels is easily obtained by setting the burners and reading off the depth of bevel from dials fitted on the machine (Fig. 6). The burners fitted on to this machine as on all other machines are of the latest antiflashback construction and have proved themselves over a period of time.

The foregoing is a very brief resume of some of the standard range of machines whilst at the same time many specialised machines have been built. One such machine which is believed to be the largest in the world and has over 1000 sq. ft. of cutting area was installed in a steel works for cutting 5" stainless steel slabs. Since this machine was installed it has cut on the average of 3 miles of cutting per month without any breakdown due to failure of the equipment. Many special machines have been built for the construction of atomic power stations. One such machine was designed and built to produce double bevel and nose preparation on circular holes which were parallel to the vertical axis of a 70 ft. diameter sphere. This machine was so constructed that it was easily positioned over any particular part of the sphere as in each sphere over 200 holes have to be cut.

Hancock & Company have specialised in the manufacture of oxygen cutting machine, and with their standard range of machines and experience from special types of machines they feel confident that there is no cutting problem which they could not tackle.

British Diesel Electric Locos for East African Railways



Diesel electric locomotives for the East African Railways and Harbours Administration under construction at the Darlington, England, works of Robert Stephenson and Hawthorns, a member of the English Electric group. Two of the order for 10 have already left by sea for Mombasa aboard the Kenilworth Castle. Two more will be shipped every month until the order is completed.

The order, believed to be worth nearly £1 million, was obtained against strong foreign competition, as tenders were invited from 30 concerns in 11 countries. The 97½-ton locomotives, with a maximum output of 1,840 h. p., will be able to haul 700 tons at 45 m. p. h. on level tracks and at more than 15 m. p. h. on steep gradients at altitudes over 9,000 feet. They will also be required to operate over light rails and to do this they are fitted with a special wheel arrangement of one free and three powered axles on each bogie.

The company of Robert Stephenson and Hawthorns, Ltd., can trace its locomotive-building history back to 1825, when the famous Locomotion Number One, the first loco for use on a public railway, was built. It is claimed that their Darlington works are now among the most up-to-date in Britain.

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