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Newly Constituted Indian Railway Board

THE Railway Board has at last been reconstituted and the strength also increased from four to five. The new Chairman of the Mokamehghat Bridge Construction Project is too well known among the Officers of the Railways. He will be having the status of a Secretary of the Government in the Ministry of Railways. Under the new setup all policy and other important matters would be referred to the Railway Minister through him.

The other four Members of the Board are Mr. P. C. Mukerjee, Mr. K. P. Mushran, Mr. K. B. Mathur and Mr. P. C. Bhattacharya. Mr. P. C. Bhattacharya is not new to the reconstituted Railway Board but will continue as Finance Member.

Of the three new Members of the Board, Mr. P. C. Mukerjee was till recently General Manager of the Eastern Railway, Mr. K. P. Mushran was the General Manager of the Western Railway and Mr. K. B. Mathur, General Manager of the Northern Railway.

The Railway Minister, Shri Lal Bahadur Shastri has obviously reconstituted the Railway Board with a view to increasing the over-all efficiency of the Railways' Administration and also to step up the tempo of the progress as a result of the implementation of the various big schemes under the National Development Plans. That he has secured the support and co-operation of a team of honest, efficient, sincere and hardworking Railway Administrators in the new Members of the reconstituted Railway Board is in itself a happy augury for the railways in India and the travelling and commercial public as a whole.

The new Chairman, Shri Ghanand Pandey is a very able Administrator and his wide knowledge of railway affairs, both technical and administrative, born of several years of experience gathered in various capacities will surely help shape new policies for the development of our Railways. In recognition of his valuable services rendered to the East Indian Railway Administration in various capacities and for displaying commendable originality in tackling several engineering problems he was promoted as Joint Director, Civil Engineering, of the old Railway Board and later appointed as Director, Civil Engineering, Railway Board.

His work at the 16-crore Mokameh Project has been quite appreciative and we have no doubt that the new Chairman will really be an able and efficient lieutenant to Shri Lal Bahadur Shastri.

The other three new Members, Messrs. K. P. Mushran, K. B. Mathur and P. C. Mukerjee are also very able senior Officers with wide engineering and administrative experience and their inclusion in the new Board is commendable and the whole team, we sincerely hope, would work in perfect co-operation in keeping itself posted with the trends in the country in the coming years, its needs and requirements, plan for the future with imagination and a wider perspective under the able guidance and direction of the Railway Minister and implement big schemes for the railways.

The basic idea, as we gather, behind the reconstitution of the Railway Board is quite sound and that any clear-cut demarcation between the technical and administrative services of the railways would not lead to better efficiency. This view is no doubt shared by many in India and in Great Britain among knowledgeable circles.

We wish the Chairman and other Members of the Railway Board all success in their new assignments.

THE JANATAS

The Bombay-Poona Janata Express which is second fastest train on the South-East Mainline of the Central Railway (second only to the Deccan Queen) took on a "New Look" from September 15th, 1954 when the previous rake was withdrawn and an all-blue new Schlieren Coach rake was put into service in its place. It is an all-third class train with a seating capacity of nearly 900. Each coach has two compartments to seat 40 persons with comfortable wide seats, fans and good lighting. Each of the two compartments has 4 bay with 2 fans each and night lights with independent switches. The construction incorporates several modern techniques among which are the anti-telescope design for greater safety and an integral structure of body and underframe.

The new train is strengthened over the week-ends to carry the rush of traffic on Saturday evenings from Bombay and on Monday mornings from Poona.

Scarcely a fortnight after this improvement had been introduced on the Bombay-Poona Janata Express, another amenity for Bombay-Madras third class passengers was provided by converting the weekly Janata trains (13 Down & 14 Up) between Bombay and Madras into a bi-weekly service. This was introduced on October 1st, 1954 when the winter Time Tables were brought into operation.

SIGNALLING OF INDIAN RAILWAYS

The Two Aspect & Multiple Aspect

By J. S. Fiddes, Chief Signal & Telecom. Engineer, Western Railway

I. British Practice. II. 'A' and 'B' Class Signalling in India.
III. Three Aspect Signalling of Single Line Crossing Stations.

I. BRITISH PRACTICE

THE Semaphore Signal was introduced about a hundred years ago and the Distant Signal (or the Warner Signal as we know it in India) was first used about 1875.

The controversy and criticism of the British System have been on the following grounds:—

(a) The Distant Signal on a post by itself, formerly displayed a red or green light at night, thus in bad weather if the Distant was missed by the Driver, the Home "at danger" could be mistaken for the Distant at caution. This was the cause of an accident in Gloucestershire about 1924 and the next year the aspects of the Distant were changed to yellow and green.

(b) If the Station is blocked, "line clear" for the next train can only be given after the train has been stopped at the previous station and the Driver warned that the section is clear, but the station is occupied.

(c) With the Distant at "caution", the Driver, upon approaching the first Stop Signal, if cleared, does not know what to expect at the next Signal. In other words, if the Distant is not cleared he can only travel from Signal to Signal. Therefore, if the Starter is "at danger" the Signalman has to observe the rule by which he must not clear the Home Signal, until the train comes to a stand, or nearly to a stand, at the Home Signal.

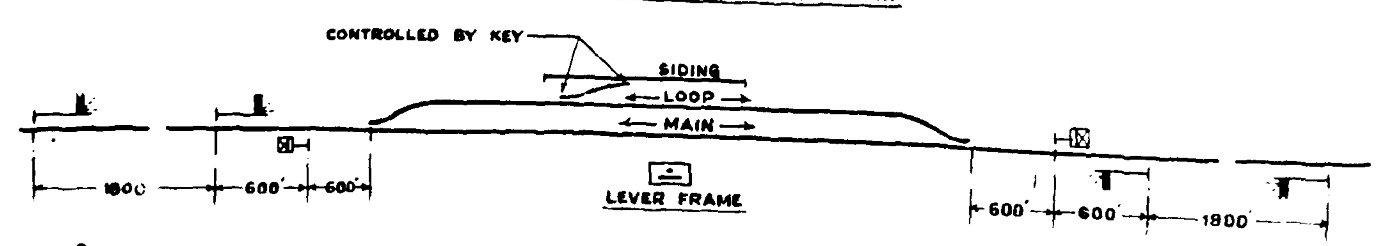
The practice of only clearing the Distant Signal when all the relative Stop Signals of the same Cabin are cleared is to be found only on British owned, or formerly British owned railways. American and continental practice has favoured the multi-arm and multi-light system. On account of the proximity of Signal Cabins in Britain and the fact that the Distant is placed at "braking distance" from the first Stop Signal (reasonable sighting distance approaching the Distant Signal may be taken into account) the Distant is often combined with the Stop Signal or Signals in the rear. This combination of a Stop Signal above a "caution" Signal is the fore-runner of Three Position Signalling and with red over yellow, or green over yellow, or green over green, the Driver is well informed of the state of the track ahead.

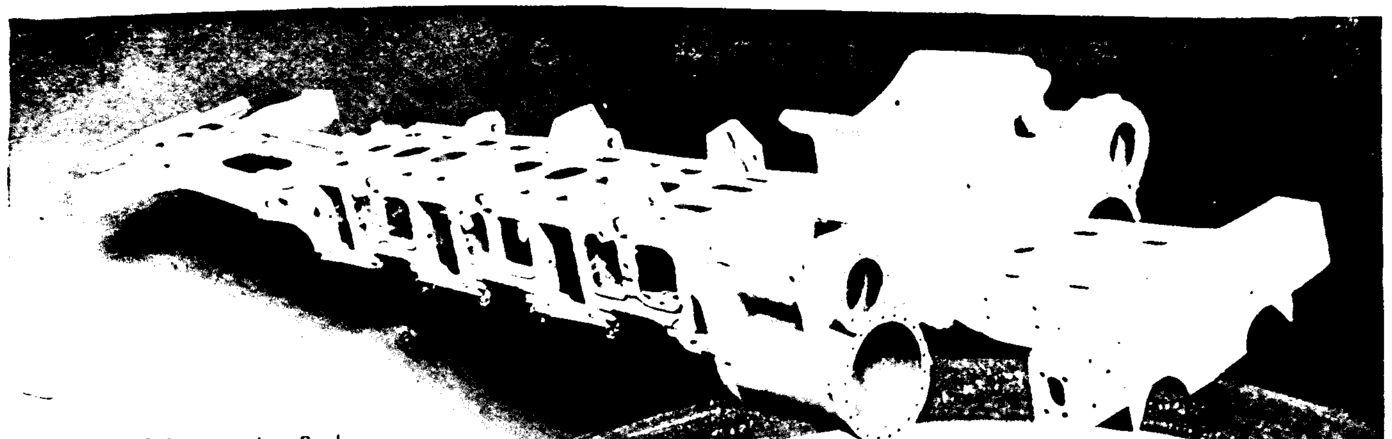
The record speed of 126 miles per hour by a steam train was attained with this type of Signalling in 1938.

The fast trains in Britain run regularly at 80 m. p. h. as a maximum speed. The latest Coronation Express recently ran non-stop from London to Edinburgh a distance of approximately 400 miles at an average speed of 61 m. p. h. So the British Railways are satisfied with the Two Aspect Signalling. It can be said that the Driver runs on the Distant Signal and if he is signalled to run through, he has the knowledge that the clear Distant tells him that all Signals of that Cabin are "off" for him.

DIAGRAM I

M.G. DOUBLE WIRE UPPER QUADRANT SIGNALLING ARRANGEMENTS FOR 30 MPH





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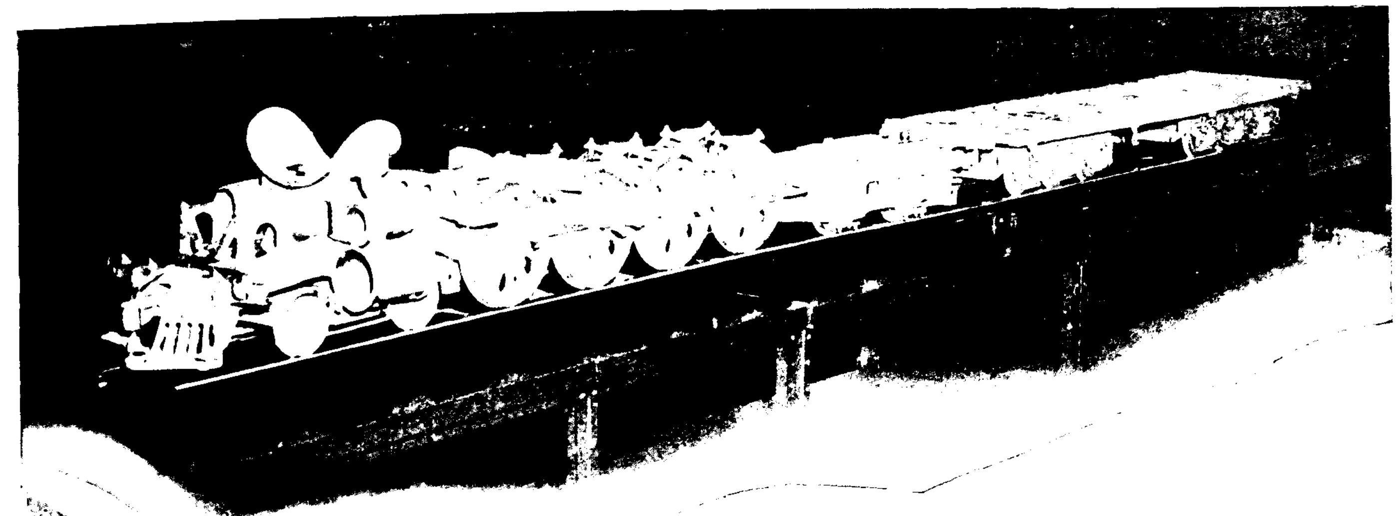

Illustrated above is an exact scale model of the running gear for a steam locomotive and tender. This model was displayed at the Indian Railways Centennial Exhibition and is currently being seen throughout India on the Centenary Exhibition Train. It is equipped with the following one-piece cast steel COMMONWEALTH Products:

Locomotive Bed	Delta Type Trailing Bogie
Front Bumper	Boxpok Driving Wheels
Front Bumper Beam	Waterbottom Tenderframe
Leading Bogie	Tender Bogies

Many of the well-known WP, WG, and YP class locomotives in service on the Indian Railways are equipped with COMMONWEALTH products known the world over for their dependability and economy in railway operation.

The COMMONWEALTH Locomotive Bed incorporates in one rugged casting many parts, including main frames, cylinders, cross braces, cradle, various brackets, and many other parts. The unit bed eliminates welded, bolted or riveted connections with the accompanying maintenance problems, thereby permitting permanent alignment of moving parts and highest availability of equipment. Great strength with less weight is assured by the economical distribution of metal to sections where it is needed most for strength. Furnished completely machined, ready for application, COMMONWEALTH Beds greatly simplify locomotive construction. Hundreds of locomotive beds have been in service for many years in Australia, France, Mozambique, South Africa, Turkey, Canada, and Mexico as well as thousands in the United States.

COMMONWEALTH One-Piece Cast Steel Products have been proven in service on the railways of 55 countries. They keep locomotives in active service longer with a minimum of maintenance, permitting most efficient operation with fewer locomotive units.

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I have to avoid using the term 'lowered' for 'clear' or 'off' because Two Position, Upper Quadrant Signalling was recommended as a Standard on British Railways in 1928 and this has generally been adopted.

II. 'A' AND 'B' CLASS SIGNALLING IN INDIA

These were adopted towards the end of the last century when it was realised that the Distant (with a red light) on a post by itself was not satisfactory. Therefore, the green light over the Distant arm was introduced which corresponds at night to the Distant signal under a Stop Signal on the British Railways. Thus our 'A' Class working came into being. It must be remembered that at that time stations were far apart and speeds comparatively slow and the application of the rule for "Section clear but Station blocked" was not practical. Therefore, a secondary system—'B' Class working was introduced by which the one-quarter mile "adequate distance" was obtained between the Outer and the opposing Advanced Starter. "Line Clear" could then be given not only with the station occupied, but also while shunting was in progress. In open country, "sighting distance" of the Outer-Warner signal was adequate. The main criticism of 'B' Class working is :—

(a) The maximum train speed for this system was never stated.

(b) There was provision for repeating the Warner if adequate "sighting distance" was not obtained. This repeating was never strictly followed such that Outers and Warners were occasionally erected at the requisite distance from the Home signals without taking into account the sighting of the signal at full braking distance.

(c) The releasing of the Outer signal by the Home signal became general practice that such "interlocking" was taken for granted. Although the General Rules provide for a "free Outer—Rule 10(d) shows the Outer 'off' and the Warner 'on' with the meaning "proceed cautiously and be prepared to stop at the next Stop signal..............", this provision became the exception.

If a Driver does not know whether the Outer backlocks the Home or not, we should have had far less accidents through the Driver passing the Home "at danger" with the Outer drooping, stuck 'off', or inadvertently lowered.

In all fairness to the 'B' Class working, it has served the Indian Railways very well. On the former MSM Railway a speed of 70 m. p. h. was sanctioned for their Double Line signalled for 'B' Class working in 1936 (please note—double line). As for sighting distance with an intense drive on correct focussing of lamps in 1935, the double green of the Outer and Warner Signal could be seen for four miles at one station on the North West line.

In most instances the viewing of the Outer and Warner is adequate and Signal Engineers have ensured that a driver has a view of the Outer and Warner for a distance of at least half a mile on sections, where the speed of 60 m. p. h. is permitted. However, there are stations where it is impossible to obtain half a mile "sighting distance" of the Outer-Warner and "repeater" should be provided.

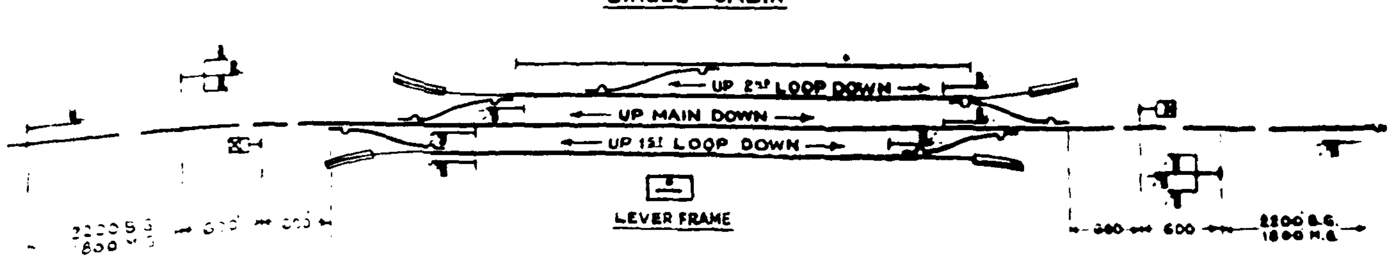
The new General Rules insist that for speeds of over 60 m. p. h. the Warner Signal must be on a post by itself at least a quarter of a mile in the rear of the Outer Signal. This is a step in the right direction for it gives the driver a "caution" signal to pass before he meets the first Stop Signal. However, with poor visibility of the Warner, there is not sufficient "braking distance" up to the Outer.

DIAGRAM II

DOUBLE WIRE UPPER QUADRANT

SIGNALLING ARRANGEMENTS FOR UNRESTRICTED SPEED

SINGLE CABIN



It must be emphasised here that although a station can be equipped with signalling to allow unrestricted speed the 'weak link' becomes the exchange of tokens. Token Exchange apparatus has been fitted on many railways but the Signal Engineer is not yet satisfied with its design and experiments are continuing. With eventual higher speeds of say 70 to 75 m. p. h. a very efficient apparatus is required. If the token is missed, the driver will travel about half a mile before he can pull up and he has then to back his train. On Double Line, as no "token" has to be exchanged, the ex-MSM Railway allowed speeds of 70 m. p. h. as previously mentioned.

III. THREE ASPECT SIGNALLING OF SINGLE LINE CROSSING STATIONS

Upper Quadrant Signalling was introduced in Germany about 1880 and in America in 1906. It was first used in the United Kingdom about 1910 and became standard practice in South Africa about that time.

Three-position Signalling of Lower Quadrant or mixed Lower and Upper Quadrant goes back to the beginning of the century but in 1908 America was using 3 Position, Upper Quadrant motor-worked signal. This was adopted in England in 1914 but the first 3 Position, mechanically-operated by "double wire" was introduced in Europe in 1919. "Double-wire" as a means of operating Points or Signals was first used on the Continent before the turn of the century.

Colour Light Signalling with the adoption of one or two "yellow" was general in the United Kingdom where sections were electrified. This chiefly afforded closer headway for trains, so that more trains could run but it cannot be said that trains could run faster. The British system of the Distant being placed under the previous Stop Signal was really the first application of three-position Signalling viz., Stop—Proceed, next Signal 'at danger'—Proceed to first Stop Signal of the next section.

The first installation of 'Double Wire' Multiple Aspect, Upper Quadrant Signalling in India was on the Bengal Assam Railway in 1931.

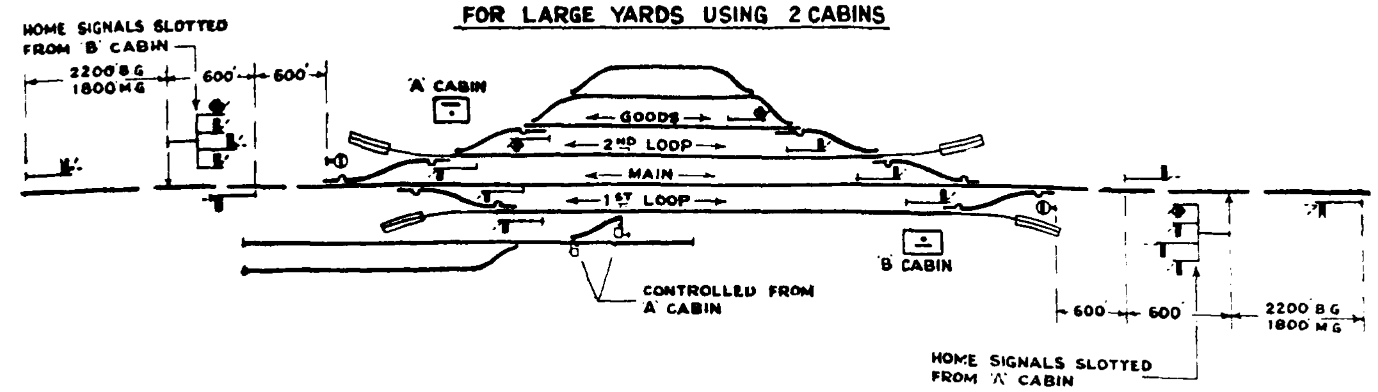
As Signals and Points can be worked by 'Double-Wire' at greater distances than with Single Wire, the layout of a standard crossing station lends itself to the application of "Double-Wire", Multiple Aspect, Signalling with one Central Cabin. A central cabin is not new in India and has been in use for many years on the ex-MSM Railway with complete satisfaction. It must be admitted that shunting offers some difficulty and provision must be made for the Station Master to ensure that the train has arrived complete. This is effected by different methods on various railways. With the Distant or Warner at "braking distance" from the first Stop Signal, the 'sighting distance' of the former can be discounted. This Signal gives information to the driver that he can either prepare to stop at the next Stop Signal, pass it at restricted speed, or at full speed.

The adequate clear distance beyond the first Stop Signal need not be ¼ mile but the 600 ft. that is usually applied to multiple aspect colour light signalling should be sufficient. Therefore, the Home Signal can be 600 ft. from the block clearance point and can be placed at 1200 ft. from the points. The question of holding the road must be considered and this is effected by route-locking keys. Once the route is set and locked, the Station Master exchanges the route key for the Up or Down Signal key, the route key being backlocked in the Interlocking Key Box in the Station Master's office.

DIAGRAM III

UPPER QUADRANT SIGNALLING ARRANGEMENTS

FOR LARGE YARDS USING 2 CABINS



For those critics who consider there is any risk that the road can be altered between the train passing the Home and reaching the Points it would require the connivance of the Station Master as well as the time factor in throwing Signals "to danger" removing the key, rushing to the SM's Office, exchanging Keys in the Interlocking Box, rushing to the Cabin, inserting the Key and altering the road. It must be remembered that under ordinary two aspect, two Cabin Schemes, the Home Signal can be placed up to 600 ft. from the points and it would require only a few seconds for the pointsman to put back the Home Signal, unlock the Points and open them. This condition is far more dangerous than with route-locking Keys of a 'double-wire' installation.

The Home Signal will tell the driver that he has either—

(a) to stop,

(b) or proceed at caution to the next Signal which is at danger, or

(c) proceed at full speed (if road is set for the straight and subject to no speed restriction) as the next Signal is at clear or caution.)

The Home is more than "braking distance" from the Starter and unless there is considerable shunting, an Advanced Starter may not be necessary. A shunting limit board is all that is required. Therefore, the Starters can be of the 3 Position type, 45° for shunting and 90° for proceeding into the next block section. This aspect will be interlocked with the block instrument such that the 90° aspect cannot be displayed unless "Line Clear" has been obtained.

The former South Indian Railway developed "Double-Wire", Multiple Aspect, Signalling with a Distant and a single Outer Signal, the Distant to display 45° for the Loop Line and 90° for the Main and the Outer showing 45° for stopping on Loop or Main and 90 for running through. However, a single Home, although provided for in the General Rules, is not acceptable to some Signal Engineers and Operating Superintendents.

In the case of Signalling for a maximum speed of 30 m. p. h. where Starters and isolation are not obligatory, the single Home or Outer is adequate, especially for a two line Station. Taking the length of the crossover into account (200 ft. for Metre Gauge) and for trains travelling at 30 m. p. h., the 'Block clearance' point can be 400 ft. from the Points and therefore, the Home Signal can be placed at 1000 ft. from the Points, the Distant being at braking distance from the Home.

Such a scheme requires route keys to hold the road as the Home Signal is more than 600 ft. from the Points and the Station Master will require the route key before issuing the Signal release key. The chief reason why this single Home was adopted was to make the costs of "double-wire" Signalling comparable to Standard I, Key-locked Signalling, requiring bracketted Homes and Outers. There was also the advantage that a reduction in Station staff could be made and time in sending men to the points was saved. Diagram I shows a layout of "Double-Wire" Multiple Aspect Signalling for Metre Gauge, allowing 30 m. p. h.

For unrestricted speeds specially where there are more than two lines, the writer considers that a bracketted Home is necessary. Three aspects are needed for the Main Line, but two aspects only for the Loops, whether trains run through on the Loop, or not.

Three position Signalling affords a clearer indication to a Driver of the condition of the section he is passing over and enables higher speeds to be maintained on busy sections.

There has been criticism of the single Cabin scheme by Operating Staff and chiefly on account of the difficulty of shunting. If there is to be considerable shunting at a station it is obvious that two cabin schemes are better and double wire signalling is not necessary, except perhaps for the Distant Signal only. But the upper Quadrant, Multiple Aspect, Signalling can still be adopted to be uniform with the type of Signalling on the Sections.

Diagram II shows a general layout with a Central Cabin and Diagram III with 2 Cabins, where frequent shunting is required.

Manufacture of Wheels and Axles

SURAHAMMARS Bruks AB, Surahammar, Sweden, has specialised in the manufacture of wheels and axles for rolling stock since 1866, and supplies wheel pairs for passenger coaches, goods wagons, motor coaches, locomotives and tramcars for all existing track gauges. The work's production also includes the manufacture of elastic (resilient) wheels for tramcars and particularly light wheel pairs with hollow axles and hardened and tempered light wheel centres. The wheels are either forged and rolled in one piece (solid wheels or built up of centres and tires.

Ore from the company's own mines is used to produce high grade pig iron low in sulphur and phosphorus, and the steelmaking plant possesses furnace equipment that can satisfy the most varied demands. Furnaces for the acid and basic open hearth processes, arc furnaces and high-frequency induction furnaces make it possible to produce the particular material which may be required by applying the most advantageous method of production. Wheel blanks, tyres and disc wheel centres are forged in hydraulic presses, one of which—a 7500 ton press is the largest in northern Europe. The blanks are usually rolled in special rolling mills to exact dimensions. The axles are rolled and forged under hammers to exact tolerances and with ample reduction. The various parts of the wheel pairs, are machined and assembled in the wheel shop, which is of recent construction.

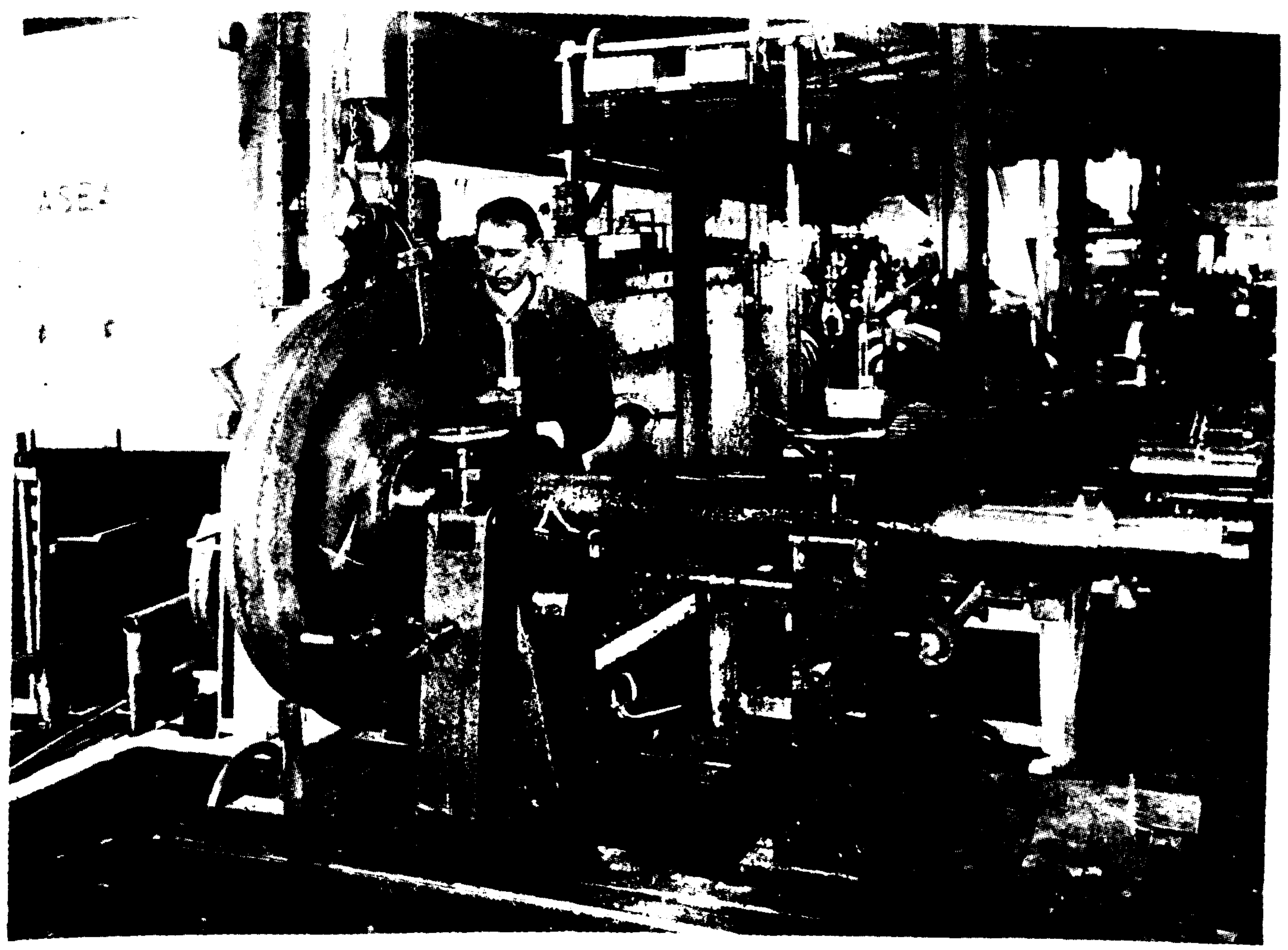
GENERAL DESCRIPTION OF A NEW ASSEMBLY METHOD

A new assembly method has now been introduced after several years of research work at Surahammar. The old method of manufacture is to shrink the tyres on to the wheel centres and to secure them with a locking ring, whilst the wheel is pressed on to the axle. The wheel seat and hub bore as well as the mating surfaces of the wheel centres and tyres are turned to the required surface finish and limits. It is stipulated that the final pressure for pressing the wheel on the axle shall lie between a minimum and a maximum value, e. g. $7\frac{1}{2}$—10 tons/inch of wheel seat diameter for railway wheel sets. This means for instance a pressure of 50–60 tons for the standard axle of the Swedish State Railways.

The process of pressing the wheels on to the axles gives rise to a number of factors difficult to control. One only need to point to the cold working and tearing of the surfaces taking place, this causing additional stresses in that part of the wheel set where the risk for fatigue fracture is already greatest. The increased speeds and axle loads are accompanied by a greater strain on railway material than before, and the method of pressing wheels on to the axles can no longer be considered to meet the requirements of our time.

Wheel seat cracks can to some extent be shown up by supersonic tests, but the final control is always carried out by inspection directly on the wheel seat after the wheel has been pressed off. One must therefore reckon with dismantling after a number of years' service, and if this is done by pressing the wheel off, the mating surfaces are destroyed.

Several of the disadvantages of the old method are avoided if the wheels are shrunk instead of pressed on.



Shrinking a Wheel on to an axle.

A shrinkage allowance of approximately 0.1 ‰ is used as a rule, which means that an ordinary wheel set with a 175 mm (6.9") diameter shall have a difference in diameter between wheel seat and hub bore of 0.175 mm (0.007"). The wheel seat and hub bore must therefore be machined with limits of approximately ± 0.01 mm (0.0004"). This high degree of precision could earlier only be obtained by individual fitting, which is impossible to carry out in mass production. More modern and better machine tools have, however, made it practically and economically possible to obtain the desired tolerances in mass production. Another advantage of mass production is also gained hereby: full interchangeability of all components.

The dismantling of a wheel shrunk on must not be done by pressing it off, but this problem has been solved with the help of the Oil Pressure Assembly Method invented and developed by Erland Bratt, SKF. This method consists of forcing oil under pressure through grooves between the wheel seat and the hub bore, whereby the hub bore expands, so that the wheel can easily slide off the axle on the oil film without being damaged.

A shrunk on wheel sits securely on its seating, it may be mentioned as an example that a standard railway wheel of 175 mm hub bore and 180 mm length of hub shrunk on to an axle with 0.1 ‰ interference could not be moved during a pressing off test, until the pressure had exceeded 120 tons.

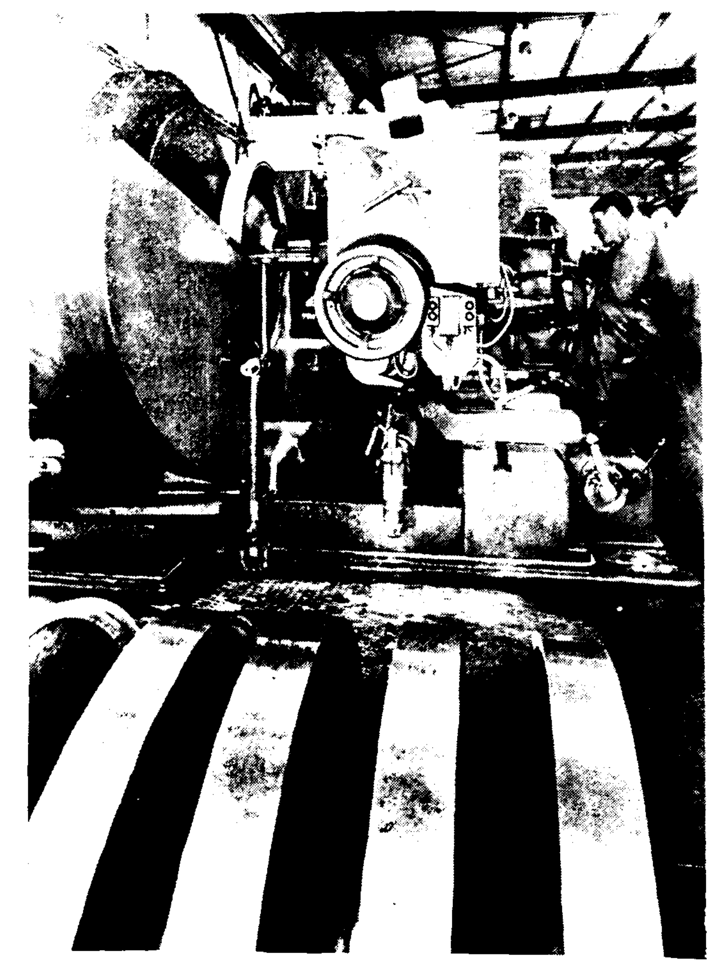
MACHINING OF AXLES AND WHEELS

The high degree of precision cannot be obtained by turning, and grinding the wheel seat, hub bore and mating surfaces of the centre and tyre was therefore introduced at the same time as Surahammar changed over to shrinking instead of pressing the wheel on to the axle. The grinding is carried out on three machines, all manufactured by LMV, Lidkoping, Sweden. The wheel seat, shoulders for the bearing seats, and journals are ground simultaneously in a centreless grinding machine. The inside of the tyres are ground in a second machine, and the bore and outside diameter of the wheel centres simultaneously in a third. All grinding is carried out with a tolerance of 0.01 mm (0.0004"). After grinding, the tyre is shrunk on to the wheel centre and secured by rolling a locking ring into a specially turned groove.

THE SHRINKING OF THE WHEEL ON TO THE AXLE

In order to shrunk on the wheel, this must be heated so that an increase in diameter of approximately 0.2 mm (0.008") greater than the interference is obtained. For a 175 mm axle an increase in diameter of 0.375 mm (0.015") is therefore suitable, which means a least temperature difference of 185 C between axle and wheel with a coefficient of expansion of 0.000012. When shrinking on hardened parts great care must be taken not to lower the hardness by too high a shrinking temperature. In this case 220 C is the highest permitted temperature, but for case hardened parts 200 C should not be exceeded.

For warming the wheels an electrically heated through-feed furnace is used in Surahammar. The furnace temperature is 220 C for ordinary railway wheels. The axle is clamped horizontally in a special jig before shrinking on the wheels. After the wheel has been taken out of the furnace the hub bore is carefully cleaned. The wheel is slung in a lifting device whose trolley is freely moveable in the direction of the axle on a track, which is adjusted to a position directly over the axle. A sprung hook supports the wheel, which facilitates mounting considerably as the wheel can be guided without great effort to prevent it dragging too much



The Wheel Centres are ground externally and internally without resetting.

against the wheel seat. The jig is fitted with a precisely positioned stop on each end against which the wheel is placed on shrinking. The distance between the wheels can be obtained to limits of ± 0.1 mm (0.004") if required.

When shrinking the driving wheels for locomotives or gear wheels it is often of great importance that the angular error between the wheels on one axle is very small. This requirement is very hard to fulfil when pressing on wheels as they often turn relative to the axle on pressing due to uneven resistance. In the shrinking process the wheel is freely moveable during mounting and with suitable fixtures a tangential precision of ± 0.1 mm measured on the periphery of the wheel can be obtained.

REMOVAL AND ADJUSTMENT OF WHEELS

The groove necessary for distributing the pressure oil is machined at the same time as the hub bore, and is placed in the stiffest part of the section if the hub is fairly symmetrical. The oil groove should be as shallow as possible with a smooth surface and well rounded edges. The oil pump is connected to a threaded hole ($\frac{1}{4}$" B S P) positioned on the inside of the wheel centre, and the oil is pumped through a 5 mm (0.2") diameter hole down to the groove.

For removing a wheel the wheel set is placed in a wheel press in the usual way. The oil pump is connected and the oil (castor oil) is pumped into the hub until it comes out at both sides, after which the wheel is pressed off the axle. The oil pressure is maintained during removal by pumping slowly until the oil groove has passed the edge of the wheel seat. The required force for pressing off a wheel in this way amounts to only a few per cent of that required for removing a pressed on wheel.

In case not sufficient accuracy is obtained on mounting for example locomotive wheels and gear wheels even with the shrink method, adjustments can easily be made by pressing oil between the hub and wheel seat, after which the wheel may be carefully turned on or pushed along the axle. Experience has shown that there is no risk of oil remaining between the surfaces of the hub bore and wheel seat to weaken the strength of the joint.

As shown in the foregoing pages, the shrink method together with the pressure oil dismantling may also be used with advantage for other shrink connections than railway wheel sets. With this method it is possible to abandon to a great extent earlier keyed connections. Keyways cause unpleasant stress concentrations, and the new method shows therefore a considerable gain from the design point of view.

If the customers prefer it, Surahammar can still use the old method of pressing the wheels on the axles.

RESEARCH WORK ON RAILWAY WHEELS AND AXLES

Both manufacturers and purchasers of wheel pairs have always wanted to be able to measure and record the stresses and strains occuring in the different parts under service conditions. Fundamental investigations of these problems have been carried out since 1947 by Surahammar in co-operation with the Swedish State Railways and ASEA (Swedish General Electric Comp.), and this research work has led to very good results. Resistance strain gauges make it possible to obtain a large number of strain values from the outer surfaces of the axles and wheels. It proved difficult at first to transfer the very weak electrical impulses obtained to the instrument cabin in the railway coach, but a solution was found in a special slip ring assembly suspended under the car body and connected with the axle by a spiral tube, which was torsion stiff but stretchable and bendable. The journal stub of the wheel set is provided with a hole corresponding to the tube, which through a radial hole opens out inside the wheel web. The cables are taken through the holes in the axle and through the tube to the sliprings. In this way the wheel set is allowed to move relative to the slipring assembly without damaging or shaking it. The enourmous accumulation of recorded measurements necessitated in the beginning much subsequent time-consuming work, but this was eliminated by a classifying impulse calculator, designed by ASEA. The measurements were as rule made on ordinary passenger trains on the lines Stockholm-Malmo-Gothenburg-Stockholm. A thorough description and discussion of this research work is given by K. Meldahl, ASEA, in the Bulletin of the International Railway Congress Ass., June 1953.

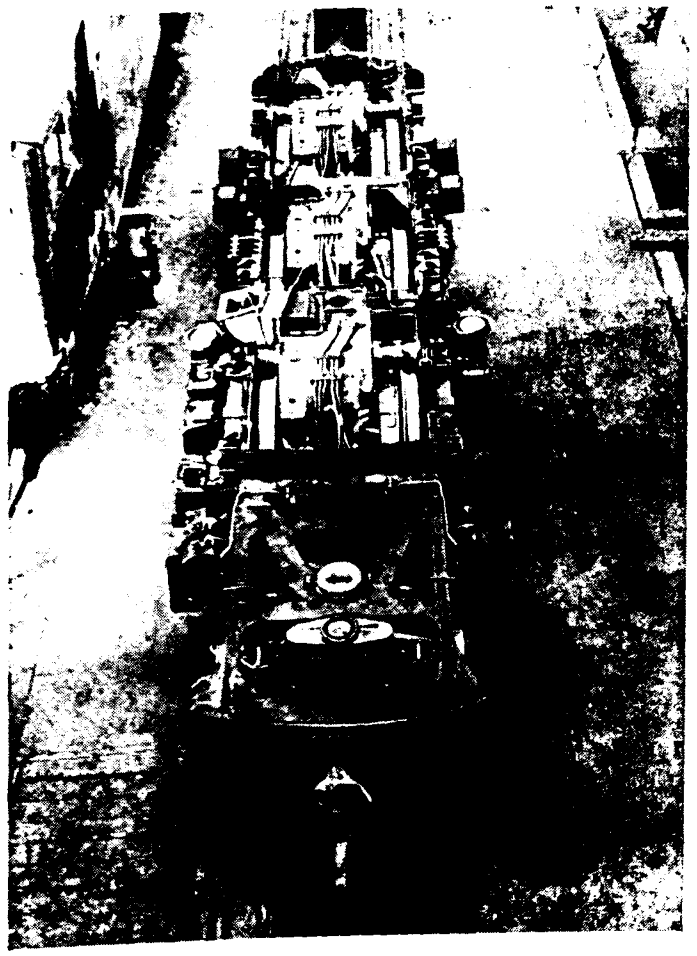
Form giving and material questions have also been thoroughly investigated. Tests have been made with models, and one of the findings was the fact that, if an axle is tapered down slightly in the middle, particular care being taken, however, that the transition to the hub has the proper contour, the fatigue strength of the wheel seats will be improved. Surahammar also has a fatigue-testing machine, designed and constructed at Surahammar for the full-scale testing of wheel pairs.

New Electric Locomotives in South Africa

THE latest stage electrifying the Cape Western main line of the South African Railways has been the extension of electric working from De Doorns to Touws River. Severe gradients and curvature on this section had restricted traffic capacity with steam traction, and imposed on the new electric motive power the exacting requirements to which reference is made in our description of the North British—G. E. C. 3,030 h. p. locomotives on another page. The locomotives were required, for example, to make two starts within 20 min. against a 1 in 66 gradient with a trailing load of 1,200 tons. In practice the equipment showed no signs of being overtaxed when the starts were made well within the specified time, the temperature of the hottest section of resistance not exceeding 300 C while the resistance compartment temperature did not rise above 100 C. Subsequent tests against 1 in 40 with loadings of 675 to 700 tons were equally satisfactory. Some of the locomotives have now run mileages of over 50,000, in the course of which the specified performance when motoring and regenerating has been achieved without adjustments being required, and there has been favourable comment on the smoothness of the transitions between the three motor groupings both in the motoring and regenerative connections.

During the last 25 years the South African Railways have electrified large sections of their system at 3,000V D. C. and have now converted their Cape Western main line between Bellville near Cape Town, and Touws River, a distance of some 149 miles. From

South African Railways "4 E" class 3,030 h.p. electric locomotive built by the North British Locomotive Co. Ltd., with electrical equipment by The General Electric Co. Ltd.



Motor Bogie and pony truck of North British G.E.C. 3,030 h. p. electric locomotive for the South African Railways.

Cape Town to Bellville on this route the previous 1,500V D. C. system is being changed over to 3,000V. Beyond Bellville, the limit of the Cape Town suburban electrification, the work is entirely new, and was completed to Touws River on May 14.

All trains, both passenger and goods, running beyond Bellville are hauled by 3,000V D. C. electric locomotives. A contract for forty locomotives for these services was placed by the South African Railways with the North British Locomotive Co. Ltd., The General Electric Co. Ltd. being the contractor for the electrical equipment.

The locomotives (fig. 1) are amongst the largest yet built for 3 ft. 6 in. gauge. The specified requirements covered both performance and train timings, the limiting feature as regards loading being the 20 miles of 1 in 66 grade between Hex River and New Kleinstraat. On down grades the speed had to be kept at the figures quoted in Table 1 by regenerative braking only. Furthermore the locomotives had to be capable of starting a 1,070 ton goods train on a 1 in 60 grade or a 610 ton passenger train on a 1 in 50 grade.

The specified haulage requirements are given in Table 1.

TABLE 1

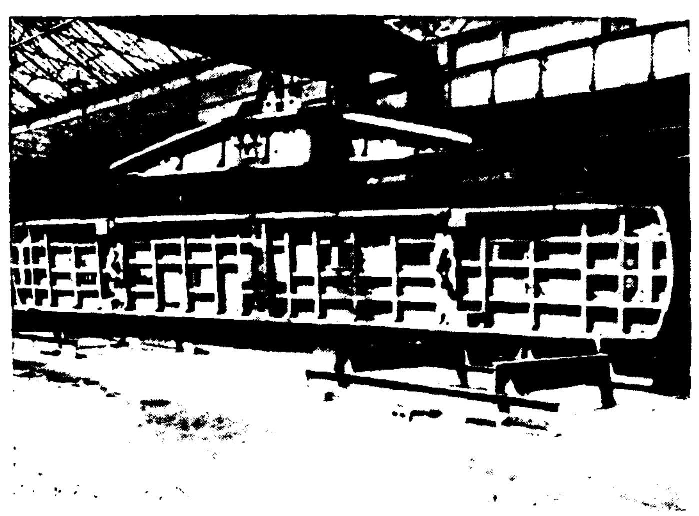
PERFORMANCE REQUIREMENTS

Type of Train	Gradient	Max Speed Required, m. p. h.
610 ton passenger	Level	56.5
	1 in 100 up	38
	1 in 66 up	34
	1 in 50 up	31.5
	1 in 66 down	40 to 55
	1 in 50 down	30 to 45
900 ton goods	1 in 66 up	25.5 and 30
1070 ton goods	Level	35
	1 in 66 up	24.5
	1 in 66 down	25 to 40

To meet the foregoing requirements a 3,030 h. p. six-motor locomotive was provided, with three motor combinations and a moderate range of field control in each combination. Ultimately thirty of these locomotives will operate on the Cape Town — Touws River section and ten in Natal.

GENERAL DESCRIPTION

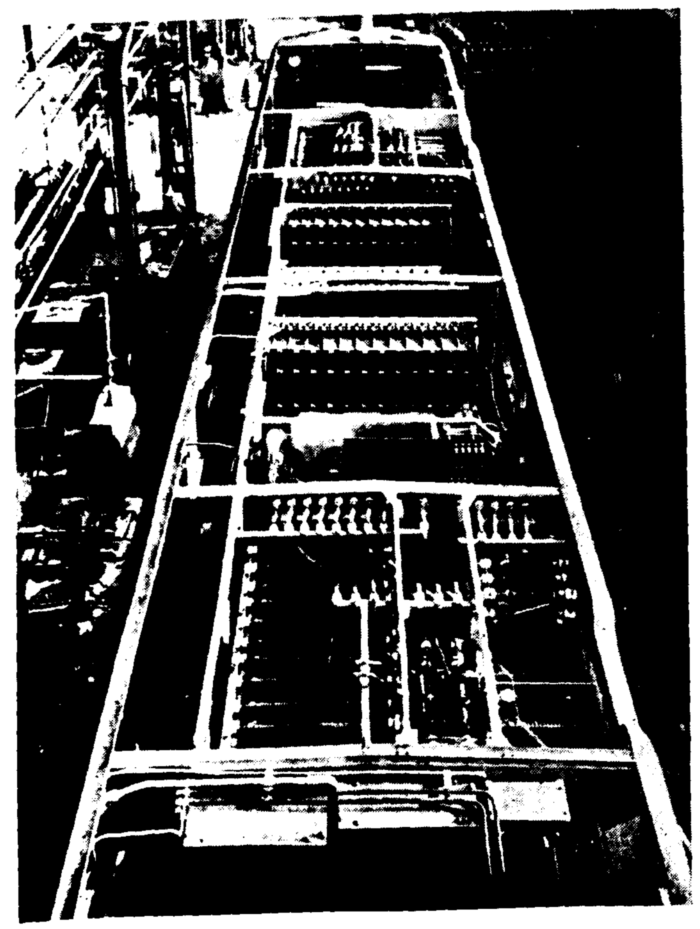
The locomotive is carried on two bogies each with three driving axles and a leading pony axle (fig. 2). The draw-gear is mounted directly on the bogie headstocks and the tractive effort is transmitted between the bogies



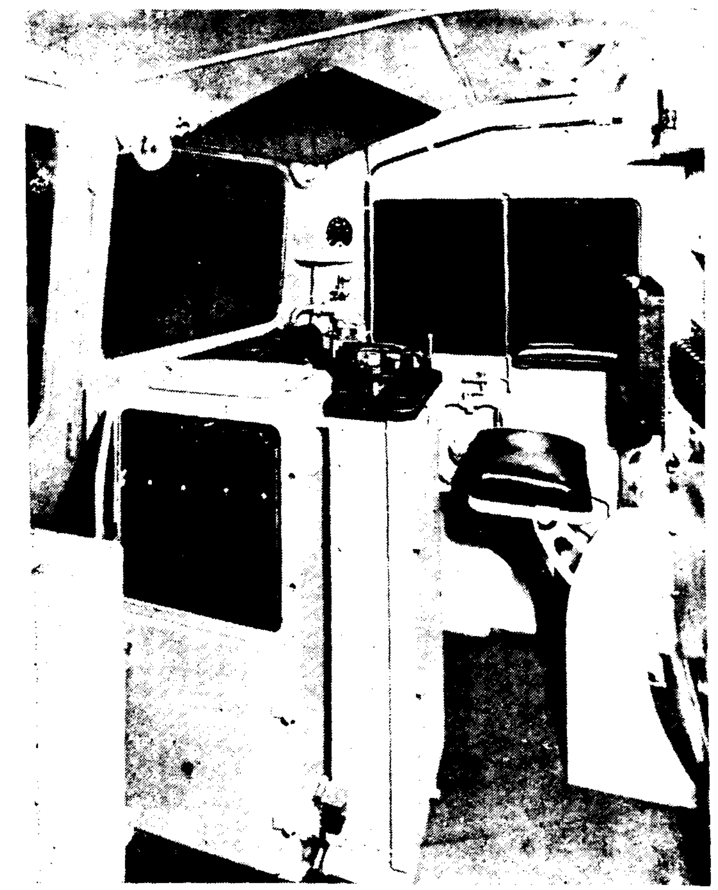
All-welded main frame of North British G.E.C. 3,030 h.p. electric locomotive for the South African Railways.

by a link and pins with spherical bushes. These bushes allow freedom for transverse and vertical movement of one bogie relative to the other. The main frame of the locomotive is manufactured as three pieces, subsequently welded to each other to form a single all welded unit (fig. 3) with flat rubbing surfaces on the underside of the frame carried on spring borne bearer pads on the bogies. On each bogie there are two main side bearers approximately opposite the pivot and two end bearers carrying slightly less weight at the inner and outer ends. The pivots carry neither weight nor tractive forces.

Transverse forces are transmitted from the pony truck to the bogie frame through rocker cams which provide a constant centering force. The bogie running is further stabilised by the friction at the bearers and by a spring interconnection of special design which tends to keep the bogies moving in phase but allows independent movement above a predetermined controlling force.



View from roof of high-tension compartment of North British/G.E.C. 3,030 h.p. electric locomotive for the South African Railways.



Driving cab of North British/G.E.C. 3,030 h.p. electric locomotive for the South African Railways.

The pony truck and leading driving axle are fully side and cross equalised while the other two driving axles are side equalised only. Principal dimensions of the locomotives are shown in Table 2.

TABLE 2

PRINCIPAL DIMENSIONS

Gauge 3 ft. 6 in.

Length over couplers 71 ft. 8 in.

Bogie wheelbase 22 ft. 5 in.

Total wheelbase 60 ft. 4 in.

Wheel dia. (driving) 4 ft. 3 in.

Wheel dia. (pony) 2 ft. 6 in.

Total weight in working order 155 tons

Adhesive weight 129 tons

Tractive effort (at 25% adhesion) 72,000 lb.

Continuous rating (full-field) 32,100 lb. T. E. at 28.5 m. p. h.

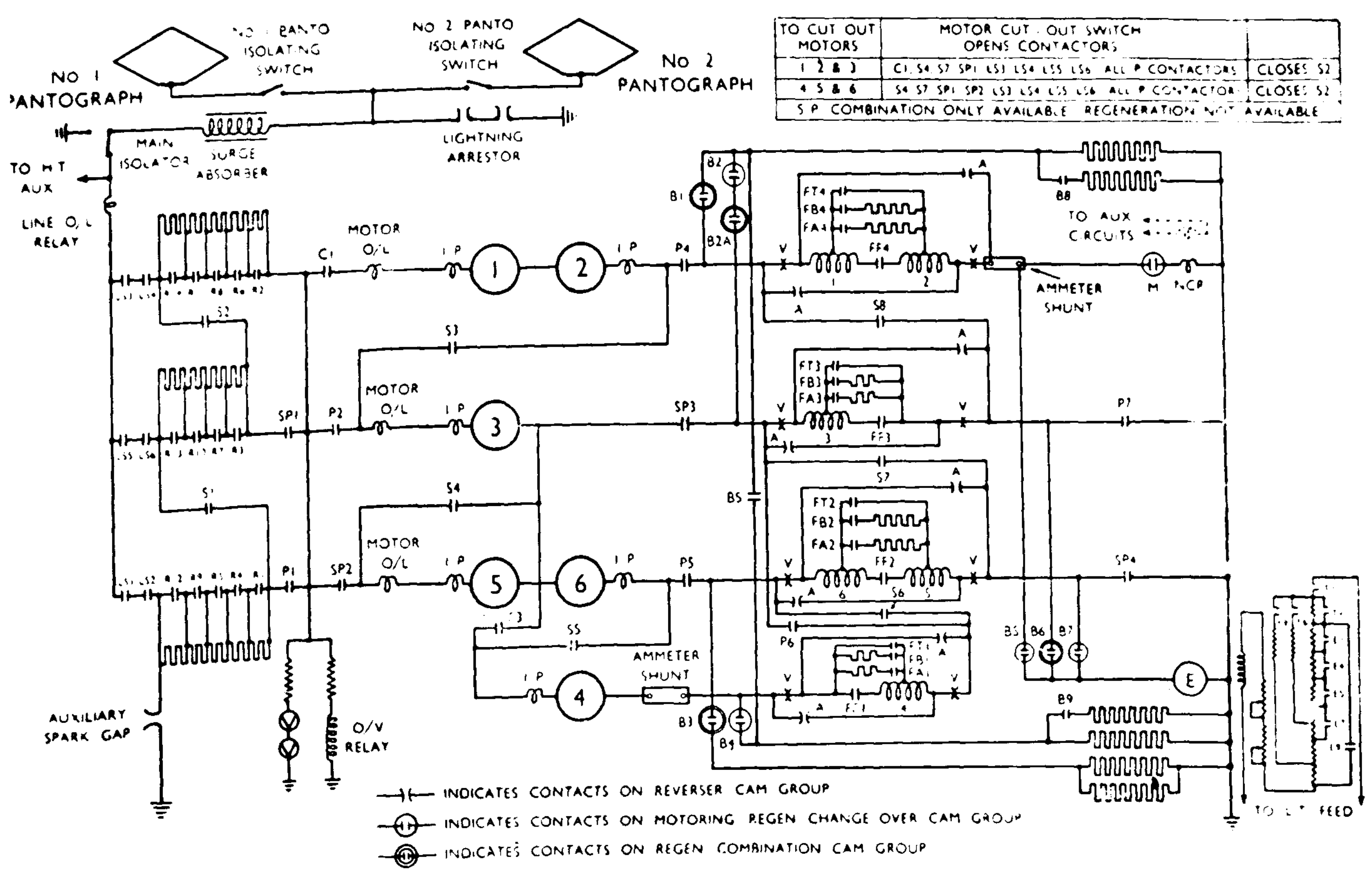


Fig. 6

Power circuits of North British/G.E.C. 3,030 h.p. electric locomotives for the South African Railways.

TABLE 2

PRINCIPAL DIMENSIONS

Continuous rating (weak-field) 25,500 lb. T. E. at 37.6 m. p. h.

One-hour rating (full-field) 41,700 lb. T. E. at 26.7 m. p. h.

One-hour rating (weak-field) 33,600 lb. T. E. at 34.2 m. p. h.

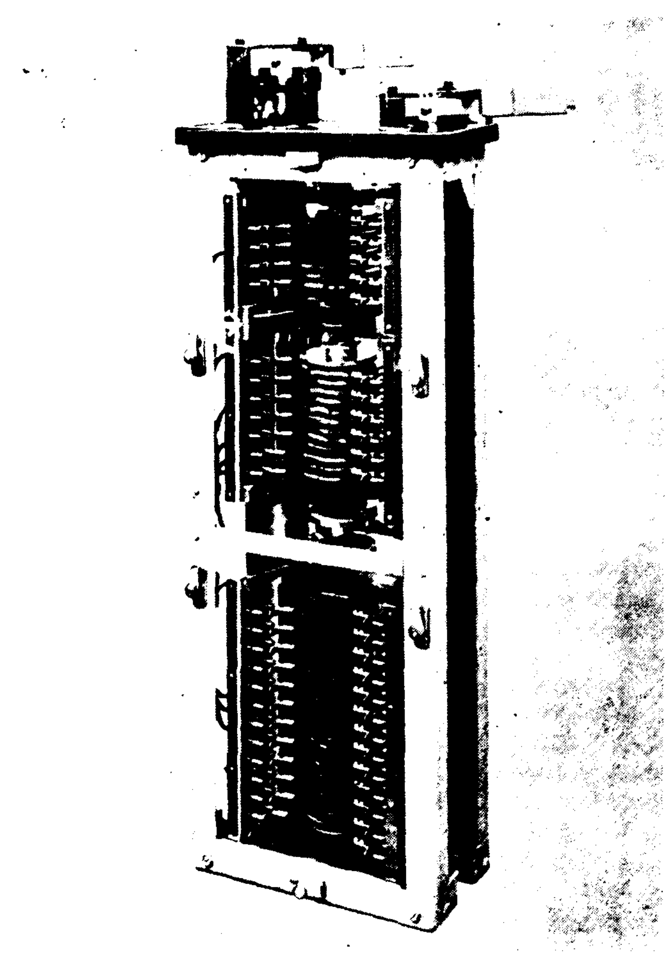
The locomotive body is symmetrically arranged with a driving cab at each end; behind each cab is a machinery compartment and in the centre portion of the locomotive is situated the enclosed high tension compartment (fig. 4).

The driver's cab (fig. 5) houses all the master control equipment. A panel in front of the driver carries the various meters and gauges. Equipment includes a speedometer, mileage counter, regenerative mileage counter, and speed recorder. Behind the driver are the main control switch and circuit breakers for the lighting circuits. The battery is situated in two cubicles on either side of the front doorway.

The machinery compartments contain the various auxiliary machines and much of the low tension control equipment associated with them. In a chamber in the centre of the locomotive is housed all the high tension power and auxiliary control gear. The ventilation of the high tension compartment is effected by diverting part of the cooling air from the ducts leading to the traction motors. The whole of the cooling air for the locomotive is filtered.

POWER CIRCUITS

The power circuits are shown in fig. 6. Power is collected from the overhead line by one or other of the pantographs; all the circuits are fed through a main isolator inter-locked with the H. T. chamber door and pantograph control. The locomotive performance demands three groupings of the six driving motors both when motoring and regenerating, namely, series, series-parallel and parallel. The motors are thus connected in series across the line as one group of six, two groups of three or three groups of two. Control is by means of electro-pneumatic contactors operated from the master controller.



Master controller of North British G.E.C. 3,030 h.p. electric locomotive for the South African Railways, showing arrangement of the drums and com-operated contacts.

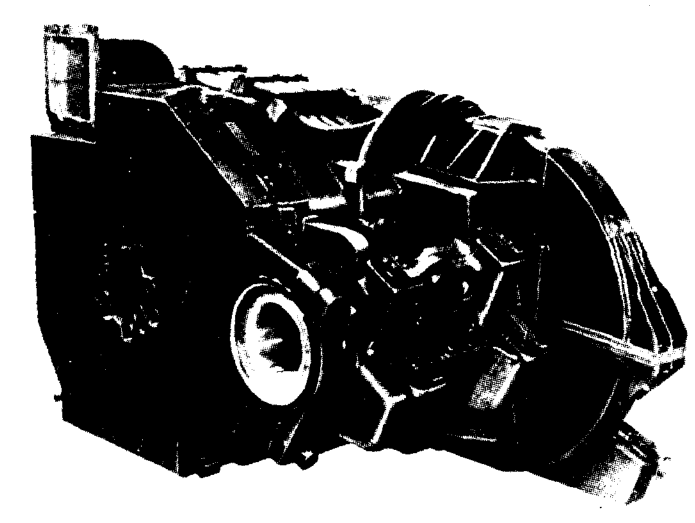
Changing from one combination of motors to another is by shunt transition which maintains a suitable drawbar pull during re-grouping. In each combination four continuous running stops are provided by field excitation control. When regenerating, the motor fields are separately excited from a variable voltage exciter and the inverse compound regenerative characteristic ensures stability. Lightning protection is afforded by means of a double spark gap and a surge absorber, both mounted on the roof, and auxiliary spark gaps with blowouts in the power and auxiliary circuits. The insulation of all high-tension equipment is designed to withstand 10,500 volts A. C.

CONTROL SYSTEM

The power contactors are electro-pneumatically operated and the master controller handles only small currents at 112 volts for operating the valves. A comprehensive system of interlocks ensures correct sequence in all circuit changes and affords full protection in the event of failure of any component. The master controller has three handles. The first selects forward or reverse running as well as the various motor combinations; the second controls the cutting out of starting resistance during motoring and regenerative braking, the final notches of this handle operating field weakening contactors in any motoring combination. Field weakening it not available when the motors are regenerating. The third handle sets up the regenerative connections, and controls the exciter voltage. As the locomotives always have a crew of two, no dead man's features are provided.

Should over-current or overvoltage relays operate, starting resistance sections are at once connected in the circuit, followed by further sections and finally by the opening of the line switches. If a motor fails, the three motors on either bogie may be isolated and the locomotive safely operated with a limited performance. All the locomotives are provided with control train lines and couplers to permit multiple-unit operation so that more than one locomotive can be driven from one cab.

The control of a locomotive of this class involves much specially developed equipment, and as it is associated both with the 3000 volt and 112 volt circuits, insulation is of prime importance. For safety, the high tension side is earthed but the low tension circuits are not earthed. This is because there may be a very high resistance



One of the six G.E.C. traction motors of the South African Railways "4E" class electric locomotive.

to earth if sand or dirt is blown on to the track. Furthermore, there is always the equivalent of an earthed barrier between low and high tension circuits when associated with one piece of apparatus.

The pantograph is of lightweight, heavy duty construction. The main feature in the design is the arrangement of the pans which neutralises the drag action due to friction.

The main 3,000 volt, 300 amp contactors are electro-pneumatically operated, and are tested with currents exceeding 8,000 amp and voltages up to 4000. A small 3,000 volt clapper type solenoid-operated auxiliary contactor is built on similar lines.

The main changeover cam groups employ an insulated bar construction carrying the fixed and moving contacts; a centre shaft carries the Bakelite cams to operate the contacts, which are spring closed and cam opened.

The master controller (fig. 7) also employs cam operation, with silver butt contacts. There are three drums on the same centre: the top being the reverse and combination drum, the middle the regenerative, and the bottom the main resistance and weak field drum.

The resistances on these locomotives are subjected to very arduous duty due to the steep grades and heavy loads hauled. They are of special corrosion-resisting cast iron, and the grids are carried on Micanite insulated bars. On each bar a take-up spring is provided to obviate trouble should slack develop, which would otherwise cause burning of the contact surfaces. Field weakening and regenerative stabilising resistances are of the strip type.

TRACTION MOTORS

Each axle-hung traction motor (fig. 8) is of the 4-pole series type, force ventilated, and weighs 5¼ tons with gears and gear case. Motor ratings at 1,450 volts in accordance with British Standard No. 173 1941 are: Continuous rating, full field, 232 amp., 420 h. p., 672 r. p. m. Continuous rating, weak field, 242 amp., 440 h. p., 888 r. p. m. One-hour rating, full field, 282 amp., 505 h. p., 630 r. p. m. One-hour rating, weak field, 290 amp., 525 h. p., 807 r. p. m.

Each motor is suspended from the bogie transom by a nose cast on the frame and resting in a cradle carried on rubber pads. Manganese steel wearing surfaces are provided on the nose and cradle.

The lateral forces imposed on the track are considerably reduced by allowing the motor a limited amount of transverse movement relative to the axle under the control of rubber springs between the motor and the bogie frame. The suspension bearings are clamped in position by a single cast steel axle cap located by large spigots and secured by bolts. Lubrication of the suspension bearings is effected by oil syphoned through wool packing from a large reservoir in the axle cap.

The armature is carried in grease-lubricated roller bearings and can be removed from the motor frame without opening up the bearing assemblies so that there is no risk of dirt entering the housings during this operation.

Hard mica wraps moulded on to the coils insulate the slot portion of the armature windings. The whole is consolidated, while hot, all interstices being filled with insulating cement. Armature failures have, in the past, resulted from the melting of solder in the commutator joints, and for this reason solder is used which does not become plastic until a temperature of 236 C. is reached.

The field coils are formed of copper strip with inter-turn insulation of treated asbestos; the main insulation is cambric-backed mica with an outer taping of asbestos. The final polymerisation of the impregnated synthetic resin varnish gives coils of great strength with excellent insulation and heat dissipation properties.

Studs of fatigue resistant alloy steel with non-magnetic bushes fix the interpoles to the motor frame. This construction (patent applied for) coupled with careful grading of the interpole gap, ensures proper interpole strength and greatly assists commutation.

The motors drive the axles through single spur reduction gearing manufactured by Alfred Wiseman Limited. The resilient gearwheels comprise a carbon chrome toothed rim mounted on a cast steel hub, the drive being transmitted from rim to hub through Silentbloc rubber units. A high degree of resilience is obtained by using two Silentblocs in series, one mounted in the rim, the other in the hub, with a steel pin forming the connecting link.

AUXILIARIES

Each locomotive is provided with a 43kW motor exciter set which energises the motor fields when regenerative braking is used, and a 22kW motor generator for supplying the L. T. power and lighting circuits. Incorporated in each set is a blower which supplies the cooling air for three of the traction motors. Both motor and generator armatures are mounted on a commonshaft with the field system hoosed in a single fabricated frame. The driving motors are two-pole machines operating from the 3,000 volt supply. The exciter and L. T. generator are four-pole machines. The equaliser connections of the exciter form part of the commutator assembly and are entirely separate from the main winding.

On the 22kW set, the blower takes sufficient load to permit the use of a series wound driving motor, but for the 43kW set an additional field is provided on the motor to limit the speed range between maximum and no load on the generator. Both the exciter set and the L. T. motor generator are force ventilated.

The driving motors of the exciter and L. T. generator are protected by a circuit breaker which can also be set and tripped by hand and functions as a means of starting and stopping the machines. Current from the L. T. generator is used for battery charging, the fields of the exciter set, for the two exhauster motors, compressor motor, lighting, control circuits and heaters. All these machines have automatic starting equipment to limit the starting current peak. Lighting and control circuits are protected by circuit breakers, no fuses being used.

The battery floats across the L. T. generator and supplies the lighting and control circuits if the L. T. generator is not running. In an emergency it can be used to run the exhausters for a limited period.

BRAKE EQUIPMENT

The Westinghouse brake equipment provides straight air brakes on the locomotive and means for operating vacuum brakes on the train. Regenerative braking is interconnected with the mechanical brakes so that in the event of failure during regeneration the vacuum brakes are automatically applied.

The compressor is automatically controlled and supplies air via the main reservoir for the locomotive brakes, sanding, horn, control and pantograph equipment. Two vacuum exhausters operate the train brakes.

The Westinghouse exhausters are driven by 110 volt series motors; the armature is mounted on an extension of the exhauster crankshaft, while the motor frame is spigoted to the crankcase.

The brake rigging is fully compensated with brake blocks on each side of the twelve driving wheels, each bogie having two brake-operating cylinders. An automatic slack adjuster allows for wear of brake blocks and tyres.

SANDING EQUIPMENT

Air sanding is operated by electro-pneumatic valves controlled by the driver. Each bogie has eight sanding boxes so that, for either direction of travel of the locomotive, eight wheels are directly sanded.

A Neat Piece of Welding is Making Engineering History

By Peter Davison

AUSTRALIANS are making engineering history with the first all-welded steel, heavy-duty locomotive bogies.

The bogies are for 115-ton diesel-electric locomotives which pull a lot of Australia's express trains, including the crack trans-continental express on the long run between Port Pirie in South Australia and Kalgoorlie, 1,100 miles west across the gibber-strewn Nullarbor Plain in Western Australia.

Next year the fast Australian-built streamliners will be pulling trains in Pakistan and Hong Kong.

These engines, like those on Australia's own railway network will be running on welded steel bogies.

They will be delivered on time too, thanks to the initiative and ingenuity of Australian engineers.

When the Clyde Engineering Co. began making the "Mainline" locomotives, local foundries were not equipped to supply cast steel bogies quickly enough for the orders the company had from overseas and from the Australian Federal Government and Australian State Governments.

They could have purchased cast steel bogies from the United States of America, but time would have been lost and, more important, it would have increased the dollar cost of the locomotives. Already dollars must be spent for the power unit, generator, controls and some minor equipment.

Australian engineers saved the situation—and some dollars.

They calculated that rolled steel, hot pressed into shape and welded, would make bogies as strong and as efficient as the cast steel jobs.

They were right. One of the bogies has already completed over 300,000 miles of hard running without any trouble showing up.

The bogie, called a truck in some countries, on a diesel-electric locomotive is the bogie frame, bolster, axle and wheels which together support the locomotive. The axles and wheels, of course, are made of cast steel.

The bogie frame, like an automobile chassis, has two side rails and cross members. The bolster is a heavily braced steel platform attached at each corner to the bogie frame by heavy coil steel springs. It is on this strong, reinforced steel table connected by a pivot, that the locomotive rests.

The complete bogie is 18 ft. long by 9 ft. wide and weighs about 25 tons.

The Australian locomotive has two of these with three axles and six wheels each.

Thickness of the steel in the bogies varies from ½ inch to 1¼ inches. Cutting is done with an automatic oxy cutter and the shaping in hot cast iron dies, in heavy hydraulic presses.

Fabrication of the various steel patterns into the complete bogie is done in sections, each section being put together in jigs to ensure accuracy. A manual welder tacks the pieces and a heavy automatic welder completes the job. All the sections are then joined together by tack welding in the final jig and then welded automatically as before.

Success of the bogies depends upon three important steps in their manufacture.

First, great care is taken in selecting the steel. Only highest grade weldable steel is used and a careful check is made for flaws and other defects.

Just as important is the manner of welding.

The job is clamped to huge positioners which tilt it to almost any angle and allow the welding to be done in the down-hand position, that is, the steel to be welded is beneath the welding torch. This ensures maximum penetration, high class welds.

The third and most important step contributes most—heat treatment. The bogie is allowed to "soak" in 950 degrees Centigrade, a process known as normalising.

This is done in a furnace large enough to hold the whole bogie; it is the last stage of the fabrication before

axle boxes, axles and wheels, motors and other parts are fitted.

Soaking the steel at high temperature re-chrystallises it, equalising welded metal and parent metal. It also relieves any stresses in the metal and leaves the bogie in the strongest condition to resist the terrific road shocks and stresses it will take in service.

The Clyde Engineering Co. has so far built 46 locomotives at its factory a few miles from Sydney, capital of the eastern Australian State of New South Wales.

Right now they are working on nine of the "Mainline" locos for Pakistan. These will be presented as a gift by the Australian Government under the Colombo Plan. Value of the order in nearly £A1,000,000.

When they have finished the Pakistan engines, the company has more orders for Hong Kong and the Australian Commonwealth and State Governments. By the end of this year (1954) the locos will be rolling out of the sheds at the rate of one nearly every week.

The company also makes smaller, industrial diesel locomotives used extensively in Australia on sugar cane farms and in other industries.

The "Mainline" locomotive weighs from 110 to 115 tons, is 61 ft. long by 9 ft. 9 in. wide and 14 ft. high. It is powered by a 1,750 horsepower, 16 cylinder, two-stroke engine. Locomotives for Australian railways are geared to a top speed of 90 miles an hour although the engines have a top speed of 125 miles an hour.

The "mainline" locomotive is based on a design of the Electro-Motive Division of General Motors Corporation, U. S. A., which supplies some of the equipment.

Manufacture of Railway Equipment

SATISFACTORY progress in the manufacture of a large number of locomotives and electrical equipment ordered for the Indian Railways with manufacturers in Europe has been reported by Mr. F. C. Badhwar, Chairman of the Railway Board, who has returned to New Delhi from a tour of the United Kingdom and some West European countries.

Mr. Badhwar visited many of these factories to examine the progress achieved and to finalise certain outstanding technical matters connected with specifications and procedures for inspection of the stock at various stages.

On the whole progress appeared to be satisfactory although some factories seemed to be slower in making a start than others. It was also noticed that the capacity available in Western Germany and the United Kingdom for steam locomotive manufacture was not fully used at present.

In view of the alternative designs offered by some European firms for the Rs. 15-crore Ganga Bridge, Mr. Badhwar took this opportunity to study the latest developments in bridge designs and erection techniques for long spans. He has brought back useful information for the engineers of the Ganga Bridge, Project.

MANUFACTURE IN INDIA

During his visit, he discussed with leading manufacturers the question of the early manufacture in India of electric traction equipment. Great importance is attached to this question by the Railway Board. Mr. Badhwar also examined the question of provision of electrical multiple unit stock and other equipment for electrification of the Railway lines in the Calcutta area.

Mr. Badhwar attended the annual conference of the International Railway Congress Association in London as leader of the Indian delegation. The delegation participated in most of the discussions on important technical subjects such as types of Railway electrifications, improvements in signalling, recent developments in locomotive design, and modern permanent way practice. Indian Railways have a longer route mileage

(Continued on page 30)

CORROSION ON STEEL-COACHES

Cause and its Remedy

By W. P. Niyogi, G.I.Loco.E., (Lond.), M.I.I.S., (B'ham.),
Member, A.A.R. (Chicago), A.R.E.A. (Chicago), and V.D.I. (Germany).

AT the present age almost all the countries in the world have concentrated on building metal coaches and most of which are of steel. But the biggest snag in the steel coaches is its periodical corrosion, specially after it is swept over by the annual monsoon in a country like India. Now the headache of the engineers as well as of the scientists of the world is to find out the cause of corrosion on steel and its remedy. For this reason, The British Iron and Steel Research Association has formed a Corrosion Committee to investigate into the matter and they have found out some of the reasons why rust forms on iron and I would like to describe some of those collected from them.

WHAT IS RUST?

The natural tendency of every metal on the earth surface is to return to its original state from which it was obtained. Similarly, iron or steel tends to revert to the crude form of its ore from which man's craft has wrested it. This happens when the metal combines with the oxygen present in the atmosphere and forms oxide. Thus when iron or steel forms its oxide, it is known as rust.

HOW STEEL RUSTS?

The rusting on steel can effect from air, from water or from soil. If the weather is damp i. e. the atmosphere contains moisture, the oxygen of the moisture has a great affinity towards steel to form its oxide. This happens if there is some projection on the surface of steel to arrest dust and moisture. If the surface is very smooth it rusts in a much lesser quantity.

Surface condensation can take place due to the difference of temperature between the inside and outside of the steel panels.

The water rusting is still more severe on steel and it corrodes the metal with a very rapid speed. This corrosion is accelerated by the combination of copper with galvanised steel. The traces of copper dissolved in water deposit on the zinc-coated steel causing a very highly dangerous corrosion cell. Another big enemy for corrosion is the presence of wood in contact with steel as wood has a special tendency of collecting water and keeping the surface of contact with metal damp, to cause rusting of the metal.

Soil is another cause of corrosion on steel if it is kept buried for a long period. In the absence of air in the soil, the oxygen needed for the corrosion is derived from the reduction by bacteria of sulphates present in the soil. This, sometimes, completely removes the iron in the metal, leaving a matrix of brittle carbon, liable to be shattered by any shock. This is known as graphitisation.

However, the causes of corrosion on steel-coaches may be attributed to the first two, as very seldom a coach comes in contact with bare soil. The main reasons for such corrosions are the presence of the external attachments to the carriage shell such as the ventilators, the weather strips, the rain water gutters and so on. The projected portions of such fittings tend to arrest dust and moisture from the atmosphere and cause rusting. Also the non—flushed finish of the outside panels may cause arrest of moisture and dust. It has also been noticed that rusts originate from the existence of projected screw or rivet heads and from projected seams of welding on the panel body. Another cause of corrosion on steel is its contact with non-ferrous material such as wooden packings, brass window channels, brass screws and so on. Though brass itself is non-corrosive but the presence of copper in brass helps towards corrosion of iron.

(Continued from page 28)

than the Railway system of any of the members of the Association. The French Railway come next with about 6,000 miles less and British and German Railways take the third place with about 14,000 miles behind the Indian route mileage.

Interchange of information on operating matters and organisational procedures with senior representatives of European Railways confirmed the fact that Indian Railways are up to date, progressive in outlook and efficient in performance.

HOW TO STOP CORROSION?

Here comes the most important portion of discussion. There are many aspects one has got to take care of to stop corrosion. Firstly, I must admit that there is nothing in this world which can completely stop corrosion; because it is a natural phenomenon of every earthly substance to decay. Human power only can decelerate the rate of corrosion and save some expenditure in renewing it, which, of course, is the urge behind this investigation.

Firstly, the composition of steel counts a lot towards the stoppage of its corrosion. Then it is followed by the pre-treatment of the metal, the design of the structure of carriage shell and finally, the protective coatings to be given on the finished surface.

COMPOSITION OF STEEL

Various experiments all over the world has confirmed that the rate of rusting of bare mild steel depends considerably on the relative humidity of the atmosphere. In a vast country like India, whose length and breadth cover several thousands of square miles, the humidity in atmosphere varies appreciably between different parts of the country. On the desert of Rajasthan, where the humidity lies below 70%, the rusting is negligible, whereas, in the states of Bengal or Bombay, where the atmosphere is fully humid and polluted with smoke and salt from sea-water, the rusting is well over 5 mils per year.

This rate of corrosion can be decreased by alloying the bare steel. It is found that chromium-nickel steel is virtually incorrodible in normal atmosphere. By the addition of low-percentages of chromium and copper, the corrosion resistance in steel is increased by nearly 3 times. The presence of chromium helps to build up a self-healing protective oxide film on its surface which contains iron and is highly compact and impermeable and stop further rusting of the metal. It is also noticed that the addition of say 0.2 to 0.3 per cent of copper alone would increase the durability of unpainted roof sheets.

PRE-TREATMENT OF METAL

This is the most vital operation in the industries of steel products. In it depends the real prevention to steel corrosion and a good prevention will always minimise the necessities of curing it. Pre-treatment of metal may be of various ways, of which chromating or phosphating of steel is important. They have been given different patent names by different industrialists such as :— Parkerizing, Bonderizing, Walterising and Granodising. Practically all these different ways of treatment have the same effect on steel viz: a phosphate coating of iron is formed on the surface which resists further oxidation of the metal and the rough porous surface gives a better adhesion or bond to paint.

The important operation before phosphating is degreasing or cleaning of the metal. This cleaning may be done by many means such as wire brushing, shot

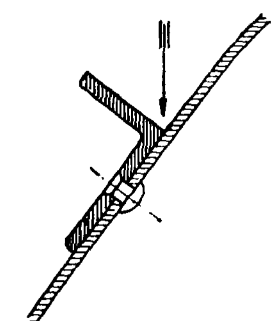


Fig. A

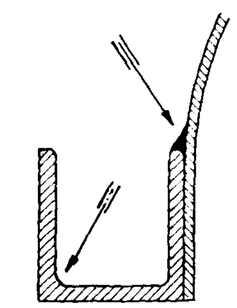


Fig. B

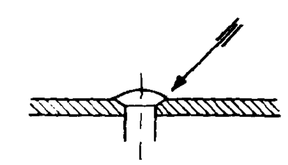


Fig C

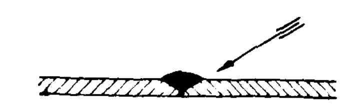


Fig D.

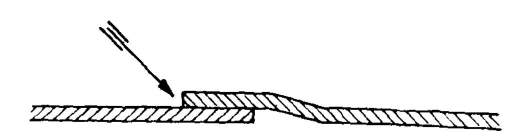
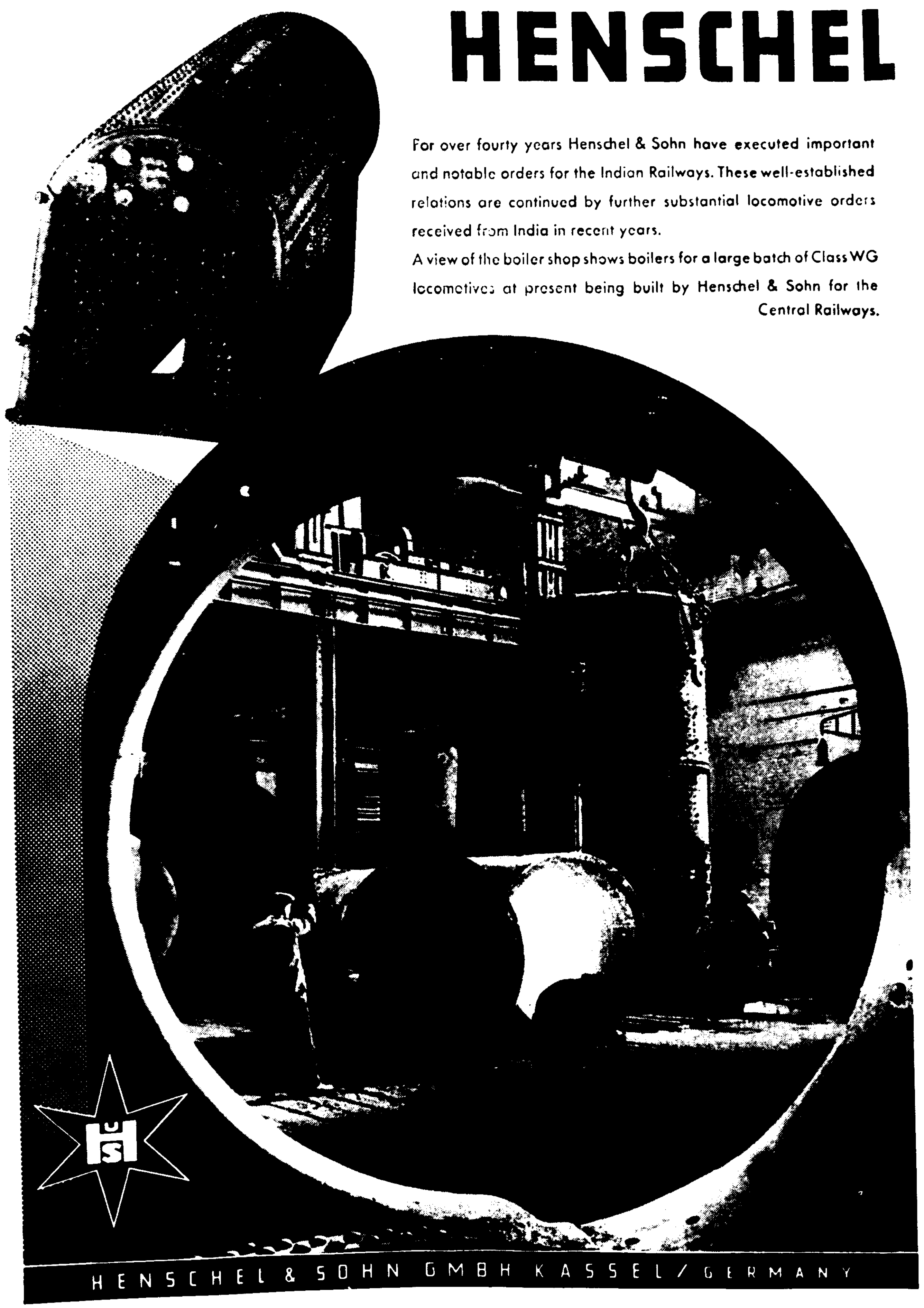


Fig E.

blasting, wiping with white spirit, caustic bath or acid bath. The cleaning of the metal does not mean merely the removal of oil, grease, dirt or any other foreign residues. The primary function of this operation is derusting or descaling. This can be done either mechanically or chemically, but definitely the latter method is more effective. So, generally the metal is acid pickled and the acid used is either sulphuric acid or hydrochloric acid; but these require washing off and neutralising after pickling. In recent years phosphoric acid has been used for pickling as the pickled surface has no harmful or corrosive chemicals requiring washing off as well as the advantage is the formation of a thin phosphate coating on the surface.



HENSCHEL
For over fourty years Henschel & Sohn have executed important and notable orders for the Indian Railways. These well-established relations are continued by further substantial locomotive orders received from India in recent years.
A view of the boiler shop shows boilers for a large batch of Class WG locomotives at present being built by Henschel & Sohn for the Central Railways.
HENSCHEL & SOHN GMBH KASSEL / GERMANY

See the glories of India's past
THE STUPA, SANCHI
THE TAJ, AGRA
THE LAKE PALACE, UDAIPUR
AMBER PALACE, JAIPUR
THE KAILAS, ELLORA CAVES
TOWER OF VICTORY CHITORGARH
A FRESCO IN AJANTA CAVES
CENTRAL AND WESTERN RAILWAYS
NEW ROUND TOUR CONCESSIONS INTRODUCED BY. INDIAN RAILWAYS NOW ENABLE YOU TO PLAN YOUR HOLIDAYS ECONOMICALLY AND VISIT ALL IMPORTANT PLACES IN THE COUNTRY WHICH ARE LIVING MONUMENTS OF INDIA'S GLORIOUS PAST.
INDIAN RAILWAYS ARE ALWAYS AT YOUR SERVICE.

The most effective solvent which may be recommended for this purpose is an emulsion produced by the Imperial Chemical Industries known as " Deoxidine ". This " Deoxidine " solution may be applied either by hand brush or by dipping. It is suggested that small iron components should be dipped in a bath of lead-lined tank containing a solution of 2 parts of water with one part of Deoxidine. The time of immersion depends on the amount of rust to be removed. When all rust has been removed the job should be thoroughly cleansed with cold water and finally rinsed with hot water to allow a quick drying. The Deoxidine should not be allowed to dry on the metal before it is washed with water.

After cleaning of the metal it should be quickly transferred for phosphating as much loss of time may cause

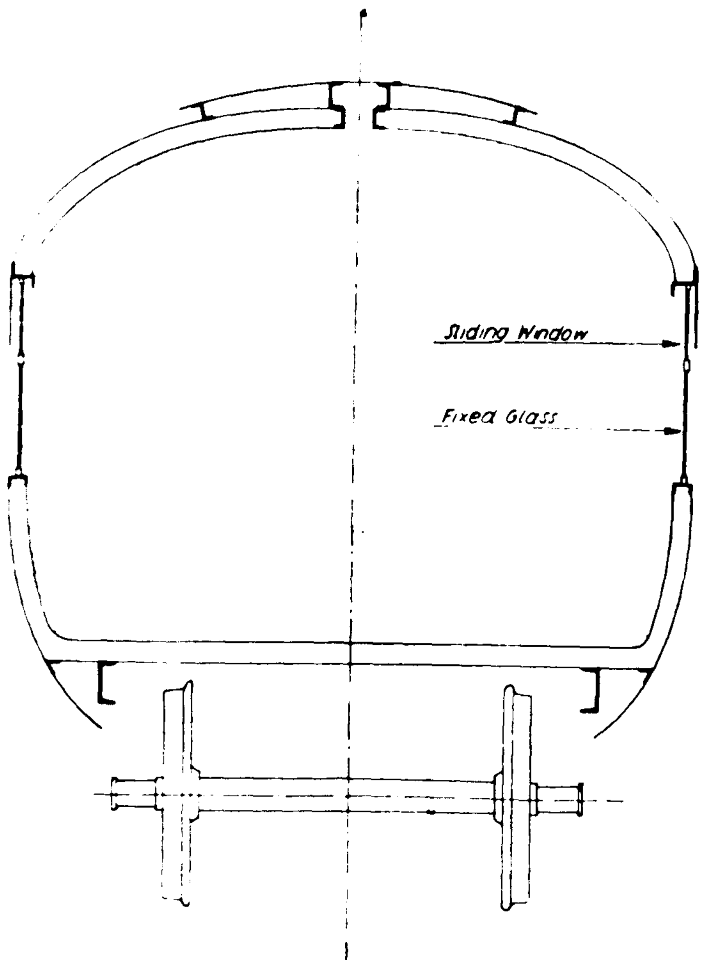


Fig. F.

the metal to start rusting again. For this purpose another I. C. I. product may be recommended which is known as Granodine solution and the operation called Granodizing. The plant consists of a 100 gallon tank of stainless steel or of heavy mild steel, a cold water rinse tank and a hot water rinse tank. The Granodizing solution of 100 gallons capacity is made up of the following chemicals with water :—

Granodine starter 2 gallons.
Granodine " H " —4½ gallons.
Toner Crystals—½ lb.

The sequence of operations is (a) immersion in ' Granodine ' solution from 2 to 5 minutes at 160° F. to 170° F., (b) rinsing in cold running water and (c) immersion in hot acidulated water rinse to assist in quick drying. The hot water is acidulated with a very weak solution of " Deoxylyte " mixed in the ratio of ½ pint to 100 gallons of water. The acid solution is used to counteract any alkaline material present after rinsing.

It should be remembered that these phosphate coatings are not rust proof in themselves and so the metal should be painted without any loss of time to give a permanent protection from rusting.

In cases of large work such as coach shells, underframes or sub-assembled roof structure, where it is not possible to dip them in any Deoxidine or Granodizing bath, only brush application of Deoxidine is suggested. A solution of Deoxidine and water in equal parts should be applied very generously, flowing it on like varnish, by a long handled brush. After leaving it wet for a few minutes this solution is to be washed down with water before it turns sticky. As soon as it is thoroughly dry, which may be done by rinsing with hot water, the surface should be covered with some protective paint without much loss of time. Unnecessary delay may start rusting again.

Another suggestion in this respect may be made of using metallic soap. Lead soap formed from linseed oil may, in the presence of water and oxygen, yield a solution which is non-corrosive to steel.

DESIGN OF THE COACH SHELL

Before designing the shell we should try again to remember the different causes of corrosion. We know that the projected portions outside the shell have a tendency to collect dust and moisture and start corrosion. The figures A and B give the cross-sections of mild steel angle weather strip and mild steel channel rain water gutter used on railway coaches and arrow marks will clearly show where the dust and water collect and real corrosion originates.

So, my suggestion would be to avoid those fittings altogether and allow the rain water to flow down washing the dust and dirt along with it. Now, let us come to the joints and the figures C, D and E will show how

rivet heads, welding seams and lap joints help in starting corrosion.

I would suggest not to have any lap joints on the outer shell at all and the rivet heads and welding seams should be thoroughly ground and polished to make them flushed with the panel. In that case no foreign particle would be able to settle, the surface being very smooth.

The figure F is a cross-sectional sketch of the outer shell of a railway carriage and this would be my suggestion for designing a carriage body. Of course, the inside structure has not got much to do with corrosion. It will be noticed that the outer shell has been made as smooth as practicable, reducing the outside obstructions to minimum. The Weather strips and rain water gutters have been completely avoided and the roof and the bodyside panels are overhanging the bodyside windows and underframe solebars respectively. The roof will stop the rain water coming in the compartment even if the sliding window is open for ventilation. The ventilators have been replaced by a third roof running along the full span, attached to the roof with small lengths of channel and Z sections. The cant rails and waist rails are also made of simple Z and channel sections respectively.

PROTECTIVE COATINGS

The application of protective coatings is though a secondary operation after the pre-treatment of metals, it is in no way less important than any other and should not be neglected. It may be any paint or a metallic coating. Any coating of non-ferrous metal will prevent rusting of steel. Different tests and experiments have revealed that zinc is the most valuable metal in this respect and a zinc coating 3 mils thick will keep the steel safe for at least 5 years in an industrial atmosphere. Recently another metal coming to importance is aluminium. A sprayed aluminium coating about 4 mils thick (O. 8 oz. per sq. ft.) would be equally effective. These metal sprays may be safely recommended for application on coach roof, which has to stand the maximum effect of atmosphere.

The most important point to be considered for paint coatings is the selection of priming coat. It is the priming coat which gives the protection to the metal and helps in building the finishing coat. Any zinc rich paint may be suggested for this purpose as zinc dust remain so compact that they are in continuous electrical contact and give a very good adhesion to outer paint. Any other paint containing lead is also equally useful.

Another new product called Cementiferrous paint is also very good protective on steel surface. This paint contains zinc dust mixed with a solution of chloride, phosphate or other suitable compound in water. When brushed on a steel surface, even if it is wet one, the mixture sets quickly to a hard, adherent and protective cementlike mass. Cementiferrous paint has valuable properties particularly as primers under ordinary oil paint and is highly suitable for application on the underframes and other under-carriage parts.

The application of sprayed limpet asbestos insulation on the inside of the panels stop condensation on the surface and is a very good protective against corrosion. This may be further recommended for the Indian coaches as an insulation against heat, which is very essential.

The application of liquid plastic on the finished outer surface will give a very good protection against any action of moisture on the panel. The liquid when thoroughly dried up will leave a very hard thin glossy layer of synthetic resin which is fully impregnable by any chemical substance. This can be applied either by hand brush or by spray gun. This is highly suitable for exterior use in tropical countries.

The liquid plastic solution produced by the Saro Laminated Wood Products Limited is known as "Sar-Rez" finish and is composed of two parts. The part A contains high viscosity resins and the part B the acid catalyst which brings about the curing of the resins. They are to be mixed in the ratio of 4 parts of A to one part of B and the mixture should not be allowed to remain more than two days before application. For brush application approximately 5% of No. 2 thinners is to be added and for spraying a viscosity of 30 seconds at a shop temperature of 68° F. is recommended, which can be obtained by the addition of 10% of No. 2 thinners. It is essential to use a non-metallic mixing pot.

After the coat of plastic thus applied by spray or brush is thoroughly dry, the surface should be flatted down with wet-or-dry silicon carbide paper. Then the surface is to be thoroughly burnished with Sar-Rez Burnishing Paste followed by Sar-Rez Polishing Compound. Burnishing may be carried out mechanically by power driven or pneumatic burnishing wheel and this will give a very highly glossy weather resisting surface. The liquid plastic has been found to be heat and fire proof.

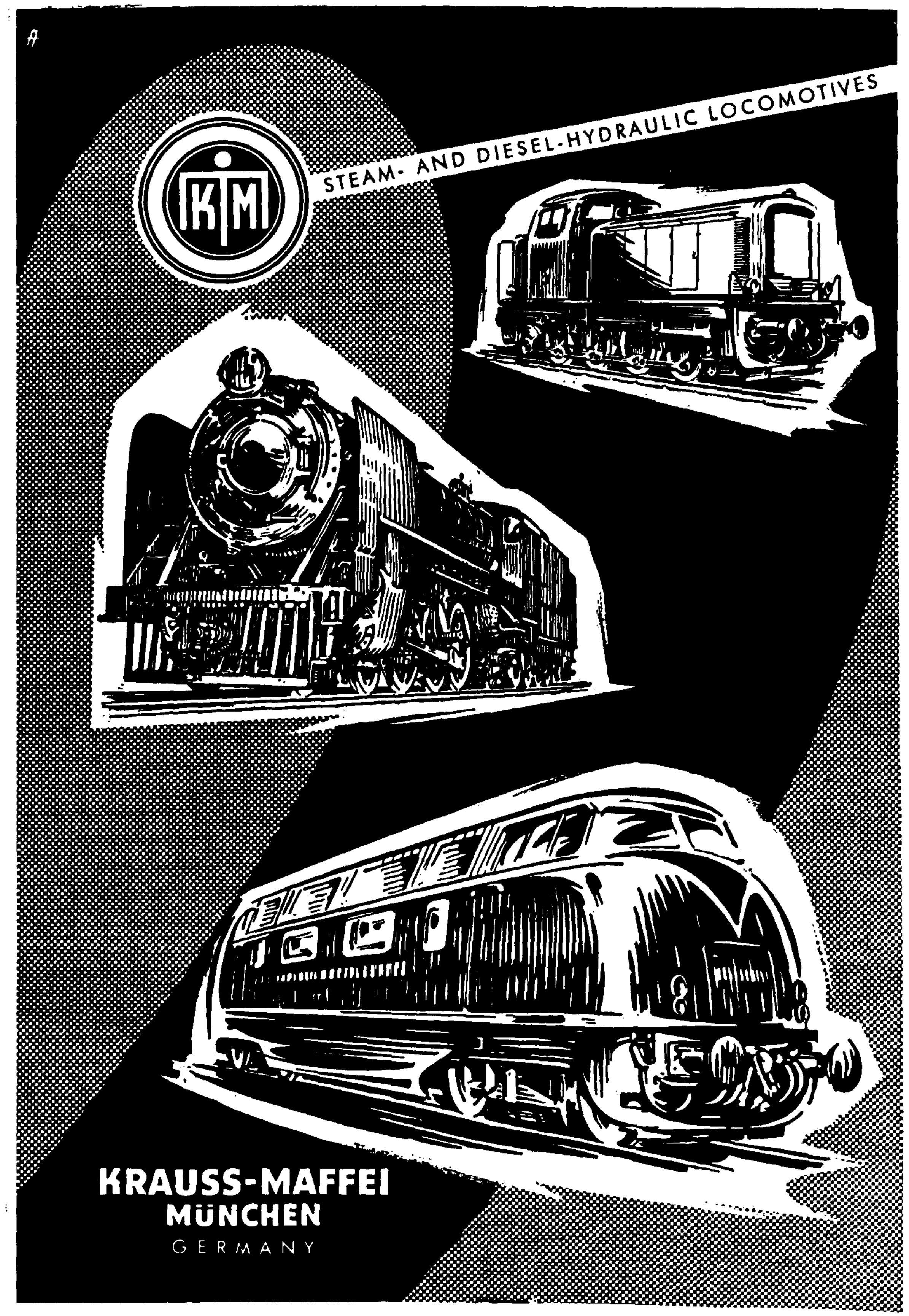
THE THIRD WOODHEAD TUNNEL

By H. C. Towers, M.I.E.E., M.Inst.T., Fellow P.W.Inst.

THE first direct railway between Manchester and Sheffield, known as the Sheffield, Ashton-under-Lyne & Manchester, was opened in sections, the first portion being brought into public use between Manchester (Travis Street) and Godley on 17th November 1841. The line between Manchester (London Road) and Sheffield (Bridgehouses) was formally opened with appropriate celebrations on 22nd December, 1854. This could only be done after the completion of the Woodhead Tunnel, a piece of work which cost, in those days, £ 200,000.

This tunnel runs under the Pennine Range and it was originally proposed that it should be a double track tunnel but to cut down the cost it was decided to bore the tunnel for a single line only. The locality of the tunnel was a wild and desolate spot and it was necessary to make over four miles of cart road across the moors for the conveyance of coal and material from the main roads. The building of workmen's cottages, stables, magazines and the erection of the essential plant occupied many months. In September 1839 a serious start was made.

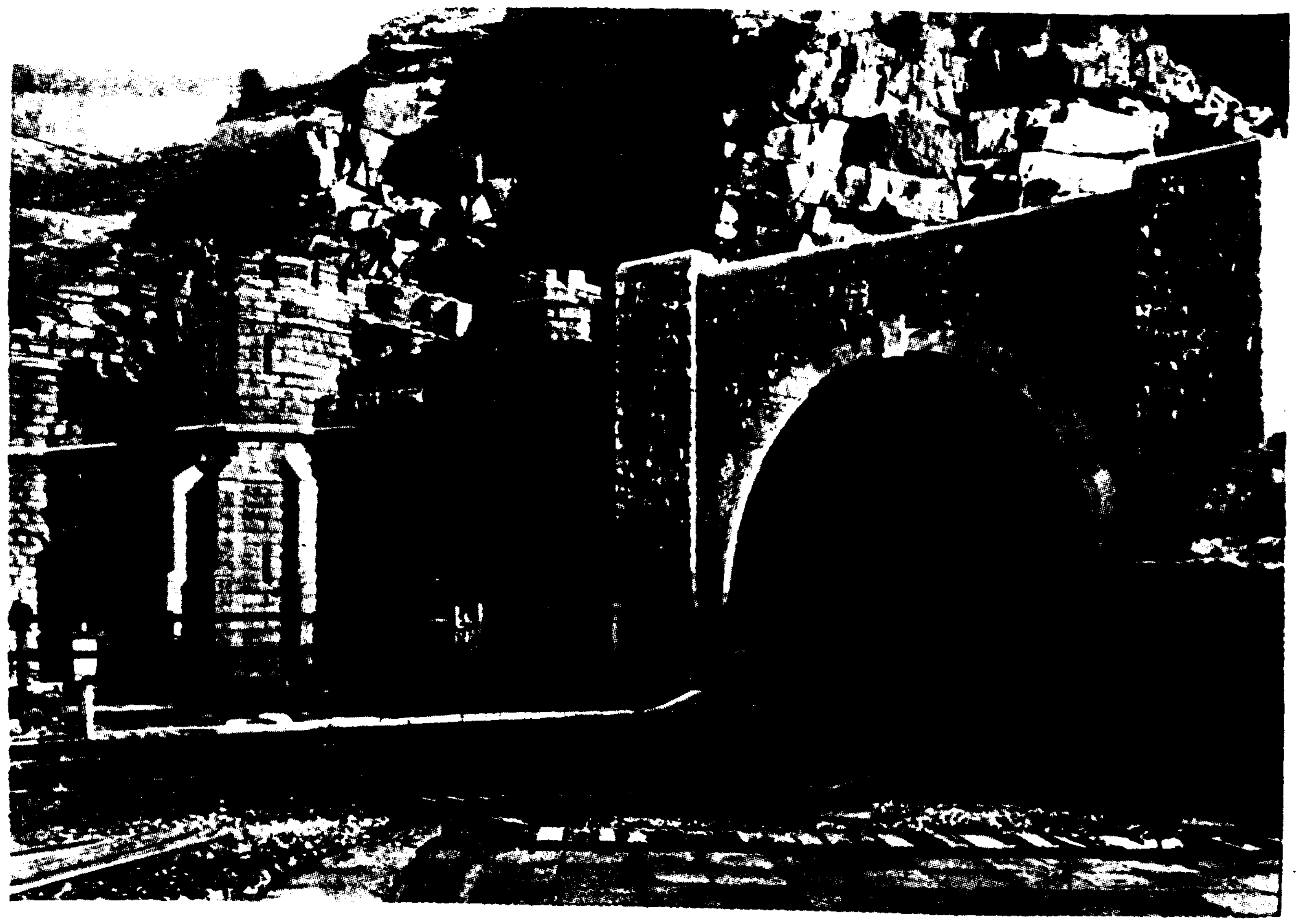
The Woodhead tunnel was built on an inclination of 1 in 201 rising in an easterly direction. For most of its length it was driven through huge millstone grit beds with which occasionally alternated argillaceous shales and milder forms of sand-stone, the remainder through slate formation and clay. Construction was accomplished by working from each end towards the centre and by means of five verticle shafts each having a diameter of about 8 feet. In each shaft a set of 9 inch pumps was provided, these being worked by a 20 h. p. steam engine. The sinking of the verticle shafts and the driving of the horizontal driftways were carried out by the Sheffield,



Ashton-under-Lyne and Manchester Railway. The arch of the tunnel was in the form of a semi-ellipse, the maximum height being 18 feet above rail level and the width 15 feet at rail level. Two open side channels, 18 inches wide and 24 inches deep were cut for drainage. Throughout the length of the tunnel 25 side arches or manholes were built, 6 feet deep into one side at intervals of about 200 yards, to facilitate the construction of a second tunnel should this eventually be needed.

The period of construction took over six years and although as many as 1,500 men were engaged in the work, a more general average was about 400. Some 15.7 tons of gunpowder were used in blasting, 8 million tons of water were pumped out and the total quantity of excavation was about 272,700 cubic yards. The tunnel was inspected by General Pasley, the Government Inspector of Railways, on 20th December, 1845, who apart from expressing his satisfaction declared that it was one of the finest pieces of engineering he had ever seen. Extending for a distance of 3 miles 22 yards it was, at that time, the longest tunnel in the country.

The single line through the Woodhead tunnel soon became a serious operating bottleneck. In 1847, work on a second tunnel was begun. The new tunnel, which

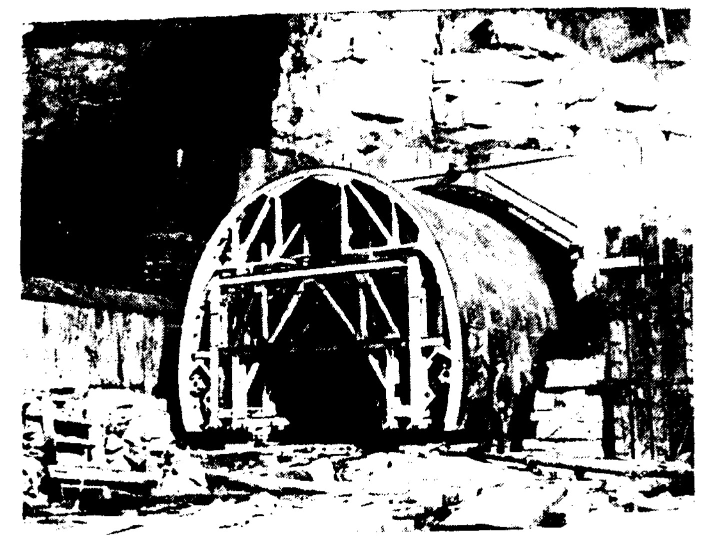


Woodhead portal of the new tunnel showing the old portals alongside.

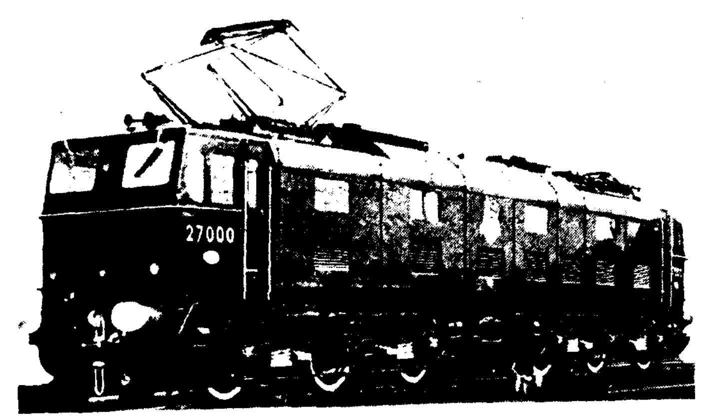
was to accommodate the up road, was driven alongside the original one, with which it was connected by the 25 manholes previously mentioned. In 1849 there was tragedy at the Woodhead end, 28 of the men succombing to cholera. On 2nd February, 1852, the second tunnel was opened to traffic.

In 1889 a system of communication was provided. Each of the 25 manholes was provided with two hand plungers, one for the up line and one for the down, a single stroke bell being applicable to both lines. By means of a comprehensive code, train crews could report their position and also any difficulties, to the signal boxes at each end of the tunnel. The ventilation of these tunnels has always presented a difficulty and they are supposed to have possessed an odour of their own which could be tasted as well as smelt. The problem of adequate ventilation occasioned the abandon-

ment of a signal box installed in No. 12 manhole for operating intermediate signals provided on the up road so as to increase its capacity. This box was opened just prior to 1902 and closed about seven years later. Signalmen prepared to man the box on a reduced shift of six hours were not easy to find, whilst the smoke made the reading of signals and the observations of tail lamps extremely difficult. Also drivers stopped by signals found starting difficult due to the rising grading. Better ventilation was obtained by the doubling of the diameter of verticle shaft No. 2, a lengthy task started in October 1912 and completed in 1915.

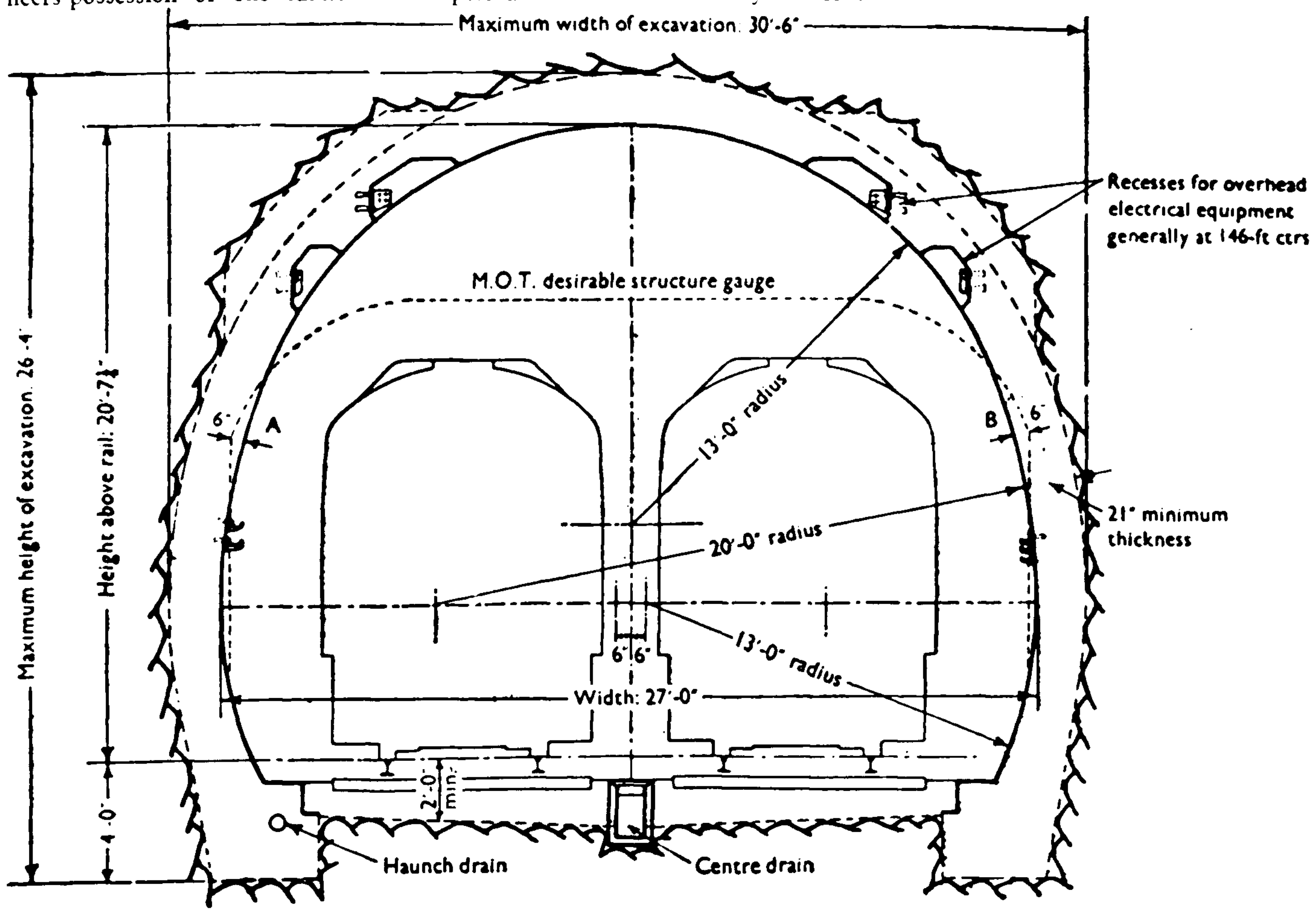


First 20—feet section of travelling steel shutter assembled at Woodhead.



Co-Co- electric locomotive built for Manchester Sheffield electrification and which hauls trains through the third Woodhead tunnel.

The traffic through the Woodhead tunnel has averaged 80 or more trains each day in each direction, 9 out of every 10 being coal trains or empties. As the tunnels were completing their century of useful service their rapid deterioration became increasingly apparent and chiefly in the disappearance of mortar in the joints of the stone lining. Maintenance was difficult owing to the increasing volume of traffic and weekend possession was insufficient to keep abreast of the repair work. In 1946 it was decided to work single line, giving the engineers possession of one tunnel over a period of nine months and then change over to the other for a similar period. This necessitated the diversion of traffic to other routes since the single line could not cope with all of it. The period of possession was still not sufficient and taking into consideration the operating difficulties with single line working and the age of the tunnels, it was decided that the construction of a new tunnel was the only solution.



Scale : 1 inch = 10 feet

Typical Cross-Section, showing M.O.T. Structure Gauge and Eastern Region Stock Gauge

Typical cross section.

Several proposals were put forward which covered the construction of a new single line tunnel and repairs to one of the existing tunnels, two new single line tunnels and a new double line tunnel. The Board of Directors of the then London and North Eastern Railway accepted the engineers recommendation for a double line tunnel and Parliamentary powers were obtained in 1947. Other works had also to be undertaken in conjunction with the proposed new tunnel, remodelling of approach track layouts at both the Woodhead and Dunford Bridge ends and the construction of new platforms and station buildings at these places.

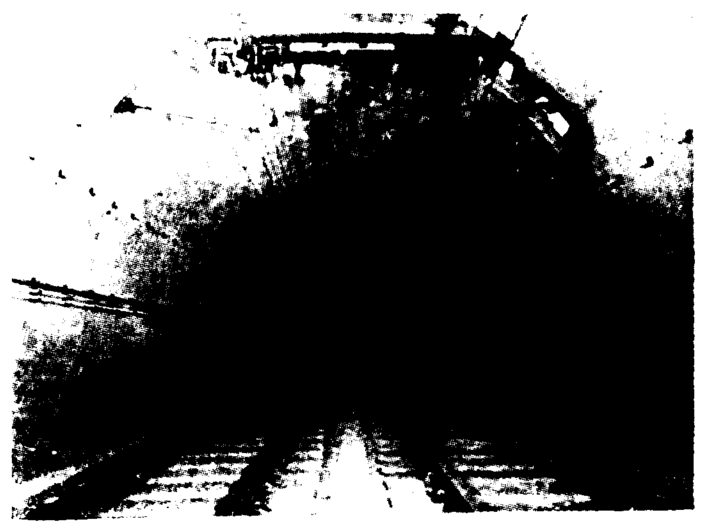
After detailed consideration it was decided to construct the new bore on the south side of its predecessors at a distance of 100 feet from the centre of the existing down line. The old tunnels are completely straight and it was planned to maintain the distance of 100 feet throughout except for a section of 600 feet through blocky sandstone at the Woodhead end where the new tunnel curves on a radius of 40 chains to permit an easy connection with the existing alignment of the approach track. The new tunnel was planned to rise 1 in 129 from the Woodhead end and then to fall from the centre 1 in 186 towards Dunford Bridge. This arrangement was adopted so that if in future it became necessary to increase the capacity of the line by permitting two trains to be on the same line in the tunnel only an alteration in signalling would be necessary.

Before work could be started it was essential that adequate accommodation be provided for the 1,100 workmen who would be engaged in the task particularly as the site was several miles from the nearest town and desolate in winter. A small township sprang up at the Dunford Bridge end of the tunnel complete with 48 wooden sectional dormitory huts, wooden bungalows for the Resident Engineer and senior supervisory staff, cinema with change of programme three times a week, recreation hall, dry and wet canteens, first aid and sick bay hut, retail store and post office.

On 15th November 1948 the newly constituted Railway Executive gave authority for the work to proceed and it started in February 1949 and the target date for completion was 3½ years later. Messrs. Balfour, Beatty & Co. Ltd. were the contractors and since they had been engaged in the repair work of the old tunnels they had local knowledge of the working conditions. The contractors planned to drive a pilot tunnel 12 feet wide by 12 feet high from each portal and from a central verticle shaft thus giving four working faces and on completion to enlarge the pilot tunnels by radial drilling from the portals. The pilot tunnel was completed on 16th May 1951 in the time estimated but in the meantime success met elsewhere with radial drilling was not experienced at Woodhead the results being most disappointing. The process had to be abandoned.

This set back created a serious problem of re-organisation since with only the four enlargement faces available it was unlikely that by the alternative method of face drilling could faster progress than 20 to 30 feet be achieved this being about half of that required. It was decided to open up additional enlargement faces and plans for this move were in hand when on 8th June 1951, with only a few hours warning, a length of 72 feet of enlarged tunnel at the Woodhead end, driven through shale and strengthened by steel jibs collapsed and completely blocked access from that portal. This obstruction to progress, which took six months to work through, was overcome by driving a haulage way around the blocked area at a distance of 50 feet and opening a new break up with two working faces. This was successful and at the same time a similar collapse threatened at the Dunford Bridge end. The threatened section was strengthened by additional steel ribs and another diversion haulage way, 600 feet inside the portal, was driven so that yet two more working faces could be brought into use. The expedient adopted to cope with the collapse became the solution to the problem of access for ultimately no less than 9,500 feet of by-pass tunnel were driven to permit the working of nine enlargement faces simultaneously.

The enlargement of the pilot tunnel was undertaken in stages; first the floor was excavated to the level of the finished tunnel and then face work was started on the



Photograph, taken one mile inside the tunnel from the Dunford Bridge end, shows the overlap span on the catenary equipment.

(Photographs by courtesy of British Railways)

enlargement. Much of the work was done full face using a steel gantry on rails which not only employed drilling platforms but equipment for erecting the steel arch ribs. These were installed closely behind the excavation as the actual work of drilling was accomplished the proximity of the two operations acting as a safeguard against further falls. 5,900 tons of steel were used for supporting the roof of both pilot and main tunnels. The drilling was done by light, hand guided type of machine mounted on a single, air operated supporting leg giving a power thrust. About 32 holes were drilled for the pilot face and 55 for the enlargement, the depth varying from 6 to 10 feet, according to the type of rock. Polar Ammon "B" gelignite, with electric gasless delay detonators, was used for explosive and an average of a little less than 2¼ lbs. per cubic yard was needed for the whole work.

Owing to the proximity of the existing down main line tunnel to the new one, and over which heavy traffic was passing every precaution was taken during blasting. Site tests previously made by the Imperial Chemical Industries' explosive engineers had shown that no harm could occur but public safety was put first and inspection was carried out after each blast. Telephones were installed at each blasting place and at corresponding opposite points in the down line tunnel all being connected to a switchboard in Dunford Bridge signal box. When the foreman in charge of blasting was ready to fire, he informed the signalman. The latter gave the "all clear" as soon as a train had cleared the tunnel and stopped further traffic entering until a railroad patrol man had inspected the line immediately after the explosion and reported back to the signalman there was no obstruction. There was a very good spirit of team work and co-operation between the contractor's staff and the railwaymen which resulted in a minimum of delay to the tunnel or to traffic.

Owing to the Manchester-Sheffield-Wath electrification no steam train would pass through the new tunnel, it was possible to use ordinary Portland cement throughout for the lining. It was originally intended to start the lining as soon as the enlarging had reached 500 feet from the portal but the failure in radial drilling caused this plan to be changed. To concrete the side walls and each in long lengths and in one operation, apparatus known as a travelling steel shutter was used, one of 100 feet length at the east end of the tunnel and another 80 feet long at the west end. Each consisted of a steel framed carriage running on bogies on the two, outer narrow gauge tracks (four 2 ft. gauge tracks were laid in the enlarged tunnel). Above the carriage, to which it was linked only by levers and a row of screw jacks, rode a skin comprised of ¼ inch steel plates between 8 inch by 14½ inch box girder ribs which were fashioned to the profile of the tunnel lining and hinged along its apex. Thus, by jacking down, the two halves of the skin moved downwards and inwards, approximately radially away from the profile.

The larger of the two shutters weighed 230 tons and was designed to support about 6 feet. Thickness of wet concrete over its span of 27 feet so the rails upon which it ran had not only to be firmly fixed but most carefully positioned on a concrete base for they in fact determined the setting of the whole lining. With the shutter in position, dry batches of concrete were brought in from the portal by train of two bogies each carrying six hoppers to the mixers which were placed as close as possible to the shutter. After mixing the concrete was conveyed to the shutter by 4 inch diameter concrete pumps at the rate of about 10 cubic yards per hour. About 150,000 cubic yards of concrete were used in the lining.

With the completion of grouting and drainage, the work of laying the permanent way was commenced. The first track was laid by hand but the second was pre-fabricated and put down by track laying machine. The overhead line traction equipment consists of steel booms mounted on brackets recessed in the tunnel walls and spanning both tracks. From these booms is supported, at a uniform contact height of 15 feet, the overhead wiring which conveys 1500 Volts DC to the pantographs of the locomotives. The wiring consists of 0.321 sq. in. hard drawn copper catenary, 0,191 hard drawn copper auxiliary catenary and 0.30 sq. in. cadmium copper wire and the supports are normally located at 146 feet intervals. There are 42 telephones in the tunnel, at 660 feet intervals all communicating with Dunford and Woodhead signal boxes.

The new signal boxes will control the working of traffic through the tunnel by means of colour light signals, alternating current track circuits and mechanically operated points. The signalling is so arranged that both the up and down lines may be used for either way working in an emergency for which special single line token instruments have been installed. Electric lighting is provided throughout the tunnel on both sides, the lamps on the down side being continuously alight at reduced voltage controls in both Dunford and Woodhead signal boxes enabling full lighting to be switched on for maintenance purposes or in case of emergency. The lamps at each side of the tunnel are spaced at 132 feet and staggered to give illumination at intervals of 66 feet when full lighting is in use.

The new tunnel at Woodhead is not only the outstanding civil engineering achievement of 1954 but one of the greatest tunnelling works undertaken in Great Britain during the present century. Commenced in February 1949 the tunnel itself was completed in October 1953 at a cost of £4½ million pounds, ½ million cubic yards of rock were excavated. There were only six fatal accidents during the construction as against 26 with the former tunnels.

The tunnel was declared open on 3rd June 1954 by Mr. Alan Lennox-Boyd, Minister of Transport and Civil Aviation at a ceremony held at the Woodhead portal. He was accompanied by Sir Brian Robertson, Chairman, British Transport Commission, Sir William and Lady Halcrow, Consulting Engineers for the tunnel, regional officers and guests. After the Minister had made a short speech he pressed a button which unveiled a commemorative tablet. The party then boarded a special train hauled by a BO-BO electric locomotive which broke a tape stretched across the tunnel mouth and traversed the tunnel to Dunford Bridge. Later, a luncheon was held at the Royal Victoria Hotel, Sheffield.

Chemical Treatment of Locomotive Feed Water—Internal Treatment

By V. P. Shivdasani, B.Sc.

INTRODUCTION

LOCOMOTIVE availability—making the most use of given locomotives has always been an important matter to a Railway Engineer.

Locomotives have to be returned to home shed/workshop for :—

(a) inspection, maintenance and overhaul of various components of the engine;

(b) inspection, maintenance and overhaul of locomotive boiler which may comprise of descaling, retubing or other replacements due to damage from the water or a boiler wash-out to prevent high concentration of dissolved solids suspended matter in the boiler water to prevent priming and carryover.

Recent advances in techniques of metallurgy and lubrication have enabled the frequency of the visits to Workshops for engine repairs to the minimum and the aim of the correct water treatment, therefore, should be to increase the periods between washouts to coincide with the visits to workshops sheds for reasons given under (a) to obtain the maximum availability of the locomotives.

VARIOUS METHODS OF TREATMENT

The treatment of locomotive feed water may be divided in three classes viz.

(a) External treatment involving the installation of softening plant at water columns.

(b) Way-side treatment involving installation of simple apportioning equipment at each watering point.

(c) Individual locomotive treatment.

This article deals with the individual locomotive method of treatment which is becoming increasingly popular as it enables groups of locomotives to be put under treatment without interference with other links and minimises capital expenditure. In this method, the treatment which may be applied in the form of a mixture of chemicals dissolved in water to make a concentrated solution or in the form of briquettes may either be injected directly to the boiler or allowed to be mixed in the tender tank water.

SOME METHODS OF APPLICATION

I. Direct Injection.

This method is used when a chemical solution is the best form of treatment or when it is preferred to use mixed powders and make them into a solution rather than use the equivalent formula in the briquette form. The chemical solution is added to the reservoir of a proportioning pump driven by some moving part of the locomotive, such as the crosshead. By means of this arrangement the chemical is injected into the boiler in direct proportion to the distance travelled by the locomotive, and if the quantity and quality of water taken by the locomotive for a given trip are known, the distance travelled by the locomotive, and hence the amount of chemical injected into the boiler, can be correlated to the water consumption.

II. Feeding Chemicals to Tender Tank.

(i) Powders.

If powders are used, these may be dissolved in a tank with a suitable apportioning device fitted to the locomotive. The apportioning gear must feed a predetermined portion of chemical to the water in the tender/tank.

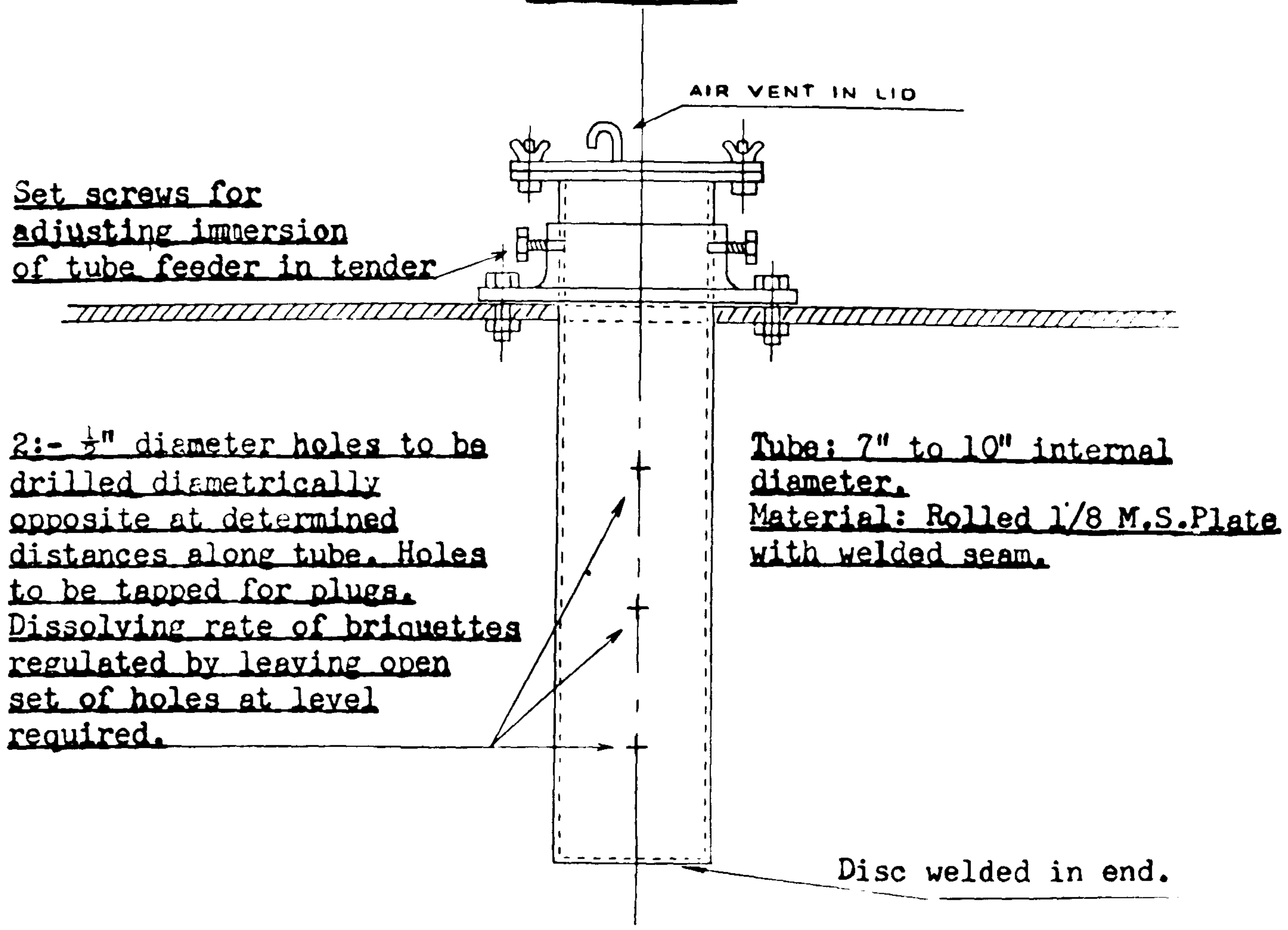
(ii) Briquettes.

The method of application of the treatment can be simplified if the required chemicals are added in the form of briquettes.

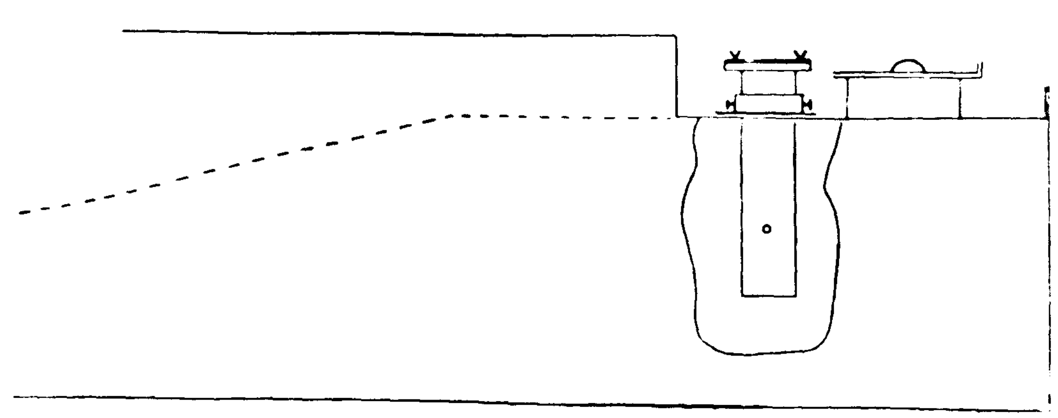
In this method the various chemicals are manufactured as small cylindrical bri-

'ALFLOC' BRIQUETTE TUBE FEEDER

3 - Day Type



Arrangement showing tube feeder fitted to locomotive tender.



quettes which are placed in a tube feeder installed on the tender or tank.

The tube feeder itself is merely a tube some 7–10" diameter and about 3–4' long filled with briquettes; its dimensions depending upon the required capacity (see sketch on page 46).

The feeder is inserted into the water in the Tender through a suitable opening made in the Tender top plate (see sketch on page 46). From the sketch it will be seen that the tube feeder can be raised or lowered in the tender and its depth of immersion varied by the set screws which hold it in position. The lower portion of the feeder acts as an ordinary continuously replenished reservoir of chemical treatment in which upper layer of briquettes slowly dissolve to form a saturated solution which gradually but evenly dispenses away over a period of several days. The tests on the device have shown that it can operate satisfactorily for a period of at least 3 days. If a locomotive fitted with a tube feeder moves to another " Link " the depth of immersion of the liquid level retained can be very quickly varied to suit the new conditions by raising or lowering the tube and by raising or lowering the liquid level by means of the removable side plugs.

PRINCIPAL ADVANTAGES OF BRIQUETTE TUBE FEEDER

1. The feeder is very cheap to construct and fit to a locomotive.
2. It can be filled by unskilled labour and needs no other adjustment while running.
3. The tube feeder requires practically no maintenance to keep it in good order.
4. The system is flexible and can be applied to any grade of locomotive and can be used as a complete treatment for hard waters or merely as a conditioning treatment for partially softened feed waters.

CHEMICALS REQUIRED FOR INTERNAL TREATMENT

The mixture/briquettes used for Internal Treatment of Locomotive boiler must consist of:—

(a) Alkali for precipitating permanent hardness of water and providing adequate alkalinity for inhibiting corrosion.

(b) A suitable anti-incrustant for conditioning the precipitates in a free flowing state so that these are easily removed during the normal blowdown.

(c) A suitable inhibitor to prevent feed line and injector deposits.

(d) An Antifoam to inhibit priming and carryover.

SCOPE OF THE METHOD

The treatment chemicals required and the quantities necessary are based on the composition of the so called average feed water which is the proportionate mixture of each separate water supply picked up by a locomotive during a given run.

Under the normal conditions an ' average feed water ' of upto 20 parts per 100,000 in hardness can be dealt with by Internal Treatment, although satisfactory results have been obtained with full treatment of raw water upto 46 parts per 100,000 containing a high proportion of permanent hardness. Usually when the average feed water of any link is higher than 20 parts per 100,000 it is preferable to install softeners at watering stations where the hardness of the water is high and soften these waters partially or fully to bring down the average feed water to below 20 parts per 100,000 provided the volume of water taken at such point is sufficient to warrant the installation of a softener. This limits the amount of precipitates (sludge) produced in the boilers and lessens the need to blowdown mainly for sludge removal which can be a limiting factor in some cases. This is an important point to be considered now that Antifoams are used because this permits a much higher concentration of soluble salts and sludge in the boiler water than previously. The above factors are given for general guidance only and in practice careful survey of local conditions on each section should be made before prescribing the treatment.

In order to get the best results possible it is essential that :—

(a) 100% water picked up on a given link is treated;

(b) boilers are blown at regular intervals to keep the dissolved solids of the boiler water at optimum condition and to prevent undue accumulation of sludge. If the hardness of the average feed water is within the limits given above, blowdowns can conveniently be confined to sheds terminals;

(c) efficient washout at regular intervals;

(d) adequate control of all phases of water treatment operation particularly of the condition of the water in the locomotive boiler.

BLOWDOWN

There are two methods of blowing down either or both may be used according to local conditions.

(a) *Continuous Blowdown.*

This may be operated from a point which is below the normal water level in the boiler and should operate on an automatic valve so that blowdown functions only when the locomotive is in motion. The continuous blowdown may be discharged into ash-pit under the boiler to prevent damage to the permanent way. The advantage of continuous blowdown is that it enables the rate of deconcentration of the dissolved solids and free flowing suspended solids to be controlled in balance with the rate at which they concentrate. Experience has, however, shown that the sludge removal is not efficient with this system.

(b) *Intermittent Blowdown.*

Intermittent blowdown is usually a manual operation and should be done preferably in a suitably designed pit in the locomotive running shed at the end of day's work. The advantage of intermittent blowdown is that since a pick up pipe of a large diameter is invariably located over the foundation ring it removes an appreciable amount of sludge with a relatively small amount of blowdown water. In some cases when the hardness of the feed water is high it may be necessary to operate the intermittent blowdown on the track to prevent accumulation of large volume of sludge.

It would be appreciated from the foregoing that whereas the intermittent blowdown is based for removing accumulated sludge continuous blowdown enables concentration of dissolved solids to be readily controlled. The two types of blowdowns may, therefore, in certain cases, be complimentary i. e. the continuous blowdown used during normal running is supplemented with intermittent blowdown e. g. on returning to the Works sheds on the end of day's run.

With the development of Antifoams, it is possible to carry much higher concentration than it was possible before. With a suitable 'Antifoam' the concentration of dissolved solids in the boiler water can safely be raised to 1,500/2,000 parts per 100,000 before priming and carryover may take place.

With Internal Treatment the sludge formed in the boiler may set the limit on the permissible concentration. Experience has, however, shown that if the hardness of the average feed water is not more than 30 parts per 100,000, the blowdown can conveniently be confined to sheds/terminals.

CONTROL

The control system needed is simple, but requires continuous effective operation to obtain correct results. This should consist of unified central control, a proper stocking and supply procedure, regular maintenance of equipment and continuous testing and control of the composition of water in the locomotive boilers. The keynote of the control system is maintaining the correct values of the water in the locomotive boiler. In the initial stages the boiler water will require testing each day for hardness, alkalinity and dissolved solids by simple and rapid field methods but later on the frequency of the water testing may be reduced to 2/3 times a week.

A suitable recording method which ensures prompt action is also an essential part of the scheme. A suitable procedure for a given link should be drawn up depending on the local conditions.

RESULTS ANTICIPATED

Experience has shown that if the Internal Treatment as described above is correctly operated within its defined limits it is capable of entirely preventing the scale formation, corrosion, undue accumulation of sludge, foaming in the boilers, and greatly extending the periods between boiler washouts.

Welding Technique in the Construction of Railway Bridges of Steel

By Graduated Engineer C. Fuchs, Bochum,

of Messrs. Aug. Klonne, Dortmund.

WELDING technique applied to railway bridge building looks back already on a development of 25 years which has not been entirely free from set-backs, particularly during the thirtieth, though in the end, the systematical investigation of the causes of such set-backs proved to be valuable in yielding important information and promoting the development of this branch of science.

The former German Reichs-Railway, and the present Federal Railway may claim to have always participated in a leading position in this development, so that, notwithstanding the initial difficulties, railway bridges subject to severe dynamical stresses can now be designed in completely welded construction.

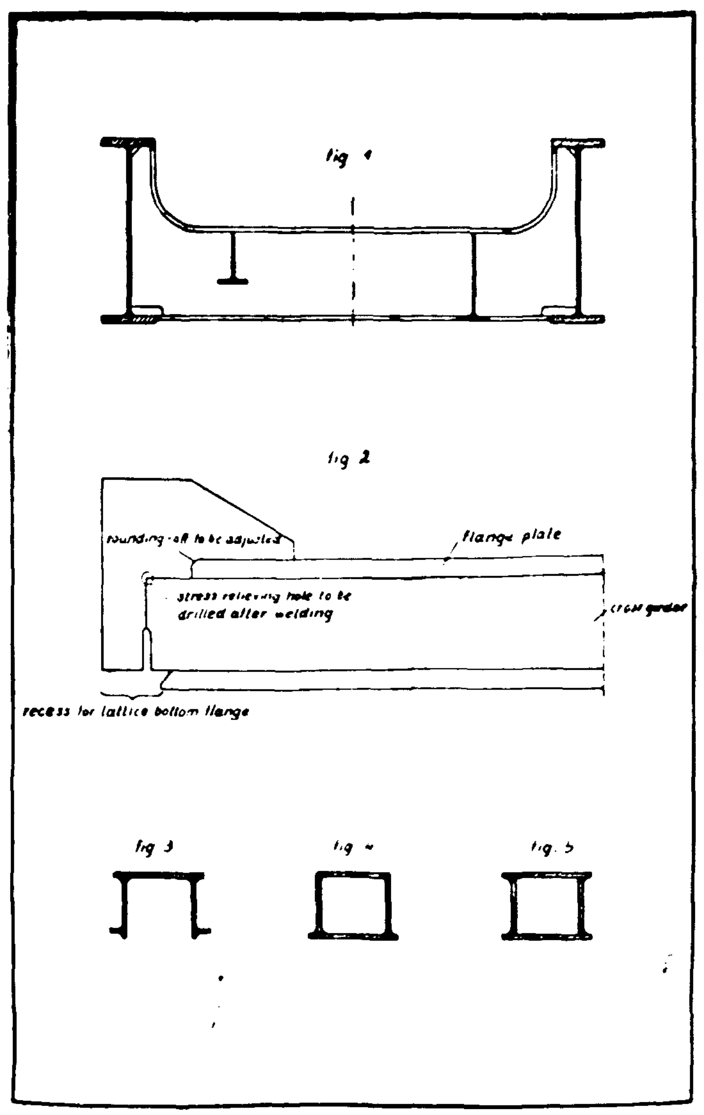
Three factors are mainly decisive for a trouble-free performance: First of all, the material used must be suitable for welded structures i. e. it must be resistant against ageing, and proof against breakage due to brittleness; then, the structural design should correspond to the requirements of the welding technique, and finally, the welding methods used are to be adapted to the widest possible extent to the importance and the type of the structure involved.

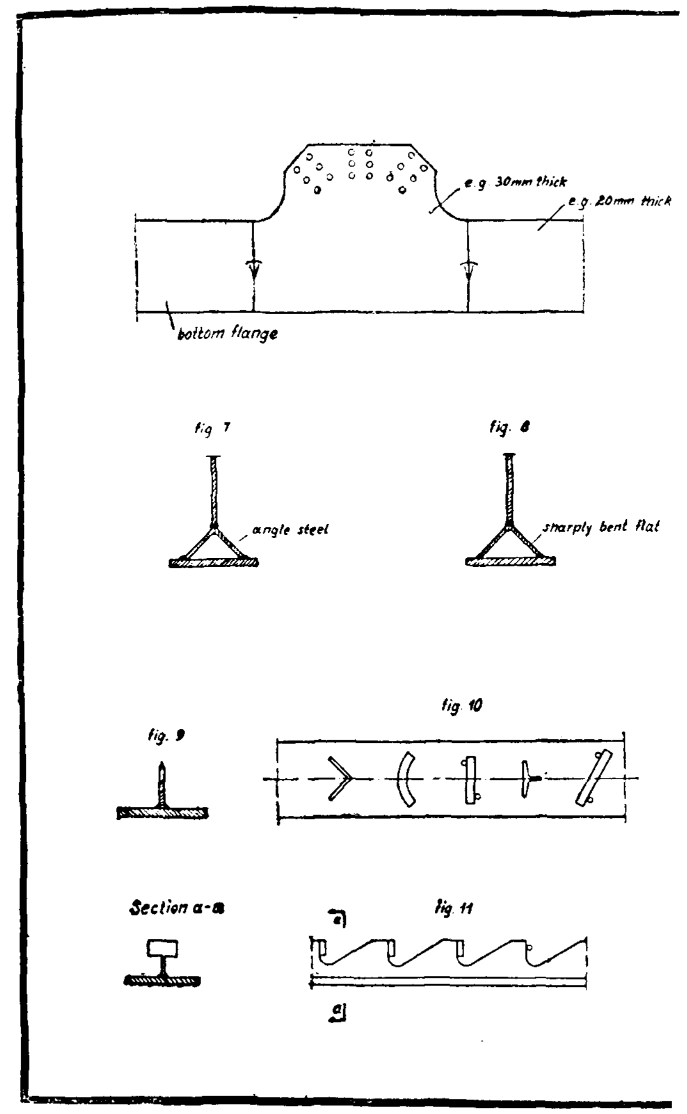
The most noteworthy advantages offered by the welding of bridges are saving of weight of approximately 30%, compared with the riveted design, furthermore, the simplified design preparation and the facilitated ordering of the required material, since plates and broad flats can be used to a considerable extent, and last not least, easier maintenance, and for the designer, the wealth of ever new structural possibilities, offered by the proper application of the welding technique. That the German Federal Railways are in a leading position in this field of engineering may be gathered alone from the fact that even at the end of the second World War the Western German Railways (without the French Zone) still had nearly 200 welded railway bridges, of which nearly half were of completely welded design. It should not be unimportant to point out that those welded bridges have withstood for a number of years traffic conditions, in most cases of a severe nature, without any exception.

It has been indicated already that any technical progress, and in particular so the welding technique, requires conscientious attention to every detail of design and construction.

It order to comply with the particular requirements involved, the material is to be carefully prefabricated.

The development of this technique is by no means concluded, as is clearly shown by recent publications. We have been successful, however, in producing types of steel which comply with any justified requirements as long as they are properly treated. It has even been possible to smelt basic converter steel types which can





be used, under certain conditions, for welded structures. In addition, a number of testing methods have been proposed with the object of determining the weldability and welding safety of the respective materials as simple and speedily as possible. The fusing-on and bending test prescribed by the German Railway Authorities requires rather a lot of material, but during all the years of its application it has proved quite valuable, indeed.

Regarding the problem of the type of design, best adapted to welding, can be said that many simplifications are still possible in this field. Committees of specialist engineers and working combines are currently deliberating and publishing structural directives and principles for the various fields of application of the welding technique. An essential principle is the recommendation to make use of butt welding to the widest possible extent. Moreover, in frequent cases it is recommended to provide stress relieving holes at

points of multiple axes of stresses, while large rounding-off, or large coping, shall by-pass such dangerous states of stress, or entirely avoid them. Finally, the designer and the welding engineer should do their best to obtain connections and unions which are notch-free structurally as well as in welding technique.

Regarding the above mentioned preference of butt welds, a trackway design has been selected for several Federal Railway bridges which is diagramatically shown in figure 1. The bridge in question is trough-shaped and provided with a bed of broken stone metal, while the dish plates and trough plates are butt welded, and simultaneously form part of the top flange of the trackway longitudinal girders. Such structural designs create, of course, slightly greater difficulties in the assembly, though one obtains thus unobjectionable transmission of forces, smooth connections, and considerable savings in weight. Having in mind the necessity to save steel, such a design should be still recommendable *then* even, if no reduction of cost should result.

Picture 2 shows a detail where by subsequent drilling of a point of intersection of welding seams the arising extensive stresses have been avoided.

Box-shaped cross sections also are being used to an increasing degree in the construction of railway bridges. A few examples are shown in figures 3, 4, and 5. The figures show a top flange, a bottom flange, and a filler bar. These completely closed, or, in the case of the top flange, box-shaped sections open on the bottom only, offer an excellent possibility to take large amounts of forces proof against buckling, and also to design the nodal point in the best manner possible.

Figure 6 shows the configuration of such a nodal point. It demonstrates that the gusset plates are continued for

a certain distance into the web plates of the flange concerned, so that that the welding seam is not located directly at the connecting line of the gusset plate.

It is a known fact that in flange plate (broad flats) those welding seams have a particularly unfavourable effect which have been placed into the centre. This has led to types of flange design, sketched in figures 7 and 8. Such designs require, of course, a larger volume of welding material.

A recommendable solution for the design of heavy girders may be seen in the flange plates provided first with a web connecting member, as shown figure 9, and these sections are then stress relieved by heat treatment before they are assembled with the web plate and welded on.

A branch of engineering quite of its own are railway bridges of composite design. For such bridges also we have entirely welded superstructures which have stood the test in practical use. The difficulties arising in this design consist, in general, in the frequently very varying dimensions of the flanges, due to the co-effective influence of the concrete slab. This is detrimental for the workshop manufacture, since the trend to make the cross sections increasingly thinner aggravates the danger of deformation just for such unsymmetrical girder cross sections. The shaping of the anchor stirrups for the transmission of the shearing forces from the concrete slab into the steel girder is by no means yet uniform. Generally used are simple stirrups, or stirrups on heavy rectangular base strips, on half-circular plates, and other shapes also, as indicated in figure 10.

All those anchoring members welded to the top flange produce, of course, transversal welding grooves in the top flange plate, a disadvantage to be compensated by placing a longitudinal rib into the middle of the top flange, or occasionally, by two longitudinal ribs at both sides of the top flange. This design, according to figure 11, has been carried out several times already, its manufacture in the shop is easy, though it is statically often insufficient, since it is not possible to transmit the forces adequately.

The above lines could only touch upon some of the problems which are at present of importance in the design of welded railway bridges. Continued close cooperation of the metallurgical engineer, the designer and the welding expert will in future also prepare the basis for a welding technique simultaneously efficient, saving in material and currently adapted to the engineering progress.

PROTECTION AT LEVEL CROSSINGS

THE effective control of traffic using roads crossing over railways has long been a problem, the prime essential being to permit both rail and road users to be warned and protected from accidents. For many years it has been common practice, especially on busier crossings, to effect protection by level crossing gates, a practice employed to a great extent in the United Kingdom. Some countries insist that such gates be interlocked with the railway signalling system, whilst others depend on the gate man taking the necessary precautions under regulations. In other countries, particularly those which are unfenced, Flashing Light signals are employed, being brought into operation automatically on the approach of trains by track circuits or rail contact devices, whilst in other instances the control is manually effected. Barriers are also used to a great extent and are being used more and more as an economical method of crossing protection, particularly for double track protection in which cases what are known as half barriers are often used, automatically controlled. Such a system prevents a road vehicle from being trapped on an automatically controlled crossing, the roadway always being open on the exit side.

However desirable it may be to construct over or under bridges, this with few exceptions can only rarely be undertaken, on account of the heavy expense usually involved and the various means of protecting both rail and road traffic is likely to be met by varying devices, gates and barriers, for a very long time.

GATES

The Type in most common use today, at least for heavily used crossings, are rod operated from a mecha-

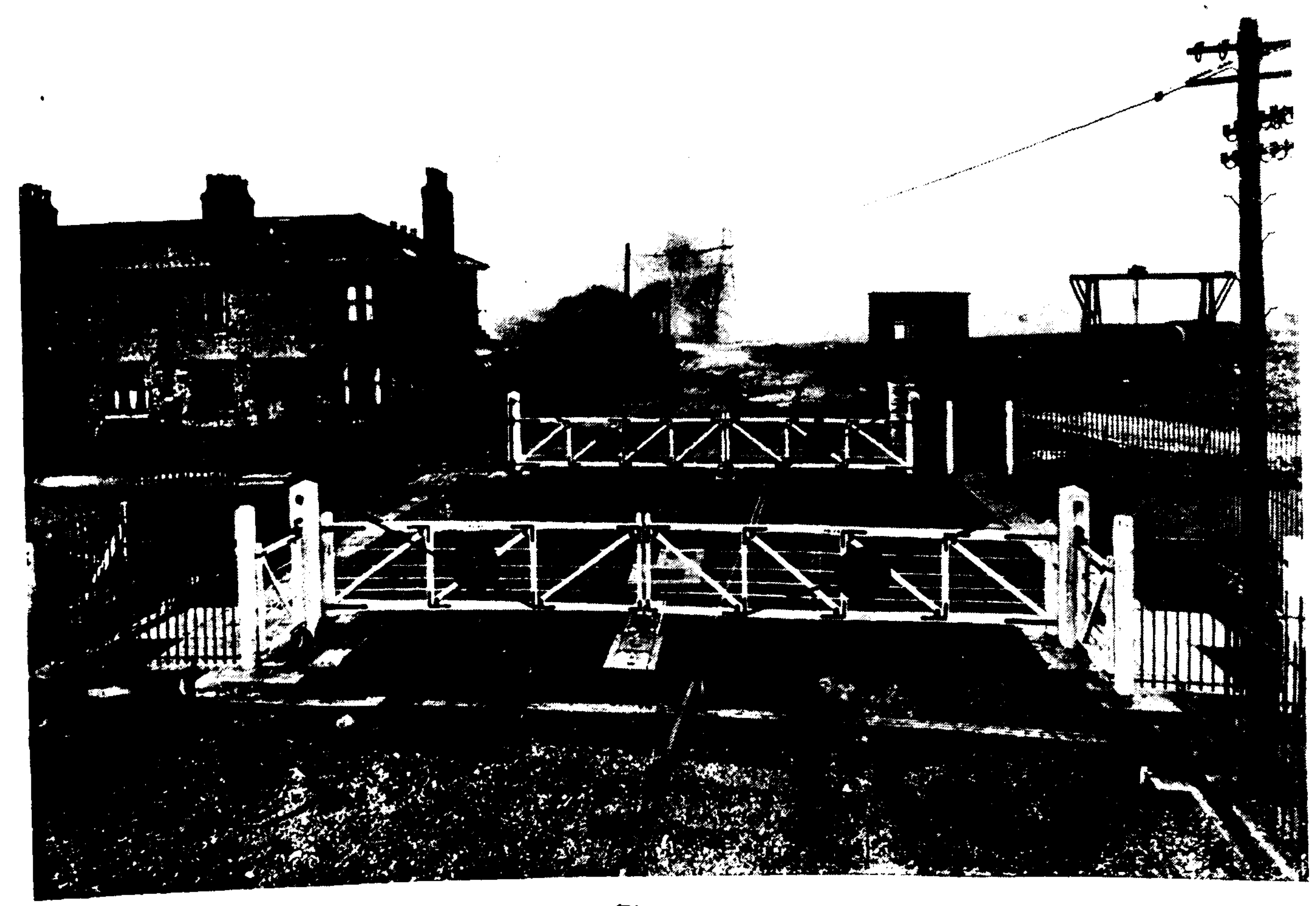


Fig. 1

nical winch and a typical set is shown in Figs. 1 and 2. In some cases these are such a size as to make their operation at frequent intervals too strenuous for a cabin-man and in such cases they are provided with power operation by a machine as illustrated in Figures 3, 4 and 5. This is designated an Oil Gate Machine and is capable of operating simultaneously sets of four of the largest gates.

Basically the machine consists of an oil pump driven by a constant speed electric motor, which pumps oil under pressure to one or the other side of a vane, the spindle of which is connected to the gate rod.

A small lever in the signal cabin permits the cabinman to start or stop the motor and also control the gates by varying the amount of oil pumped to the operating vane mechanism. The machine is compact and efficient and has proved itself very successful over a large number of years. To guard against power failures, it is customary to retain the mechanical winch and have a simple arrangement of transfering the control from power to mechanical operation.

Some installations of gates operated by a machine have incorporated road traffic signals showing either the customary Red, Yellow and Green aspects, or one aspect with 'STOP' as in Figures 2 and 6, operated from the signal box by means of a lever, or in some installations by means of a small switch.

FLASHING LIGHT SIGNALS

When it is not a requirement to fence crossings, level crossing gates are often not provided and warning and protection to users of the crossing is provided by flashing light signals.

These signals incorporate highly efficient light units which give a very distinctive warning indication of about 500 yds, and a typical one is illustrated in Figures 7 and 8.

Large bells are often fitted as an additional protection and are especially useful to call attention to the signals.

The control of the signals is normally automatic by means of treadles or track circuits. The length of the track circuit or point of the start treadle depends on the speed of train, bearing in mind that at least 30 secs.

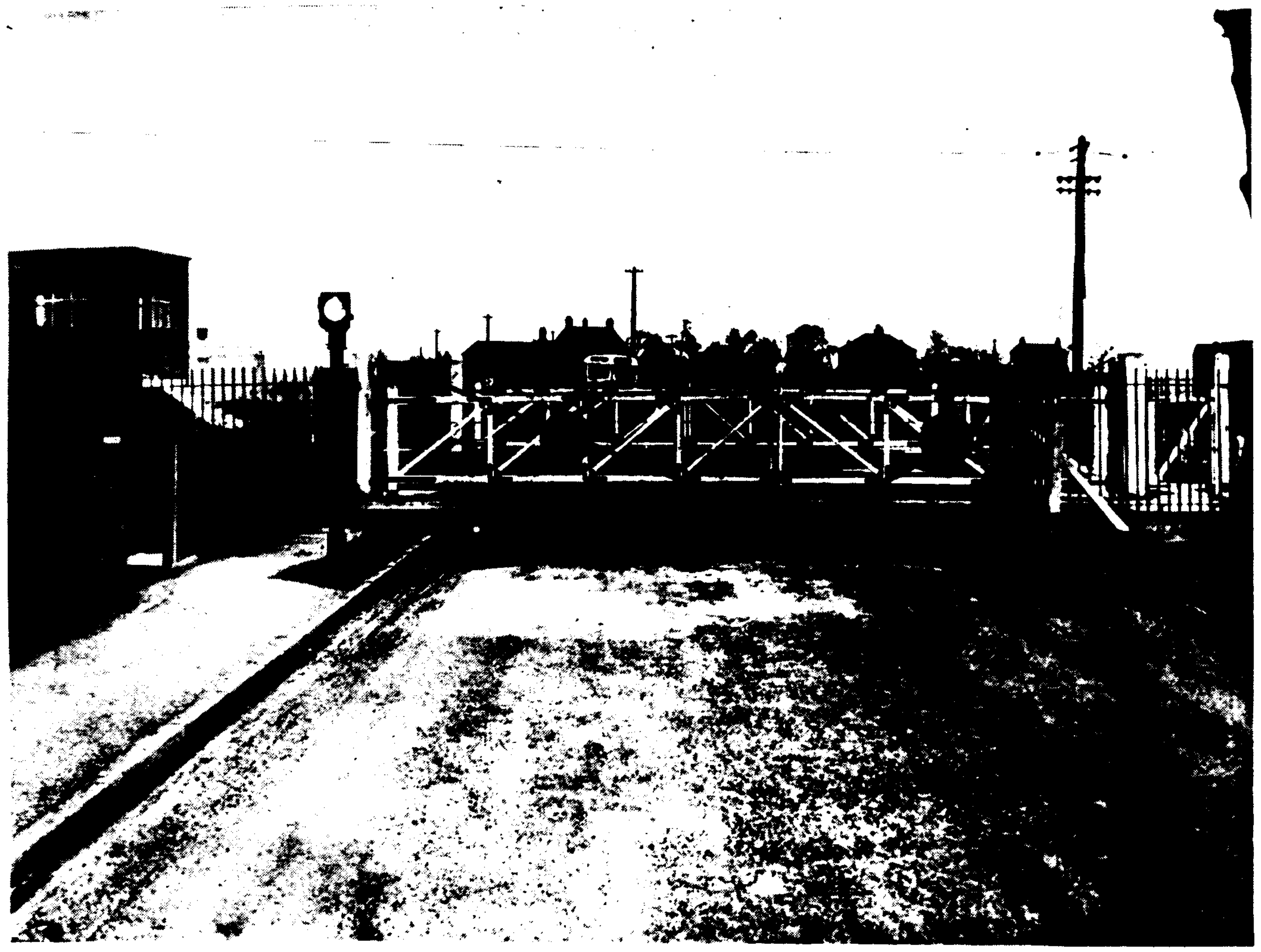


Fig. 2

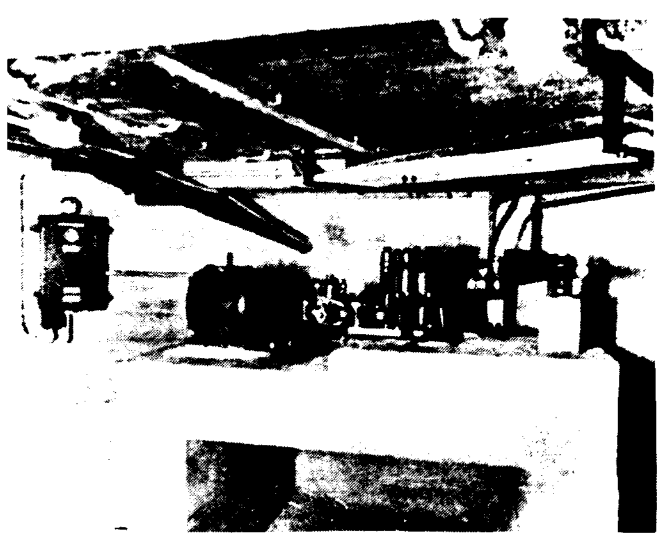


Fig. 3

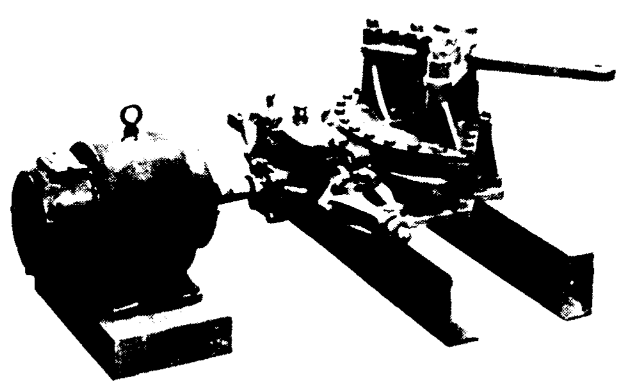


Fig. 4

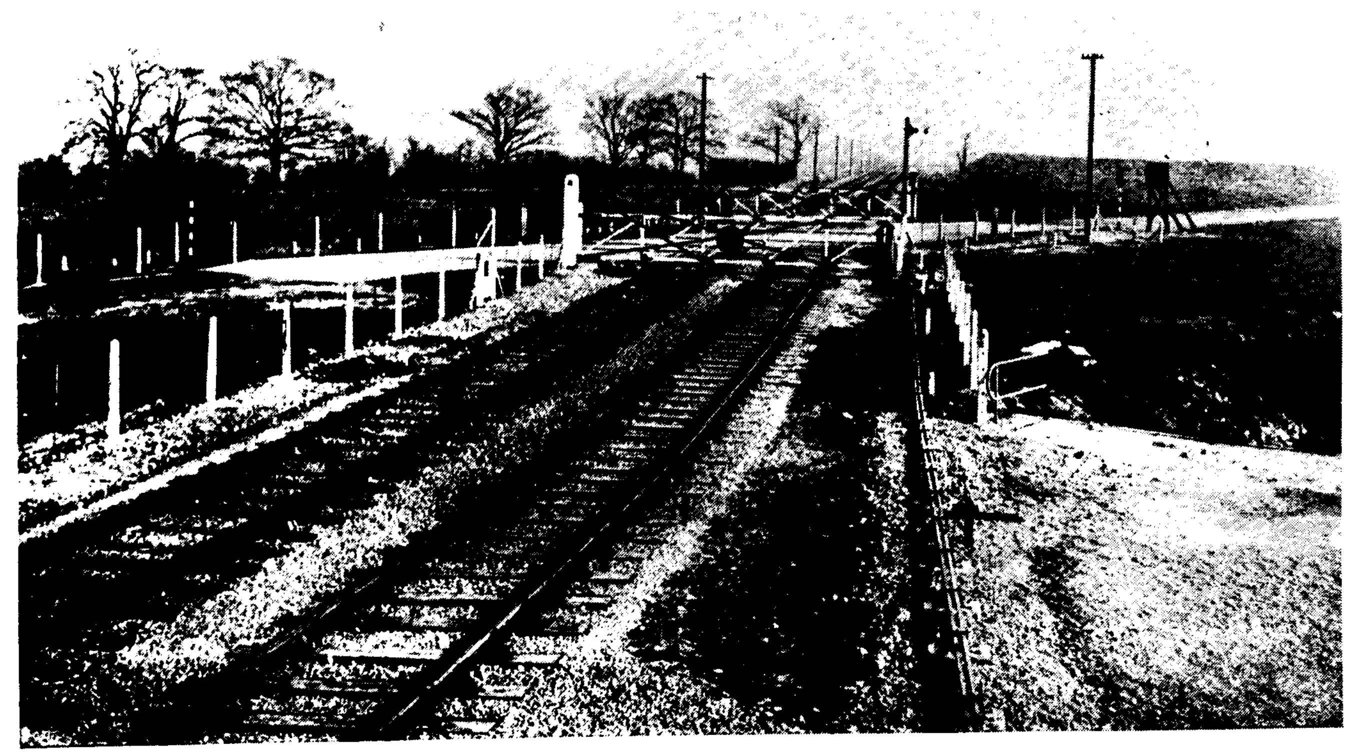


Fig. 6

Fig. 5

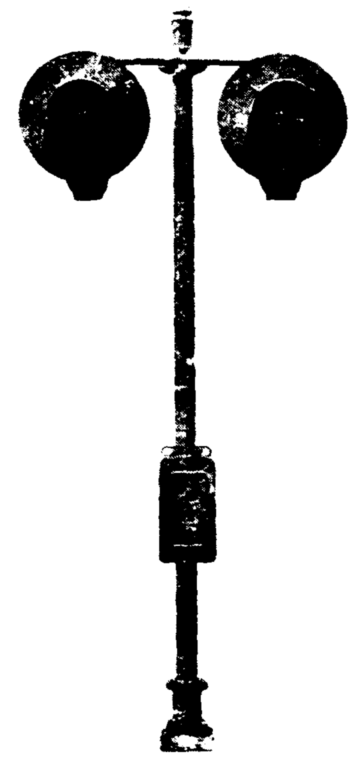


Fig. 7

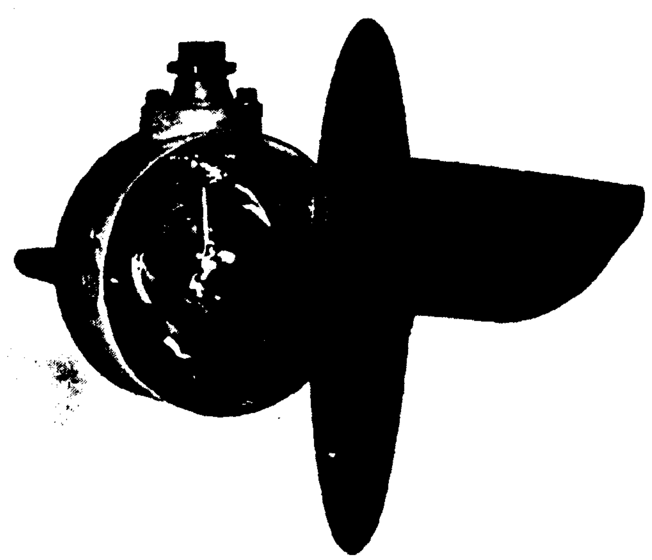


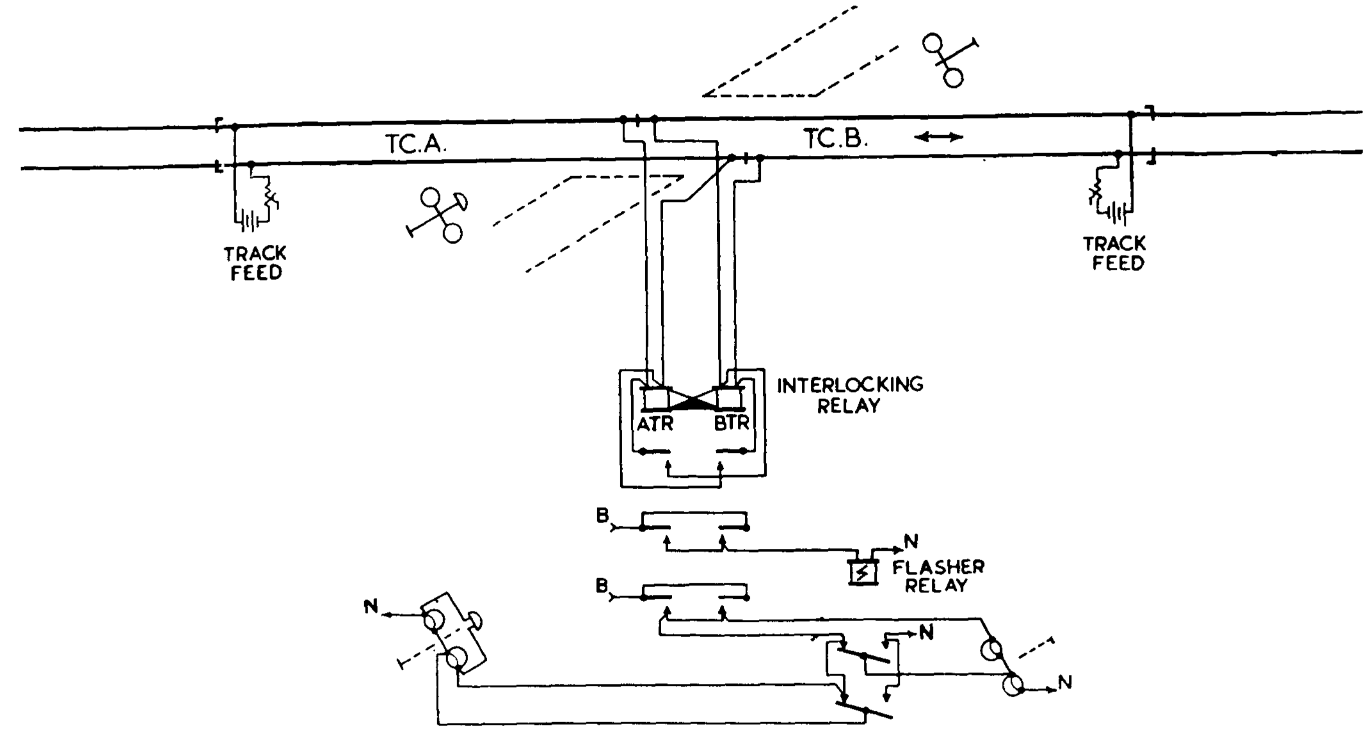
Fig. 8

Warning should be given especially if the road traffic is slow.

The introduction of high speed trains and the increasing importance of many highway crossings have created a demand for more uniform time control of highway crossing signals.

It is first necessary to measure the speed of each train before the train passes the point which would permit the minimum warning time at maximum speed. This can best be accomplished by a track circuit arranged to operate a timing device. Having determined the speed of a train automatic means can be provided for starting the operation of the crossing signal when the train advances to a point which will produce a satisfactory warning.

A typical circuit using Direct Current track circuits is shown on Figure 9. This does not include any automatic timing.



TYPICAL CIRCUIT ARRANGEMENTS
FOR
LEVEL CROSSING ON SINGLE LINES USING TRACK CIRCUITS.

Fig. 9

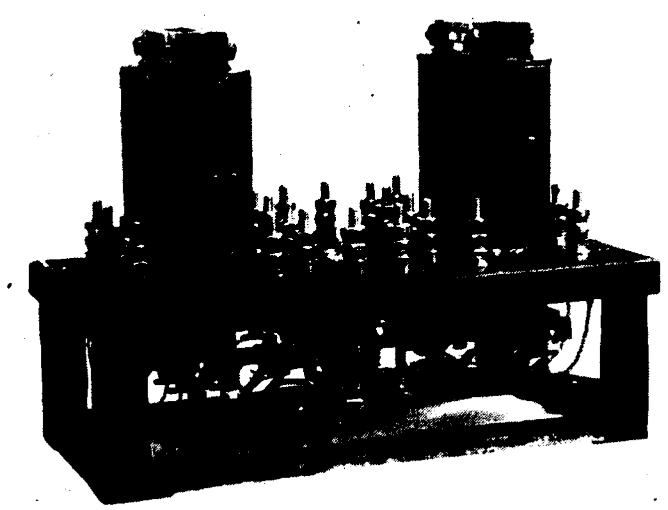


Fig. 10

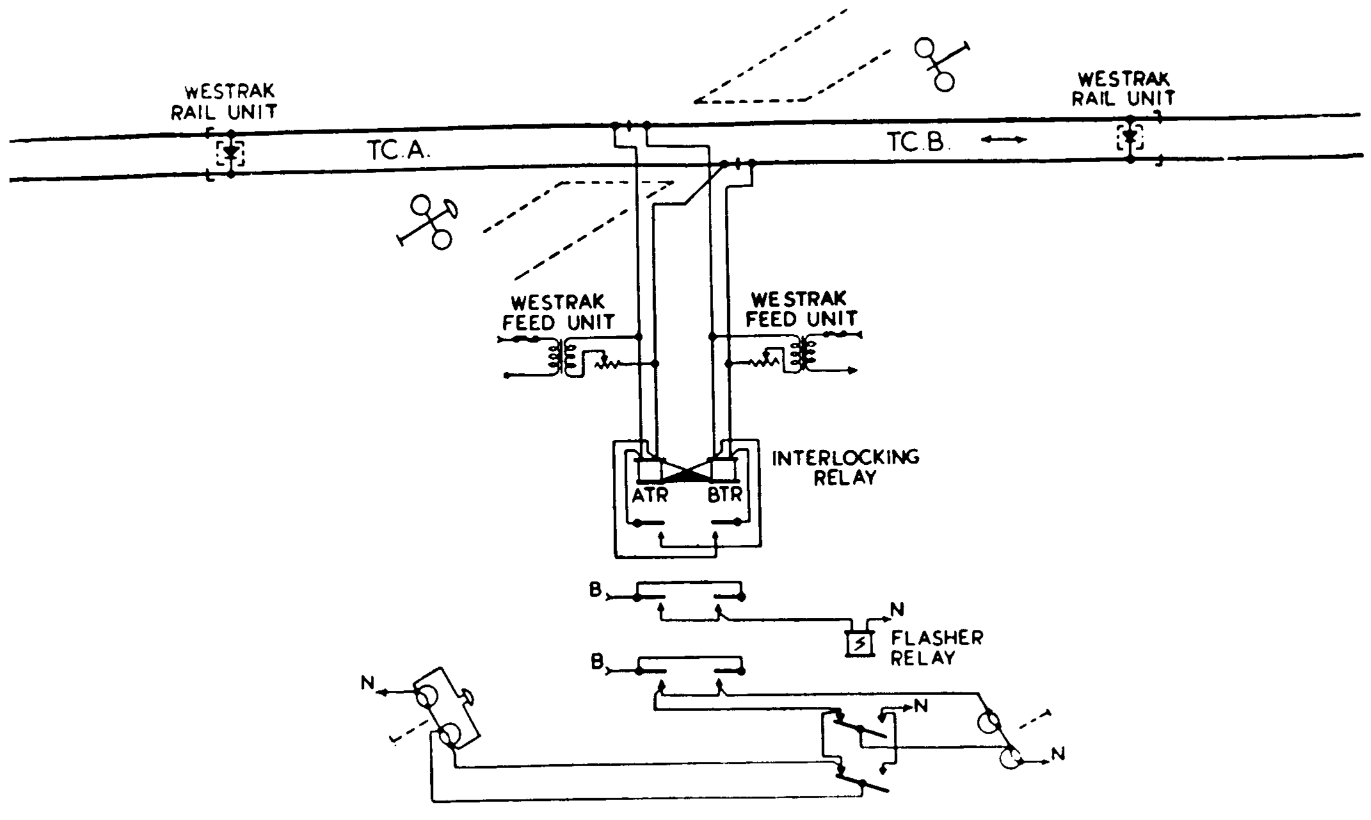
On single lines in addition to the flashing relay, an interlocking relay, shown in Figure 10, is used to permit the correct functioning of starting and stopping of the warning signals with both way working. Briefly the relay consists of two neutral relays mechanically arranged so that only one can make its de-energised contacts at one time.

With the track clear both relays ATR and BTR of the interlocking relay are energised and an approaching train will de-energise TC 'A' and 'A' TR will in turn de-energise and provide a feed to the flashing relay, lights and if fitted bell. The operation of the flasher will apply current to signals on opposite sides of the track alternately.

The flashing will continue until the train clears TC 'A' but although 'B' TC is occupied, due to the interlocking feature it will not be permitted to make its de-energised contact and, therefore, will not continue to energise the flasher relay. Unless this arrangement is used the lights would flash until 'B' TR cleared as well as 'A' TR.

In the event of a failure of the flashing relay to oscillate one pair of lights will be permanently alight.

Particular attention should be noted of the staggering of block joists. If placed in the centre of the roadway this would receive heavy wear by road traffic and if placed on one side of the crossing, the warning would



TYPICAL CIRCUIT ARRANGEMENTS
FOR
LEVEL CROSSING ON SINGLE LINES
USING
COMBINED 'WESTRAK' AND INTERLOCKING RELAY.

Fig. 11

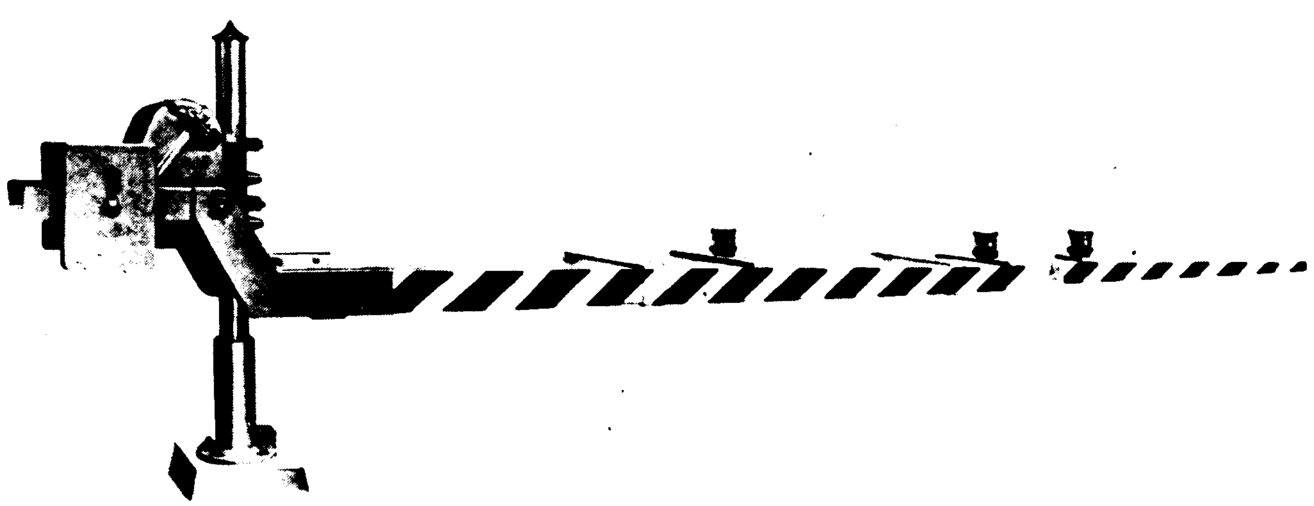


Fig. 12

cease for trains in one direction before the train had completely cleared the road.

Figure 11 shows a similar arrangement but using a "WESTRAK" rail unit manufactured by Westinghouse Brake & Signal Co. Ltd. This unit is fixed to a sleeper at the extremities of the track circuit and obviates the running of cables to these points which is very useful where power is available but is not necessary to run wires to the distant points where the warning commences. The "WESTRAK" unit is fitted in a cast iron waterproof case which is fixed to the sleeper and requires no maintenance whatever.

BARRIERS

Although flashing light signals are in considerable use in many parts of the world and are considered a satisfactory method of warning road traffic of approaching trains, it necessitates the road users being sufficiently educated to know what the flashing lights are intending to convey. It is therefore considered that further precautions should be taken if road users cannot be relied upon to understand the signals, by the installation of road barriers. The use of barriers is increasing and a description in some detail would not be amiss.

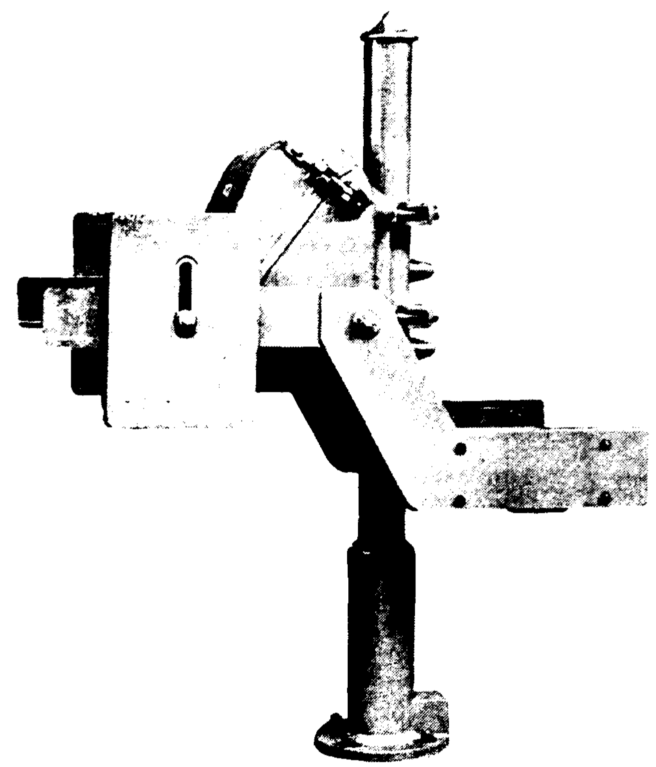


Fig. 13

These can be either wire worked from an adjacent signal cabin, normally the Westinghouse Double Wire system or by electrical operation, in which case they can be automatically controlled by tracks as in the case of flashing signals, or combined with them.

A typical barrier machine is shown in Figure 12 and consists of the operating machine powered by an electric motor. The motor drives the barrier arm from the horizontal to the vertical position where it is held securely by an electrically operated brake. In the raised position the Barrier is completely clear of all road traffic. The arm is counter balanced but biased to return to the horizontal position when the brake is released. The descent of the arm is governed by means of rheostatic braking to ensure no damage is done to apparatus.

During its descent, the design allows for the arm to be reversed at any time and raised to the vertical position if required.

It is very desirable that the boom should be of wood to prevent damage to the barrier machine if struck by a vehicle out of control, and in addition the use of a wooden book is less liable to cause extensive damage to the offending vehicle.

The boom is normally conspicuously painted and carries red lights to make it easily visible at night. The counterweights fitted to the boom are adjustable to give the required return effect and the standard weights fitted will enable any boom up to 38 ft. in length to be fitted.

Spring buffers are fitted inside the main operating case designed to bring the mechanism to rest in the event of the beam of counterweights being broken off.

A stop on each buffer provides adjustment for the final position of the barrier in the raised and lowered positions, which is made by removing the two covers and adjusting the nuts and screwed rods thus exposed. By this means the horizontal position of the barrier can be aligned from the outside of the machine, and any tendency to 'droop' on the part of the boom can be corrected.

A circuit controller is provided in the machine with capacity for a maximum of five circuits in addition to contacts employed in the barrier control circuit.

OPERATION

The operating machine is shown in Figures 13 and 14 and operates as follows.

The main shaft of the machine is driven through a train of gears by a D. C. series motor from a 12-V. or 24-V. supply, preferably from a secondary batteries, or alternatively, the barrier can be operated by a hand generator, the necessary hold-off current being supplied by primary cells. Both main shaft and motor run on ball bearings, and the idler gear is fitted with a sleeve bearing which can be lubricated. The motor drives the gears through a friction clutch, which is designed to slip when the barrier load would be such as to make the motor overload, due, for example, to the barrier being deliberately held down.

Control of the barrier is by one wire and return. Energisation of the control wire operates the brake magnet, which is fitted with a change-over contact. On

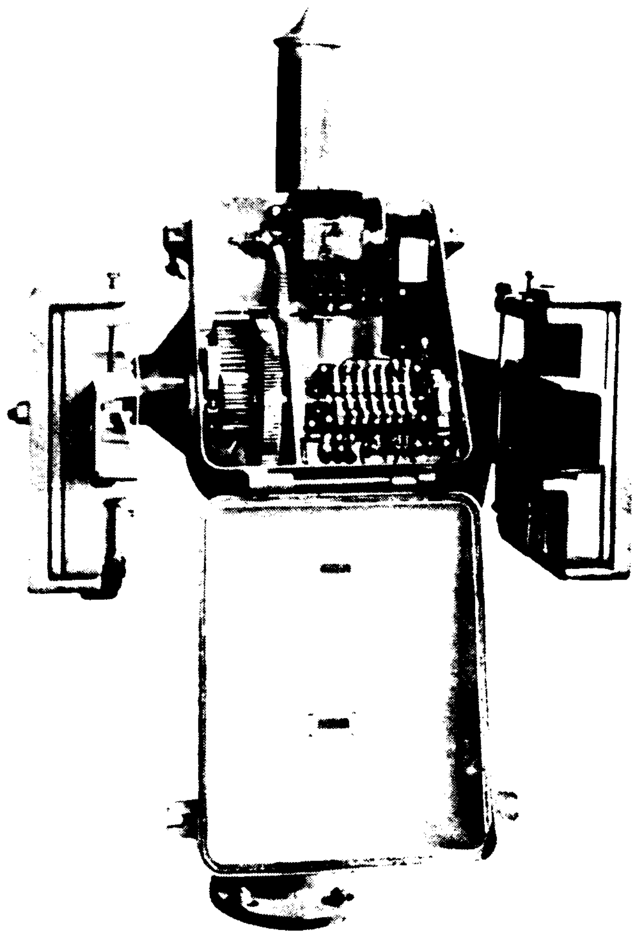


Fig. 14

picking up, the brake magnet disconnects the snubbing resistance from the motor and connects the motor to line, at the same time applying the brake. The latter acts on the motor shaft through a free-wheel so that the motor is free to wind the barrier up but cannot be driven in the opposite direction. A quick-acting limit switch breaks the motor circuit when the barrier has moved through approximately 85 deg. whereupon the motor slows down and, as soon as it comes to rest, is prevented by the brake from rotating in the opposite direction under the return torque exerted by the boom. The barrier is thus held with the boom in the vertical position.

As the barrier approaches its raised position, an economiser contact across the high-resistance portion of the brake magnet winding opens, thus reducing to a minimum the current required to hold the barrier raised.

To lower the barrier, the control wire is de-energised thus releasing the brake and allowing the motor to rotate in the reverse direction as the barrier descends under its own weight. On releasing, the brake magnet change-over contact connects a snubbing resistance across the motor. The time of descent is adjustable by varying this resistance.

In order to gain independence from supply failures, it is recommended that the barrier should be operated from a secondary battery.

In the event of the supply to the barrier being interrupted, the boom may be raised by hand to allow traffic to pass. Flashing light signals and a warning bell, or other warning devices, can be installed with these barriers.

OPERATING FIGURES

	With 38 ft. boom.		
Line Voltage	20	24	28
Time in seconds to raise	25	12½	10½
,, ,, ,, ,, lower	10	10	10

APPLICATION

Apart from their use on railways, barrier machines are finding increasing use for works entrances and the control of roads crossing runways on airfields. An interesting set of barriers recently built and installed for this latter purpose is operated by motor to the horizontal position, which is the reverse of Railway practice, and to prevent damage to the boom by a slight impact from a vehicle, the book was hinged to swing horizontally.

The barriers are provided with flashing signals and in addition, an electrically rotated 'STOP' sign and the installation comprises one of the most comprehensive barrier machines designed.

The manufacture of apparatus of all types to protect road crossings has been one of the functions of Westinghouse Brake & Signal Co. Ltd., and its associated Company in India, Saxby & Farmer (India) Ltd. for many years, and apparatus of their manufacture are in use in all parts of the world.

RESISTANCE WELDING AND RAILWAYS

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

THERE is no problem so vast and unending as the assembly of metal in its many forms. Now whilst the mind of the Engineer first conceived the rivet and the bolt — or earlier still — the forge welding, as the original means of assembly, there are to-day available processes which eliminate in many cases these laborious and expensive methods.

Welding, as one out of these modern processes, is increasingly finding a use in almost every branch of engineering both in new and repair work and its field of application is widening every day. No longer just a handy tool in the workshop, it has now established itself as having immense possibilities for production with either ferrous or non-ferrous metals.

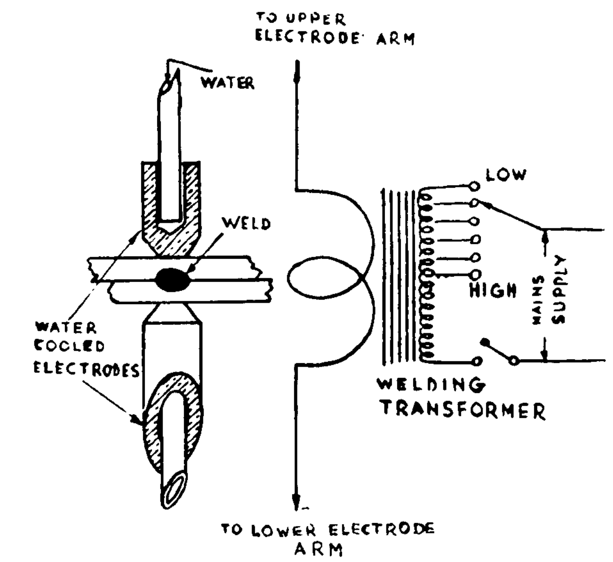


FIG. 1. PRINCIPLES OF SPOT WELDING

WHAT IS WELDING?

The term " Welding " whose origin is identical with that of the word " well " in the sense of welding or boiling up, can be defined as the process by which two pieces of metal are united by the application of heat, so as to produce an autogenous jointing with the cohession of the molecules of the two parts.

Although by the term " Welding " it is very often understood as a fusion of metal either by oxy-acetylene torch and filling rod or by the electric arc process where a run of molten metal is deposited at the assembly point, there is still another method in which the heat for welding is produced by the passage of a heavy electric current through the work-pieces while they are brought together

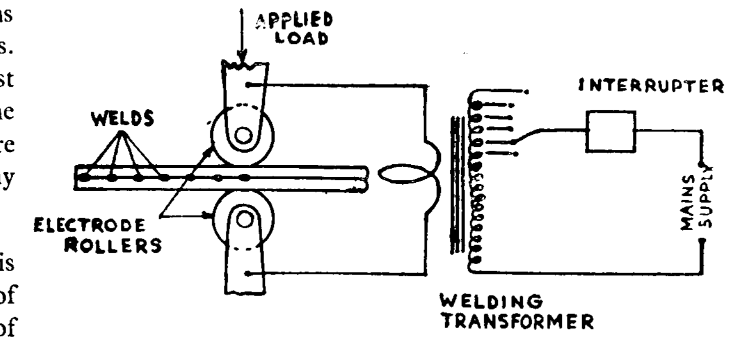


FIG. 2. PRINCIPLES OF SEAM WELDING

under pressure at the correct moment and before any fusion of the parts to be joined occurs and consolidated by instantaneous forging, the facilities for which are incorporated in the machine. These processes fall into a group generally known as the resistance welding process, the use of which in recent years has revolutionised countless numbers of assembly operations having an outstanding virtue in that it is eminently suited to repetition work on account of the ease with which it can be automatised, and the inherently short time required for welding.

EARLY HISTORY

The principle of resistance welding was first discovered by Professor Thomson towards the end of the nineteenth century. It took place almost by accident while he was demonstrating the function of a sparking coil consisting of a primary winding of a few thick turns of wire and a secondary winding consisting of a great number of turns of thin wire, to a class of students at the Frankling Institute in America. In the course of the demonstration, he connected a battery momentarily

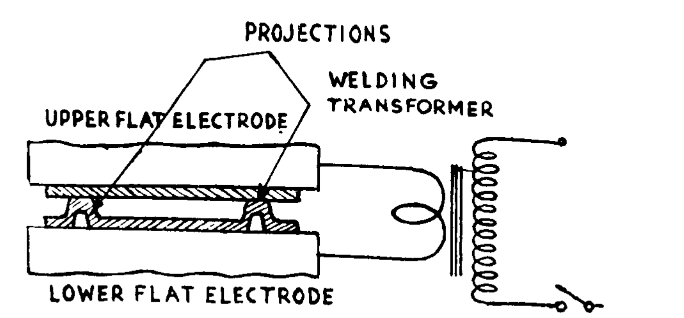
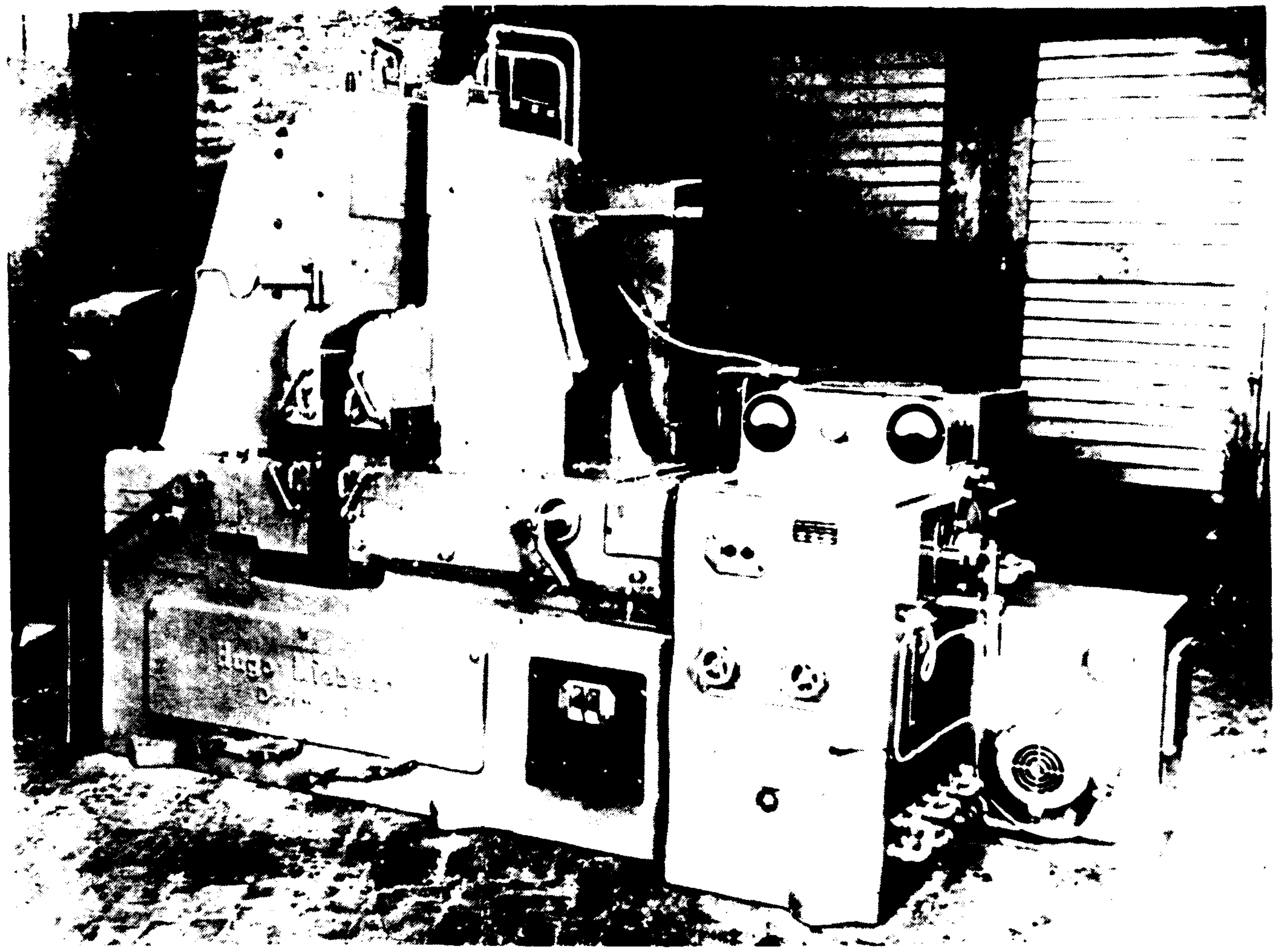


FIG. 3 PRINCIPLES OF PROJECTION WELDING



Electric Flash Butt Welding Machine (Hugo Miebach Gmbh)
(Photo by courtesy M/s. Chowgule & Co. (Hind) Ltd.)

across the primary windings to induce a very high voltage in the secondary winding from which he charged a Leyden jar. In order to find out what would happen if the process was reversed i. e. if the Leyden jar was discharged through the thin winding, he connected together the terminals of the thick primary winding and discharged the Leyden jar, as contemplated, through the thin winding. As a result, a very high current was induced in the thick winding and, due to the fact that the wire across its terminals was only in light contact with them, fusion took place firmly uniting the wire to the terminals. A weld had in fact taken place between the wire and the terminals. This ultimately led to the patenting by Professor Thomson in 1886 of the first resistance butt welding equipment whose method of operation, is described as follows :—

The two portions of materials to be electrically resistance welded are held together under clamps by means of screws while a high current is passed through them. When the temperature reaches the welding point, the spring pressure is sufficient to cause upsetting and forging of the joint, the welding current simultaneously being switched off.

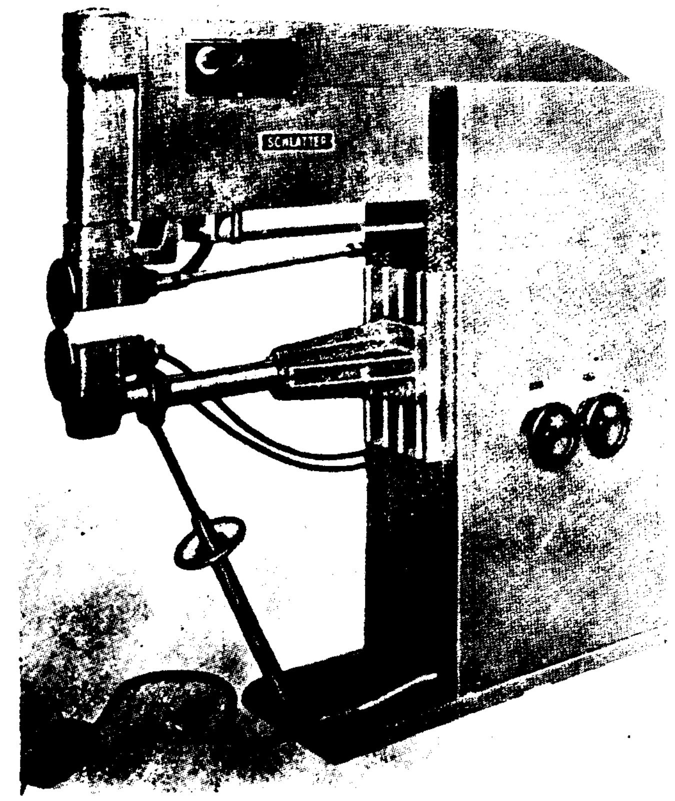
The principle as employed in the first welding equipment remains the same to date with improvements having however been made with regard to its electrical and mechanical details. The principal factors which combine to make a good resistance weld of any kind are now firmly established and may be stated as under :—

(a) Mechanical pressure over the area where the weld is required.

(b) Heat control i. e. the size of the welding current ; and

(c) Time interval for flowing of current.

Fortunately, none of these factors is critical in itself, but gross errors in several may lead to serious effects.



Seam Welding Machine (H. A. Schlatter Ltd.)
(Photo by courtesy M/s. Francis Klein & Co. Ltd.)

Thus a small current applied for too short a time will produce a weak and unsatisfactory weld. On the other hand, a very large current applied for too long a period may produce a mechanically sound weld, but the work will be "overdone".

TYPES OF RESISTANCE WELDING

The process of resistance welding can be grouped under four basic varieties which are spot, Seam, Projection and Butt welding and in this order they will be considered. Butt welding can however be sub-divided into two groups, viz., plain butt welding and Flash butt welding which has derived its name from the flash or shower of sparts which occurs during the actual welding operation.

SPOT WELDING

Undoutedly the most commonest form of electric resistance welding is the spot welding. The reason for this may be attributable to the fact that it can replace rivetting without any change in the design of the article and its introduction will not involve any extra expenditure on the part of the manufacturer in changing the drawings or layouts.

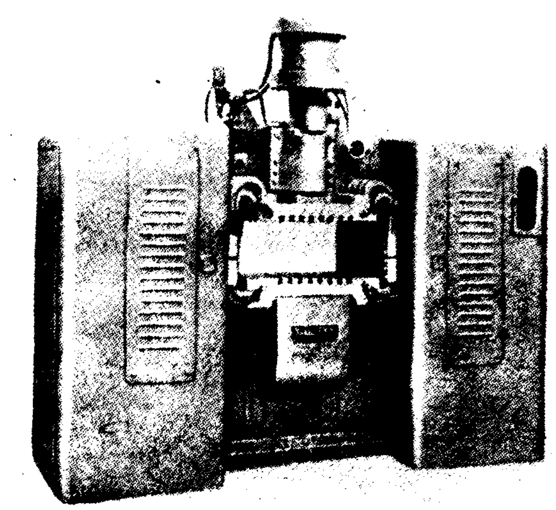
In spot welding two sheets or plates are joined together by welds formed at the interface between them. The method may also be used for joining sheets to rolled sections or extrusions, wire to wire or for sundry special applications using combinations of the above. The former however constitues the widest application of spot welding in industry.

The essentials of the process are shown diagrammatically in Fig. 1 and the cycle of operation involved is as follows :—

(a) The parts to be joined are superimposed on one another and are placed between the rocker arms (or electrode arms as they are also called). The rocker arms are made of copper alloy and carry two water-cooled copper electrodes at the ends remote from the machine.

(b) The top electrode is thereafter made to descend and impinge upon the work pieces either by foot pedal, air or compressed oil operation so as to finally clamp the two parts together under a pressure of 10,000—15000 lbs. per square inch of electrode tip.

(c) After pressure is built up on the work, a heavy current at low voltage is caused to flow



Projection Welding Machine (Sciaky Electric Welding Machines Ltd.)

through the area of the metal localized by the electrodes. The voltage may be from 2 to 4 Volts and the current from 3000 upto 50,000 amperer or more, according to the class of work.

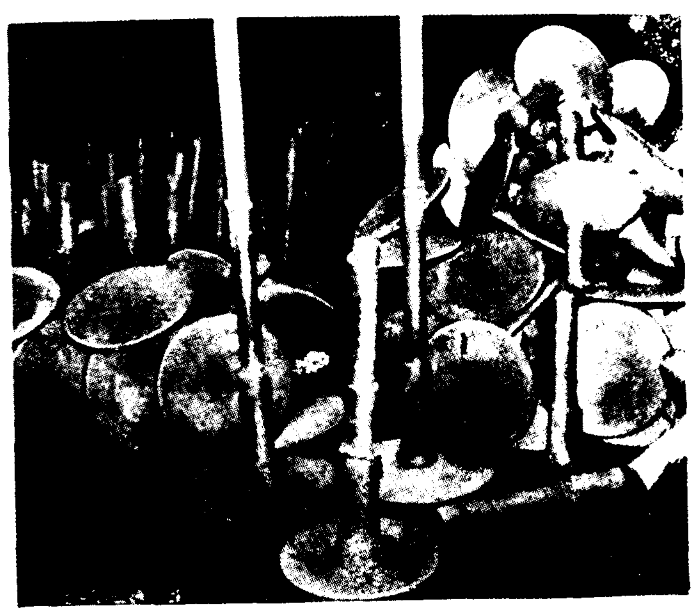
(d) The heating current is maintained for a pre-determined time, pressure still being maintained.

(e) Weld current is switched off and extra pressure is applied or original pressure prolonged in order to consolidate or forge the weld while the metal cools down.

(f) Pressure on the electrodes is released and the machine is returned back to a condition when it is ready to repeat the above sequence of operation.

For materials other than mild steel, the cycle of operations may be different from what has been indicated above. For instance, spot welding machines for aluminium and its alloys may be so equipped as to produce variable pressure cycle in order to permit the load applied to the work to follow a definite changing pattern during welding.

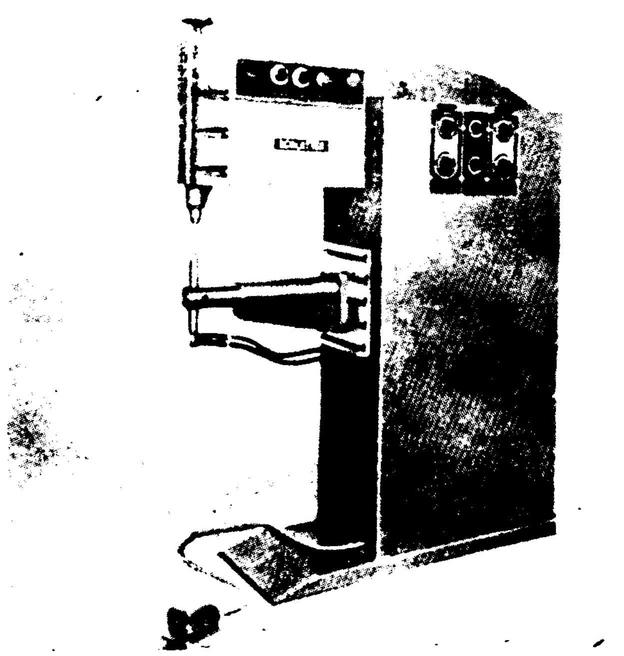
According to the type of spot-welding machine in use, operations (b) and (f) may be dependent on the operator



Buffers for railway rolling stock with welded shank.

or fully automatic. In the first place, the clamping pressure is applied by the operator by means of foot-pedal whereas with automatic operation, as in the case of power operated spot welder, the movement of the top electrode is actuated by either hydraulically operated oil pressure or air pressure controlled by solenoid operated air valve and operated by foot switch.

Although the principal factors governing successful spot welding are the same as delineated in one of the



Spot Welding Machine (H. A. Schlatter Ltd.)
(Photo by courtesy M/s. Francis Klein & Co. Ltd.)

preceeding paragraphs, the following items are also to be controlled in addition, to obtain spot-welds of high quality.

(i) Area of contact of electrodes.

(ii) Composition of materials to be joined.

(iii) Surface condition of the materials (whether scaly or rusty).

(iv) Size and shape of the electrodes.

When all these factors are considered together it may go without saying that the first requirement of good quality spot welding is a good machine embodying all the automatic features of current, time and pressure, accurately controlled. The second requirement is of course the use of optimum machine settings. An optimum machine setting can be defined as follows:—

"A machine setting which will produce a weld of the required size and quality, and which will give a minimum of variation in weld size and quality when unavoidable variations occur in such factors as supply voltage, air line pressure, electrode tip size, fit-up of the assembly, etc."

The machine settings necessary to produce the desired results are, however, still a matter of experiment for each individual machine. The British Welding Research Association in their attempt to determine

optimum settings for various processes and materials, made a series of tests and the results of such tests for low carbon mild steel sheet and aluminium alloy sheet are given in Tables I & II. It should not however be taken for granted that the settings given in these Tables are the only ones to produce good results but since these are based on practical tests and actual experiments, they may be formed the basis of carrying out experiments to determine the machine setting for each individual machine. After the settings are obtained, the only variable factor that is likely to give rise to trouble is deformation of the electrode tips under the combined effects of heat, pressure and impact. This is corrected by remachining the tips to the correct form at frequent intervals.

The third requirement is cleanliness which should be maintained in all respects. To start with, the machine itself should be kept free from dust and next the electrodes where the presence of dirt will interfere with the free passage of electric current. The surfaces of the parts to be welded are also to be free from dirt, grease or paint besides scale and rust as their existence will not only weaken the welds, but may cause a "splashing" effect involving risk of injury to the operator's eye.

TABLE—I

Settings for Welding two equal thickness of Mild Steel Sheet.

Sheet thickness in.	S.W.G.	Electrode Pressure (lb.)	Electrode tip dia. (in.)	Weld current (Amps.)	Weld time (Cycles)
.028	22	275	$\frac{3}{16}$	7,500	7
.036	20	275	$\frac{3}{16}$	8,000	10
.048	18	380	$\frac{7}{32}$	8,800	13
.064	16	500	$\frac{1}{4}$	9,700	17
.080	14	620	$\frac{9}{32}$	12,000	20
.104	12	770	$\frac{5}{16}$	12,500	25
.128	10	1000	$\frac{11}{32}$	14,000	32

TABLE—II

Settings for welding two equal thickness of aluminium alloy sheet.

Sheet thickness in.	S. W. G.	Electrode Pressure (lb.)	Weld current (Amps.)	Cycles (based on 50 cycles per sec.)
.022	24	300 — 400	17,000	1
.036	20	400 — 650	21,000	2
.048	18	450 — 700	23,000	3
.064	16	500 — 800	26,000	4
.080	14	600 — 900	29,000	5
.128	10	700 — 1,200	36,000	8

SEAM WELDING

This process is similar to spot welding except that the electrodes instead of taking the form of points for "Spotting" are in the form of motor or power driven copper rollers between which the sheets to be joined are passed; and as these rollers rotate, intermittent pulses of current are fed through them and a series of overlapping welds in the shape of a continuous welded seam are formed making water and gas tight joint. The principles of seam welding are depicted in Fig. 2.

For uniting long seams which have no mechanical irregularities, seam welding is generally preferred to spot welding because of the faster production owing to the continuous movement provided by the roller electrodes and better control over the work while it is in the machine.

Seam welding is mainly confined, in the case of steel, to fairly thin stock not exceeding ¼" in thickness. It is a much quicker process as speeds of welding of 10 feet a minute on thin sheet of the order of, say, 0.028 inch, are not unusual.

Table III gives a fairly accurate basis on which to prepare the machine settings for seam welding mild steel sheets.

TABLE—III

Sheet thickness. in.	S.W.G.	Pressure (lb.)	Electrode wheel face width (in.)	Timing Cycles "on"	Cycles "Off"	Speed inch per minute	Spots per inch.	Minimum overlap of sheets (in.)
.022	24	500	5/32	1	½	144	14	5/16
.036	20	650	3/16	1	1	120	12½	7/16
				2	2	72	10½	
.048	18	750	¼	2	2	72	10½	½
				3	2	60	10	
.064	16	800	¼	3	2	60	10	½
				3	3	48	10¼	
.125	10	1,200	5/16	5	5	36	8½	5/8
				6	6	30	8¼	

PROJECTION WELDING

In this process, which is a modern development of spot welding, a high current is passed through the contact between a sheet containing a number of projections, and one without, so that a number of welds similar in shape to spot welds can be made simultaneously. In projection welding flat electrodes are used which apply pressure to an appreciable area. The projections on the sheet localise the current and hence spot welds are produced at each point. Where due to unsuitable shape of the parts at the points to be welded spot welding is not possible, projection welding is resorted to. Welding of disc to cup, making a T-joint etc. are instances in point. Fig. 3 depicts the principle of projection welding.

The technique of working is similar to that of the spot welding. In place of electrode tips, flat electrodes which are large enough to cover all the projections to be welded at the same operation, are used. The top electrode applies the correct mechanical pressure to ensure correctly forged welds. As the material at the projected points heats up, the projection collapse and union takes place at all points simultaneously. The projections required are generally from .03" to .07" depending on the thickness of the sheets to be welded.

BUTT WELDING

As its name implies, butt welding is a process of uniting by butting the ends of bar or strip metal, where electric current at low voltage causes heat and mechanical pressure makes the weld. As already stated earlier, this type of welding comprises—Plain butt welds and the flash butt welds.

In the first type, the two parts to be united together in an endwise direction are gripped in water cooled vice clamps made up of copper blocks and forming the electrodes. The principle of producing the weld heat mainly by the electrical resistance of the joint faces is basically the same as in other forms of resistance welding. When the current is switched on, the temperature at the contact point rises until the metal becomes plastic when the parts are forced together by some mechanical leverage system or by an hydraulic plunger. This mechanical pressure is maintained until a distinct burr is formed at the junction, thus showing that plastic flow of the metal has taken place.

The flash-butt welding or flash welding as it is called for short, is a variation of the plain butt welding, only in that the ends of the workpieces are brought initially arcing into very light contact causing a flashing action due to effect between them whilst the current is passing. The weld is finally consolidated by the sudden application of a pressure which is generally one ton per square inch of the sectional area in case of ordinary mild steel, whilst for higher strength materials the unit forging pressure required increases accordingly so that for steel of 40 to 45 tons tensile strength, the pressure required is 2½ to 3 tons per square inch, calculated on the weld area. The term "flash" is also applied to the collar thrown out on a butt weld.

In flash welding there is on need for the parts to be a good surface fit. On the other hand the irregularities in the fit of the joint faces, help in producing the arcing effect for developing the required heat to melt the ends. The following figures are the readings taken over a number of welds made on some of the railway rolling stock details.

TABLE—IV

Flash Butt Welding of Railway Components :

Description of the detail.	Area Sq : inch.	Approximate welding time.	Units per 100 welds.
1. Boiler foundation ring	17	5 Minutes	500
2. Buffer	7	2½ Minutes	200
3. Reversing rod	3	45 Seconds	100
4. Pull Rod	½	5 Seconds	14
5. Brake Beam	2½	35 Seconds	66
6. Side coupling rods	6	2 Minutes	200
7. Piston and piston red	12.56	4 Minutes	400

RESISTANCE WELDING APPLICATIONS IN RAILWAYS

The potentialities of welding in the Railway industry were visualised several years ago, but mainly as an asset in repair work. The post-war demand for large quantity of rolling stock has, however, opened up new fields for this technique and welded designs for passenger carriages, wagons and locomotives have been adopted in many countries as a standard practice.

The development of electric resistance welding in recent years has been a boon in this direction. It has made available to this industry new and efficient manufacturing procedures. Thus it is possible to-day, for example, to weld in a simple and perfect manner single parts to composite elements which formally had to be made by a complicated and expensive forging or steel-cast process. Furthermore, material can often be saved by appropriate welding of steels of different quality in the manufacture of high grade tools. In short electric resistance welding offers one or more of the following advantages: faster welding, easier fabrication, less distortion, simpler operation and economy of materials.

In producing carriage or wagon body shell, spot welding plays a very prominent role. Apart from achieving as very smooth and clear appearance free from rivet heads, the advantages derived are:—

(a) No drilling or punching of holes.

(b) Reduction in weight due to the elimination of rivets.

(c) Speed of assembly and low working costs.

In the works of London Transport's Railways, rails are welded into lengths upto 300 ft. by means of the flash-butt process which has produced results of great consistency both under test and in service. No other form of welding has been found adequate for the severe conditions encountered on those railways. Rails delivered from the rolling mills in specified lengths averaging about 60′ are fed into the welding machine on a powered roller-conveyor. London Transport has standardised on continuous rails with adjustment switches at ½ - mile intervals on tracks in the open for all straight track and easy curves.

Some of the commonest applications of one or other forms of electric resistance welding in railway industry are:—

(a) Joining standard railway lines together in long lengths.

(b) Joining complicated drop forgings to simpler structures, e. g. buffer plungers to shanks, draw hooks to shanks, etc.

(c) Manufacture of link couplings.

(d) Manufacture of metal windows, frames or doors etc.

(e) Joining boiler tubes.

(f) Producing built-up underframes and body structures.

(g) Bolt and hinge manufacture.

(h) Producing welded axles.

(i) Making reversing rod, regulator rod, side coupling rods, pull rod, connecting link etc.

(j) Manufacture of brake beam, axle guards, bearing spring box.

(k) Repairs to screw couplings.

The list above is only illustrative. As experience is gained, many more startling uses for resistance welding in railway industry will become apparent. Railway Workshops have problems far beyond those of the average manufacturing or maintenance shop and this type of welding along with the other types, paramount in repair and fabrication work as they are, will soar to new found heights in the production field in railways, in years to come.

DIESEL-HYDRAULIC TRACTION

THE low thermic efficiency of the steam locomotive, i. e. the inferior utilization of the calorific value of the fuel burnt underneath the boiler, be it coal or oil, has always induced the railway engineers of all countries to search for new sources of energy for train traction.

The purely electric operation with overhead wires no doubt offers the best utilization of energy, if it can rely on existing water power. Its universel introduction, however, is handicapped by the high initial cost. It is, therefore, limited in all countries to lines with especially dense traffic or special operating conditions, as suburban traffic, under ground railways, etc.

Under these circumstances it is quite reasonable that efforts are being made to employ the diesel engine for train traction, as it not only possesses the highest thermic efficiency among all prime movers, but also requires much less weight and space than a steam power plant of equal capacity. This, however, gave rise to other problems as the diesel engine cannot be coupled directly to the drive wheel and, most of all, can also not start under load. In addition, its speed can be varied only within certain limits. The diesel engine, therefore, requires separate start and transmission gear which provide the diesel locomotive with the torque and speed characteristic or, in short, with the running characteristic of the steam locomotive. The development of the diesel locomotive, then, is closely connected with that of reliable gears and power transmission devices. Diesel locomotives of small capacity have been known already for 30 and more years. The construction of reliable diesel locomotives of medium and large capacities, however, was only possible, after a suitable power transmission had been found. The development led from the mechanical to the hydraulic power transmission. This work was essentially carried out in Germany. At the same time, diesel-electric power transmission found a wide field of application in the United States.

The hydraulic power transmission was invented by Hermann FOTTINGER in 1905. His ideas are contained in the basic German patent No. 221 422, dated 24th June 1905. Fottinger was the first one to connect a liquid pump, driven by a prime mover, with a liquid turbine, receiving and transmitting the output of the pump, so closely that while omitting coils, diffusors, pipe lines etc., he obtained a passable efficiency of transmission. He used primarily the power transmission consisting of pump and turbine with the fixed vane ring arranged in between, a design which he called transformer and which is today generally known as "converter". This converter permits the conversion of the torque of the driving engine in such a manner that the driven portion will transmit a higher torque at a correspondingly reduced speed.

Fig. 1 *Fixed Vane Ring*—shows the rotating pump wheel and the rotating turbine wheel.

The engine capacity arrives with torque M_1 and speed n_1 and leaves the converter with torque M_2 and speed n_2 to enter the motion. The curve shows the torque plotted against the speed.

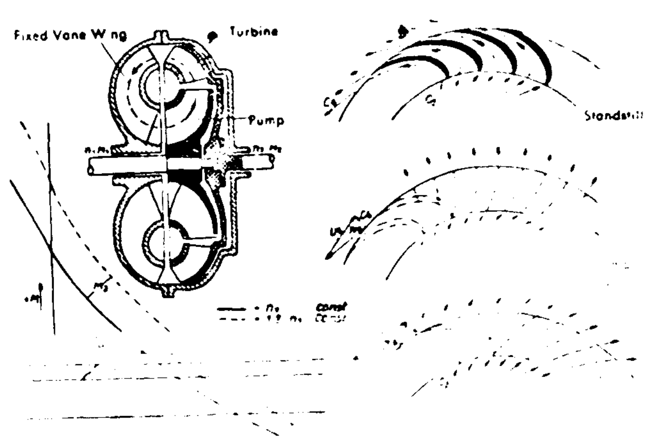


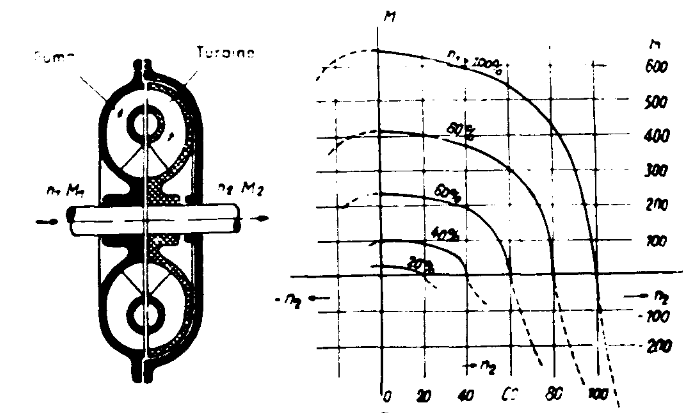
Fig. 1

As in the case of a turbine, the right side of the illustration shows the direction of flow from the pump wheel to the turbine wheel, i. e. the admission to the turbine blades at standstill (top), medium speed (center), and high speed (below).

But Fottinger also knew already the secondary type of hydraulic power transmission, the coupling, consisting of the direct connection of pump and turbine wheel without fixed vane ring. The purpose of the hydraulic coupling is *not a* conversion of the torque by reducing the speed, but a linear power transmission with high efficiency and with primary and secondary speed being approximately equal.

Fig 2. The right side shows the torque plotted against the speed from naught to 100 percent of full load and various partial loads.

Around 1930 the designers of combustion engines discovered the usability of *converter* and *coupling* for their purposes. While, however, in the USA only the auto-



M = Torque
n = r. p. m. of driving part

M = Torque
n = r. p. m. of driven part.

Diagrammatic section and efficiency curves of the Voith turbo-coupling
Fig. 2

motive engineers adopted hydraulic power transmission to facilitate shifting, as it dampens vibrations and abolishes shifting shocks, and thereby increases driving comfort in automobiles, in Germany, hydraulic power transmission was developed for essentially greater capacities, especially for the drive of diesel locomotives and diesel railcars. According to statistical evaluations, the capacity of the converters and couplings which are daily manufactured and assembled at present totals many hundreds of thousands of horsepowers, of which the greatest portion goes into automobiles. But there are also hundreds of thousands of horsepowers of hydraulic power transmission built into rail vehicles of up to the greatest capacities.

The Fottinger transmission consists of a *turbine pump*, a *turbine* and *a fixed vane ring*. These three elements are most closely arranged and contained in a common housing. Oil, and lately even fuel oil, is used as power transmitting agent.

The turbine pump is driven by the crankshaft of the diesel engine directly or through a gear transmission which adapts the engine speed to that of the pump.

The power of the engine is transferred in the pump wheel to the working liquid in the shape of energy of pressure and velocity. The oil is thrown into the closely adjacent turbine and there deflected by the turbine blades. It passes the fixed vane ring then, whose vanes return it; so it can be sucked in again by the turbine pump.

During this cycle the mass energy of the circulating oil exerts a torque on the turbine wheels by which its flow is deflected, and this torque is directly proportionate to the degree of deflection.

Fig. 3. With rising speed and incidentally increasing travelling velocity the converter is emptied by the automatic control, coupling 1 is filled and thereby put into action. With further increase of the travelling velocity coupling 2 is automatically filled.

Emptying and filling of the converter occur automatically and simultaneously, so there is *no* loss of time in shifting.

It should be emphasized here that the Fottinger transmission represents a combination of engine and machine. If an analogy is permitted to the diesel-electric power transmission, it can be said : the pump is in its kind a hydraulic generator, the turbine a motor.

Due to the strong dependency of the power intake on the speed, the turbo-sets can be built small, thereby light and cheap, if they are made to operate at high speeds.

In order to provide the possibility to use engines of large capacity with heavily varying speeds with one standard type of the Fottinger transmission, there is a

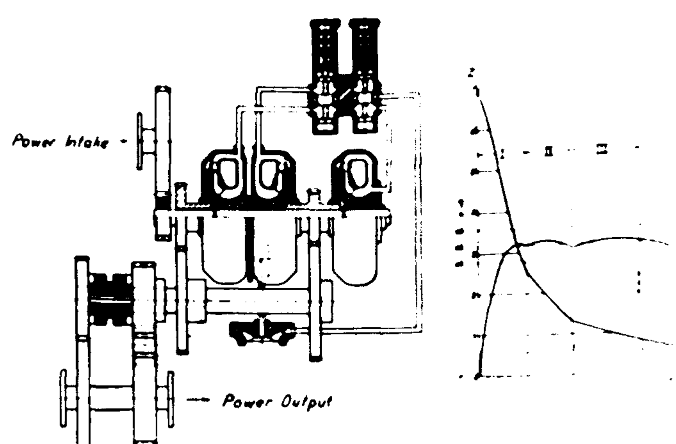


Fig. 3

gear transmission placed before the converter, which adapts the two speeds, namely the engine speed and the usually much higher speed of the pump, to each other.

Regulation of the capacity when running with partial loads is simply carried out by regulating the driving speed of the Fottinger transmission, i. e. the engine speed. With decreasing speed the output of the pump drops with the third power of the speed and incidentally the output of the turbine. This strong dependency on the speed is naturally of great advantage for the control of capacity. Attention, however, must be paid to the ratio of speeds at no-load and full load. Engines of comparatively high capacity and narrow variability of speed, due to the drop of power intake with the third

power of the speed, reach still a comparatively high capacity at no-load, which may become too high for certain purposes.

The efficiency of a Fottinger transmission, being dependent on the turbine speed, proceeds along a flat parabola. It is greatly influenced by the direction in which the blades are hit. If the oil enters the blades smoothly, there is a minimum of losses and the efficiency parabola reaches a peak. On either side of the peak, i. e. at lower and higher speeds of the turbine, the impact losses depress the efficiency. Depending on the size of conversion of torque great or maximum efficiency is obtained. In a concrete case a mean value is chosen with a satisfactory conversion of torque.

The energy lost in power transmission between pump and turbine by friction, impact and the like is transformed into heat. The working agent oil is getting hot. Therefore, a portion of the oil is withdrawn from the converter during operation, cooled in a cooler in an efficient manner and with low consumption of energy, and then returned to the converter. The oil temperature is controlled by a thermometer, and in the case of automatic cut-out of the installation, by a thermostat. With proper dimensioning of the cooler no trouble can arise from heating up of the Fottinger transmission. Heat abduction, though, from the transmission is not carried beyond 30 percent of the intake capacity in order to avoid too big coolers and to enforce economic operation. This is especially important for countries of warmer climates.

For reasons concerning design and hydraulics it is usually necessary that the converter runs at considerably higher speed than the engine. In these cases a gear transmission is placed between engine and converter. The gear ratio depends on the speed of the engine being used. The manufacturer of diesel-hydraulic locomotives, therefore, can choose among engines of various makes and with different speeds provided that the outer dimensions of the engines are approximately equal.

According to the experience of recent years the enquiries are centering more and more around locomotives with a maximum output at low axle loads. This offers ideal possibilities for diesel-hydraulic locomotives with high-speed engines. Three reputed companies of the German Combustion Engineering Industry (Daimler-Benz, MAN and Maybach) have, during the past years, developed special engines for locomotive service with capacities of 1000 HP at speeds of 1500 r. p. m. on orders of the German Federal Railway. The argument is frequently raised against this development from the low to the high-speed engine, that the latter of necessity would show higher wear and therefore shorter running capacity than the low-speed engine. Experience has not confirmed this view in any way. On the contrary, competent authorities of the German Federal Railway point out with all emphasis, that speed alone is no criterion for the specific exertion of the elements of an engine.

As is well known, American locomotive engines have speeds between 720 and 1000 r. p. m. In spite of this, however, due to their greater piston strokes they have piston velocities at these low speeds of from 7.9 to 9.7 m. p. sec. Compared with this the piston velocities of the railcar and locomotive engines used by the German Federal Railway are of practically the same magnitude, namely 10 m. p. sec. in spite of their higher speeds. The mean effective piston pressure of the German engines lies around 9 kgs p. sq. cm., that of the American ones around 9.5 to 11.7 kg p. sq. cm. This alone shows already that the specific exertion of the low speed engines is not necessarily less than that of the faster running German engines. In addition, the German vehicles are equipped with speed control, so that as a rule the engines are running at full speed but for a comparatively short period. Accordingly, the mean piston velocity actually performed is lower, if taken on the average over the entire life.

There is the additional problem of economy in maintenance and overhauling of the engines. As a matter of course, heavy engines are more expensive, as the price per kilogram of construction does not vary much between low and high speed engines. Spare parts of the low speed engines naturally are also costlier due to their greater dimensions and weights.

By corresponding design and appropriate dimensioning of the elements influencing the thermic behaviour, automotive diesel engines have reached from 150000 to 300000 km of running capacity between two overhaulings, and there is nobody today, who would be especially surprised about it any longer. High-speed railcar engines too have reached the 300000 km limit on a large scale, although still more unfavourable conditions prevail in their case than with locomotives. Setbacks must only be expected, if nsufficient attention is paid to the cooling cycle, if oil, fuel and air are not properly filtered, if frequent cold starts are performed, and if the requirements of the faster running engine are disregarded. This, however, is not only detrimental to high, but also to low—speed engines.

For stationary and also for marine oil engines for which running periods with very long interruptions and low speed are specified and where low weight is of minor importance, low speed may still be of advantage today, provided that they operate with lower piston velocity and a lower mean piston pressure.

In locomotive engineering, however, the aim must be to keep the dead weight as low as possible, for it must be carried over long distances and great differences of altitude, and must be frequently accelerated and retarded. It is, therefore, preferable to increase the motor capacity within the permissible range of weight, instead of dragging dead weight along.

High-speed engines are naturally of smaller dimensions. They require less space in the locomotive and permit, if necessary, erection together with the transmission directly on the bogie. If the engines are fastened to the main frame, their smaller weight permits lower engine heads, so that visibility of the line from the central driver's cabin is essentially improved.

WHAT ARE THE TASKS THIS DRIVING SET MUST PERFORM IN THE LOCOMOTIVE?

It must provide the possibility to start the locomotive smoothly with the acceleration ranging from the lowest to the highest feasible value.

This can be done without any difficulty. There is no mechanical connection between power intake and output, as the power is transmitted by the circulating oil. The engine speed is simply increased, starting from the idling speed, until the infinitely variable torque of the turbine exceeds the driving resistance. This turbine torque, however, being strongly stepped up yet on its way to the axle, is a multiple of the engine torque when starting, i. e. while the turbine still stops or turns very slowly. This means, that, if required, a great starting tractive effort can be exerted.

The driving set diesel engine—Fottinger transmission in the locomotive must ensure a tractive effort or a torque which, with rising travelling speed, drops in the shape of a hyperbola. This results from the fact that the engine capacity is constant. The practical requirements limit the known ideal hyperbola of tractive effort

$$Z \cdot v = c. N$$

in the direction of the ordinate by the available adhesion weight which determines the practically obtainable starting tractive effort, and in the direction of the abscissa by the desired maximum travelling speed. In order to satisfy both requirements, the Fottinger transmission for most cases must be built as multiple-step transmission, e. g. as shown in the illustration as two-step transmission, one transmission for two converters, one transmission for one converter. The problem was solved by various firms (Voith, Maybach, and others) in different ways.

(A) VOITH-TRANSMISSION TYPE L 36 R (FOR RAILCAR T 36R)

This transmission was developed for diesel locomotives and railcars up to 1000 HP.

It consists of one converter (I) for the start and two converters for medium (II) and high (III) travelling speeds.

For starting the fuel lever is placed into operating position and the converter (I) filled by the respective control elements. As soon as the locomotive has reached a certain speed which also depends on the speed of the engine, converter (I) is emptied and simultaneously converter (II) is filled until, at further increase of the travelling speed and depending on the engine speed, converter (III) is put in action.

The torques of the individual converters are transmitted by two reduction gears with various step-down ratios to the reversing gear. By the claw coupling, which must only be shifted at standstill, the forward or backward drive of the locomotive is realised.

(B) VOITH-TURBO TRANSMISSION TYPE L 3

Fig. 4. The turbo transmission type L 3 is especially designed for locomotive drive. A diagrammatic section

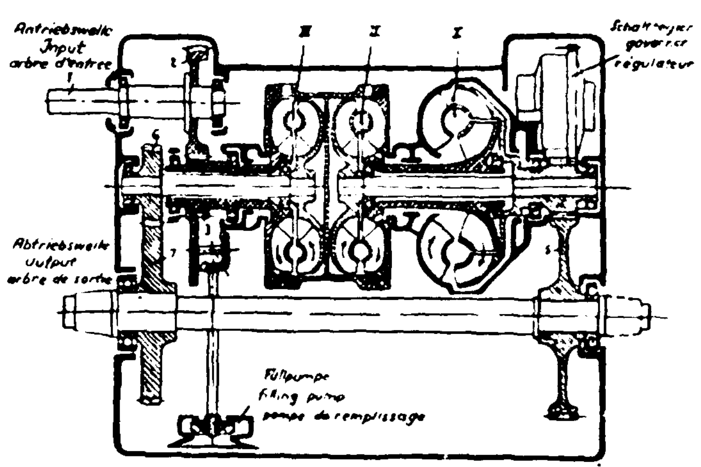


Fig. 4 Section through Voith Turbo Transmission, Type L 3. I Torque Converter, II and III Fluid Couplings.

shows fig. 1. It includes 3 turbo circuits, namely 1 converter (I) for starting and low-speed range and 2 couplings (II) and (III) for medium and high-speed range. All pump impellers of these 3 circuits are connected to the same primary shaft driven by the engine through the input shaft (1) and step-up gears (2), (3). The turbine runners of the converter and the medium-speed range coupling have a common shaft and drive to the layshaft through gears (4), (5), whereas the high-speed range coupling drives through gears (6), (7) with a lower ratio, thus giving the different speed ranges. The engaging and disengaging of the circuits is effected in the very simplest way only by filling and emptying. By this principle all gears remain in constant mesh and no friction or claw clutches, free wheels etc. are needed. Therefore, this transmission represents a construction simplified to the utmost extent in combination with a fully reliable automatic operation. In addition, this principle enables to prevent any essential dropping of the tractive effort during the change-over due to the overlapping of the emptying and filling of the circuits.

The step-up gear is provided for to get a primary speed high enough to reduce the dimensions of the circuits to a suitable figure and, in addition, it serves to adapt a certain size of transmission to various engines with different output H. P. and speed of rotation only by changing the ratio of the step-up gear.

The brain of the control consists of a small centrifugal governor, which operates the piston control valves effecting the filling of the circuits depending on the travelling speed of the locomotive.

The control impulses from the driver effect only the engaging and disengaging of the transmission as a whole. It is well proved practice to combine the operation of the fuel control lever for the engine in such a way that the transmission will automatically be engaged as soon as this control lever is moved from the idling position into the working position and vice versa. Thus, the driver has only to operate a single controller or handwheel, so that he is able to give full attention to the observation of the tracks and signals. Furthermore, it is made very easy to provide for remote and multiple control of the transmission.

For the starting of the locomotive the fuel controller has to be moved into the working position. By this, the socalled filling valve is engaged and the torque converter will be filled via the control piston valve. As soon as the locomotive has gathered the change-over speed, the centrifugal governor causes the emptying of the torque converter and filling of the medium speed range coupling and so on.

When entering a gradient the locomotive speed decreases, and a change-over back to the low-speed range coupling and converter is effected in a similar way as mentioned above. To observe a certain prescribed vehicle speed the driver has only to operate the fuel control lever to adapt the motor speed.

By moving the controller back to the neutral position the converters are emptied and the engine can idle while the vehicle coasts freely. Re-engaging is effected as soon as the controller is moved again into the working position, whereby that circuit will be filled which is connected up with the prevailing locomotive speed.

The character of the tractive effort speed curve achieved by a Voith Turbo Transmission of the type L 3 is to be seen from fig. 5.

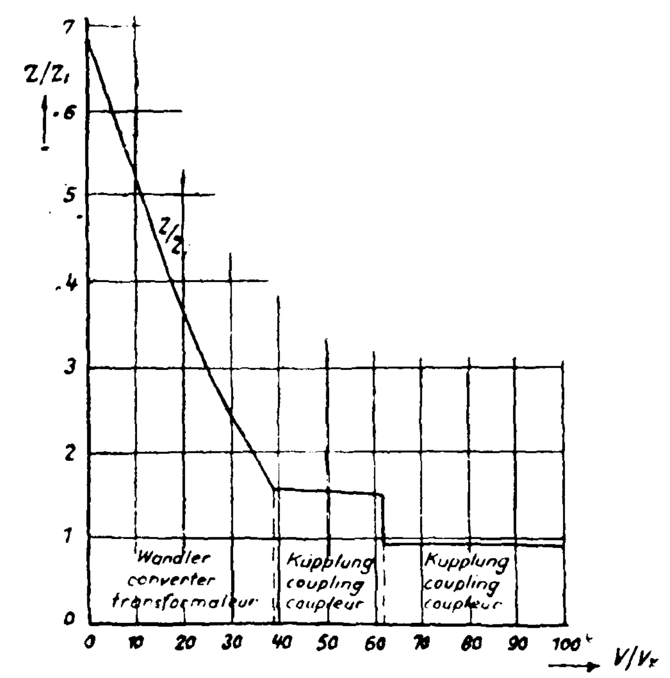


Fig. 5 Z-V Curve for Turbo Transmission, Type L. 3.

Fig. 6 Here you see a three-step converter by Voith.

In order to maintain a certain speed, all the driver has to do is changing the position of the fuel lever. This provides the possibility of a most simple remote-control, if several coupled locomotives are to be operated from one driver's cabin, as only the fuel lever (controller) must be remote-controlled for the regulation of the speed.

(c) A third type of hydraulic power transmission is the "Mekydro-Gear" of the Maybach Motorenbau A. G. With this system one permanently filled converter is used only, and a mechanical gear with several steps arranged behind it.

The outstanding feature of the hydraulic portion is the sliding turbine wheel with blades for forward and backward drive. While coupling, the forward blades

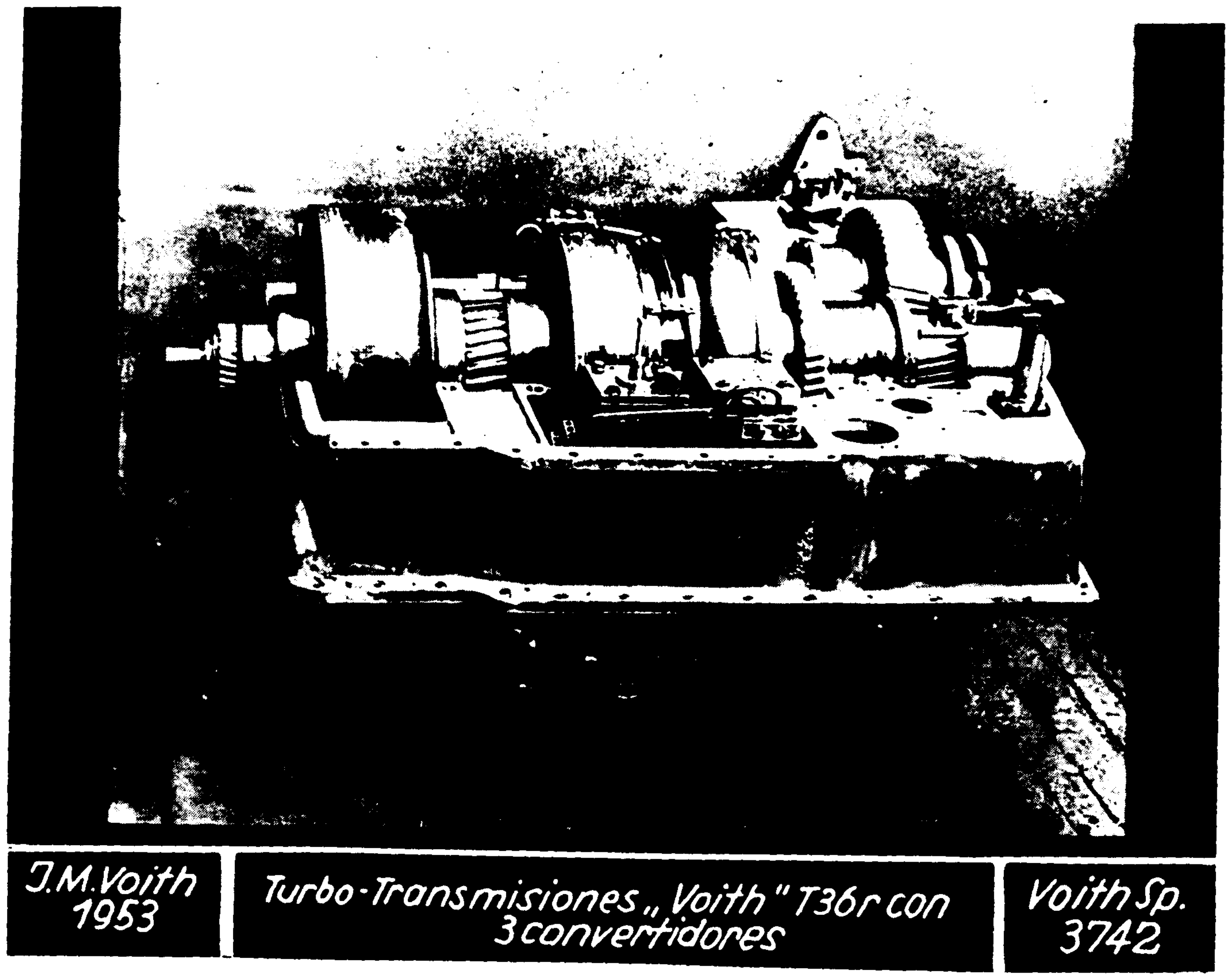


Fig. 6

are withdrawn from the cycle and the backward blades engaged. Thus the coupling claws for the speeds determined by the controller can be actuated most quickly.

Fig. 7 This transmission requires but one converter which alone transmits the torque and can operate with various reduction gears arranged behind it. As mechanical reduction gears require little space, this provides the possibility to build transmissions of a large range of speeds and small dimensions.

There is also a group of three spur gear sets which permits shifting of four speeds.

One the left you see the reversing gear for forward and backward drive.

In the Mekydro-Gear also shifting depends on the engine and travelling speed and is actuated fully automatically by an ingenious control.

The various steps are automatically engaged and disengaged by a claw coupling, and can be shifted by the retardation of a claw portion through the turbine wheel with backward blades.

The shifting from the first to the fourth step can be effected without loss of time in fractions of a second.

In the lower part of the illustration you see, as before for the Voith-transmission, the η diagram, i. e. again the efficiency plotted in this case against the speed, and furthermore the ZV—diagram showing the relation of the tractive effort to the speed.

A comparison of the traction methods produces the following result:

In line service the steam locomotive realises 6 to 8 percent and in shunting only 3 to 4 percent of the totally used energy. The diesel loco-

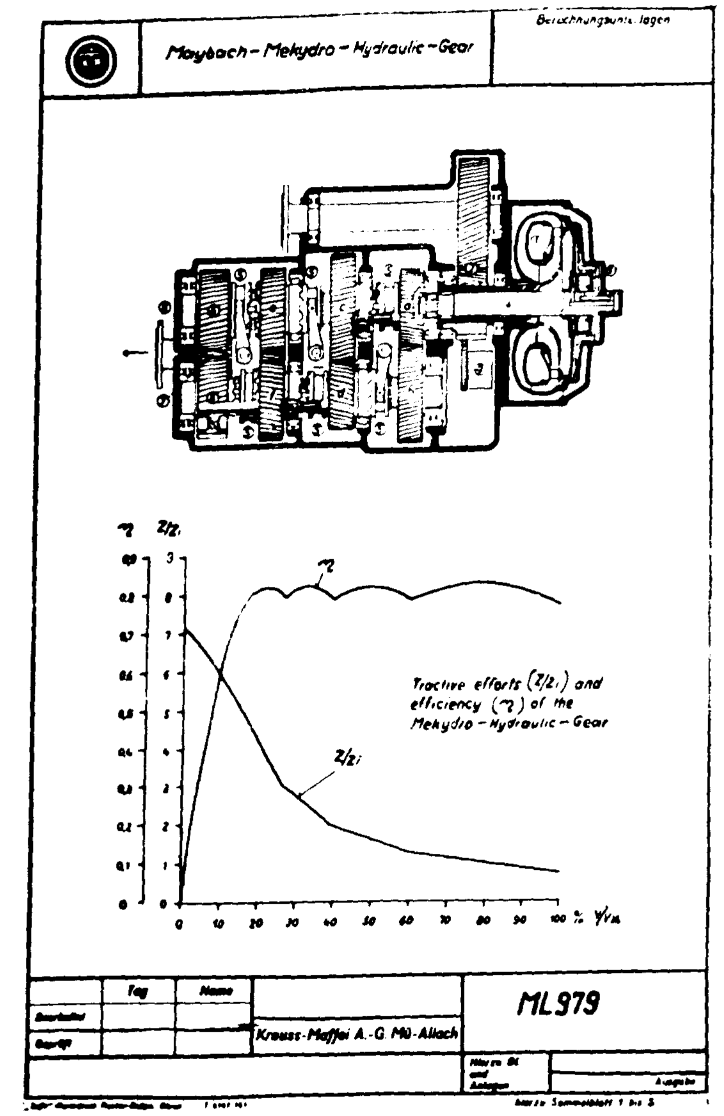


Fig. 7

motive, however, converts 24 to 26 percent of the energy into work on the draw hook.

Following are a few further advantages, although no doubt they are not unknown:

GREAT ECONOMY IN OPERATION

The diesel locomotive consumes fuel only while travelling, as the engine can be stopped at standstill. The fuel consumption is directly related to the load of the locomotive. The steam locomotive continuously burns coal even during standstills of extended duration in order to maintain steam-pressure.

AN ESSENTIAL SHORTNING OF SERVICING AND PREPARATION TIMES

There is no need of slag removing, boiler cleaning, feed water treatment, and feed water storing.

LONGER UTILIZATION PERIOD

Since only little time is required for servicing, preparation and repairs, the locomotive can be operated practically all day long. For this reason when changing over to diesel traction the number of locomotives can be decreased. Depending on operating conditions two diesel locomotives can replace three steam locomotives. Under especially favourable conditions two diesel locomotives can do the service of four steam locomotives.

LOW MAINTENANCE COSTS

As the power plant of the diesel locomotive consists essentially of comparatively light components which can be easily exchanged, repairs can be carried out more quickly and cheaply than in steam locomotives with their heavy bulky components as cylinders, pistons, rods, etc. There is also no need of such installations as coaling and watering stations and their maintenance costs.

SIMPLE OPERATION

The diesel locomotives, especially those with hydraulic power transmission are outstanding by the exemplary simplicity of operation. The sole operating element is a handwheel or a controller by which the engine capacity and thereby the travelling speed is regulated. Also the combustion of diesel oil in the engine is in no way depending on the skill of the operator, as against firing of solid fuels of various kinds in the steam locomotive, whose efficient combustion requires much training and experience of the fireman.

LOW COSTS FOR PERSONNEL

In contrast to the steam locomotive the diesel locomotive requires but one operator. Safety devices (dead-man installation) will stop the locomotive automatically in case of sudden incapacitation of the operator. The costs for personnel are still further lowered if for heavy trains or steep gradients several locomotives must be employed as in diesel traction by the use of remote-control several units can be operated from one driver's stand.

CLEAN OPERATION

No annoyance of passengers and operator by smoke, soot and smell.

FIRE HASARD

Diesel locomotives do not endanger forests of parched scrub and grassland by flying sparks. They can even be rendered firedamp-proof, which is of great importance if the locomotive must operate in the neighbourhood of explosive and hasardous materials, e. g. gasoline tanks, powder and amunition factories, oilwells, harbour areas, warehouses etc.

LOW WATER REQUIREMENTS

In regions where water is scarce or unsuitable, diesel traction is the solution.

LOW WEIGHT

Diesel locomotives are lighter than equally strong steam locomotives and require no heavy tenders for water and coal. They can therefore be built with less axles with the same axle load, or with lower axle load with the same number of axles.

SHORT OVERALL LENGTH

The overall length is of importance with regard to short platforms and especially to shunting lines. For the previously mentioned reasons the diesel locomotive can be built cheaper than a steam locomotive of the same power.

Fig. 8 and 9 give an interesting comparison :

Steam locomotives against diesel-hydraulic locomotives. Please compare the service weights of 117 tons against 60 tons, the adhesion weight of 50 tons against 60 tons, therefore full utilisation of the service weight. Also compare the axle load of 16 tons to 15

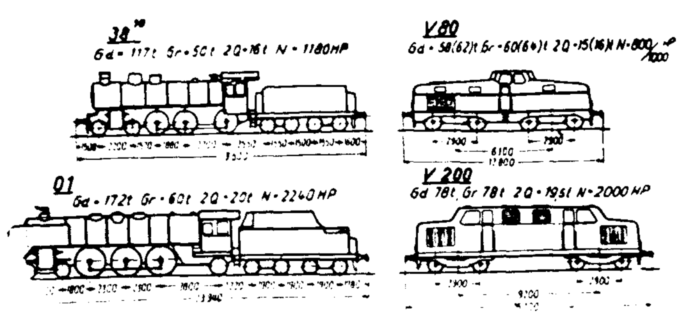


Fig. 8

tons with ballast 16 tons and the stated capacity of roughly 1200 HP to 800 and 1000 HP respectively. Note, therefore, the ratio of service to adhesion weight and the overall length of 18.6 to 12.8 meters.

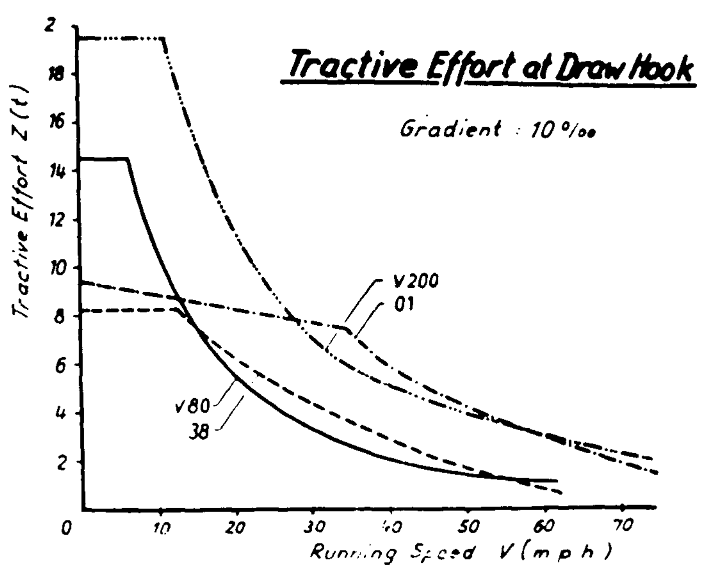


Fig. 9

In Fig. 9 you see the well known German express train locomotive of series O 1. compared to the diesel locomotive V 200 of the German Federal Railway.

The figures of the lower picture too are self-explanatory.

Service weight : left 170 to 72 tons

Adhesion weight : 60 to 72 tons

Axle loads : 18 tons

Capacity : 2240 to 2000 HP.

Below you finally see again the overall lengths of one or the other locomotive.

THE HIGH COEFFICIENT OF FRICTION

Due to the smooth power transmission to the axles one can figure with a coefficient of friction of ¼ with diesel locomotives as against the customary value of : with steam locomotives. The adhesion weight of the diesel locomotive therefore can be kept lower for the same initial tractive effort.

THE BETTER TRAVELLING CHARACTERISTIC

The diesel locomotive permits the use of simple bogie designs which ensure best travelling characteristics. Negotiation of curves by a bogie is considerably superior to that of a locomotive with fixed axles.

REDUCED WEAR OF RAILS AND TYRES

When bogies are used the angle of approach and the guiding forces in negotiating curves are less and therefore also wear of tyre and rail.

Uniform small wheel diameters for low and high-speed locomotives. As the motion possesses only rotating, fully compensated masses, the speed of the axles is not bound to the limits customary in steam locomotive engineering. This provides the possibility to equip high-speed locomotives with wheels of small diameters, in contrast to steam locomotives with rod drive, where wheel diameters for high-speed locomotives are getting larger and larger. The diesel locomotive therefore permits the use of uniform types for goods and passenger service.

Simple arrangements for taking on fuel, storing and maintenance of the diesel locomotive. They require less area loss equipment and correspondingly less investment than steam locomotives.

LOW COST FOR TRANSPORT OF FUEL

The higher calorific value of diesel oil as compared to coal, also the essentially better thermic efficiency of diesel engines, result in the fact that in diesel traction there is only 1/5 and less of the fuel quantity required than with steam traction. Where fuel must be carried to the consumers by rail, diesel traction requires only 10 to 20 percent of the transport capacity needed for steam traction. In addition, diesel oil can be pumped, whereas coal must be shoveled or necessitates special loading and unloading equipment.

GREATER TRAVELLING CAPACITY BETWEEN SERVICE STOPS

Due to the facts mentioned above the diesel locomotive can travel considerably longer distances without refuelling.

ABSOLUTE INDEPENDENCE

This advantage of the diesel locomotive is outstanding in comparison not only to electric traction with overhead wiring, but also to steam traction, as it is not depending on stationary service installation, as coaling and water stations, slag removing pits, etc.

Fig. 9 Here a ZV-diagram comparison of the tractive effort to the travelling speed of steam and diesel locomotives. Shown in fig. 8 Gradient O o/oo.

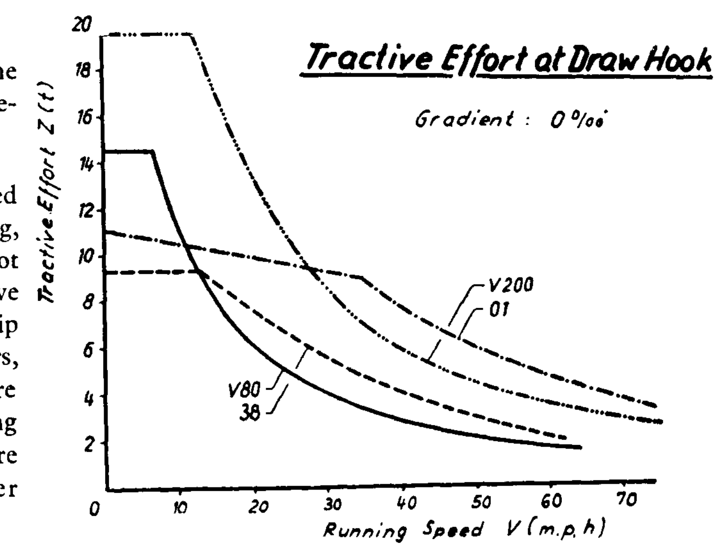


Fig. 10

The advantages of the diesel-hydraulic transmission are obvious. Even with lower travelling speeds there are much greater tractive efforts permanently available, which entail considerable improvements of the time table.

Remarkable are the higher maximum speeds of the Diesel loco. V 200 with 140 km p. h. as against series 01 steam loco. with 120 to 130 km p. h.

Fig. 10 These advantages of the diesel-hydraulic locomotives just mentioned are still more marked when gradients have to be overcome as here the weight of the locomotive takes effect. The surplus of tractive effort of the V 200 has considerably increased as compared to the illustration of the gradient of O o/oo.

BRITISH RAILWAYS' SAFETY RECORD

British Railways during 1953 recorded an average of only one passenger fatality in 71,000,000 passenger journeys and only one serious casualty in every 27,000,000 journeys, according to a report presented by Lieut.-Col. G.R.S. Wilson, Chief Inspecting Officer of Railways, to the Minister of Transport and Civil Aviation.

Referring to this report, Sir Brian Robertson, Chairman of the British Transport Commission, told a press conference: "We were pioneers in the building of railways; we have had the best railways in the world — and we will have them again".

Indian Standards Institution Notes

THE Indian Standards Institution has announced the publication of an Indian Standard covering expanded metal made from steel and used for general purposes.

The ISI has prepared this standard with a view to improving the quality of indigenous manufacture, and in implementation of the recommendation made by the Indian Tariff Board in its 1949 Report.

The Indian Tariff Board (now the Tariff commission) had estimated that the demand for expanded metal in the country was of the order of 3,000 tons a year and had opined that through strict adherence to standard specifications India could develop an export market also.

To meet the need of different types of plants manufacturing expanded metal in the country the standard specifies two long-way meshes in a number of cases for the same short-way mesh.

While the present standard confines itself to expanded metal intended for general purposes, the ISI has also under preparation a separate standard for expanded metal for use as surface reinforcement for concrete.

For the guidance of indentors a table has been included in the standard giving the sizes of expanded metal sheets normally carried in stock by Indian manufacturers.

The standard has been prepared by ISI's Basic Ferrous Metals Sectional Committee which includes nominees of: Army's Technical Development Establishment, Roads Organization (Ministry of Transport), Railway's Central Standards Office, Directorate General of Supplies & Disposals, Naval Headquarters, Bureau of Mines as also representatives of Indian Engineering Association, Engineering Association of India, Indian Institute of Metals, the Steel Re-Rolling Mills Association of India and other important manufacturing interests.

* * *

An Indian Standard Specification covering Reels for Electrical Winding Wire has been issued by the Indian Standards Institution.

This standard prescribes requirements for reels for covered, solid, round wire for winding electrical machinery and apparatus. The standard also lays down certain requirements for marking the reels and for reeling, packaging and labelling of wire. It reduces the wide range of sizes of reels at present in use with a special emphasis on design proportions. It lays down that a ratio of 2 : 1 between the flange and barrel diameters should not be exceeded. This provision is expected to lessen tension variations and to faciliate unwinding by the user. Apart from this, reel dimensions have been based, as far as possible, on sizes already in use in order to minimize modifications.

This standard has been prepared by ISI's Electrical Conductors and Insulators Sectional Committee which includes nominees of the Central Water & Power Commission, the Central Railway, Directorate General of Posts & Telegraphs, Engineer-in-Chief's Branch, the Government Test House, Indian Electrical Manufacturers' Association and other important manufacturing interests.

* * *

Indian Standard Specifications for Cotton-Covered Copper Wire and Enamelled Copper Wire have been issued by the Indian Standards Institution.

The Standard for Cotton-Covered Copper Wire sets out the requirements for High Conductivity Annealed Round Copper Wire having a cotton covering of one or two layers. It classifies the wire as 'Ordinary' or 'Fine' depending upon the thickness of cotton covering.

The Standard for Enamelled Copper Wire covers the requirements for High Conductivity Annealed Round Oil-Based Enamelled Wire used for winding coils for electrical machinery and apparatus. It specifies two classes of coverings, namely, normal coverings and thick coverings, but only a limited number of sizes having the thick covering have been included.

These standards have been prepared by ISI's Electrical Conductors and Insulators Sectional Committee which includes nominees of the Central Water & Power Commission, the Central Railway, Directorate General of Posts and Telegraphs, Engineer-in-Chief's Branch, the Government Test House, Indian Electrical Manufacturers' Association and other important manufacturing interests.

* * *

An Indian Standard prescribing methods for testing weight and uniformity of coating on galvanized iron and steel wires and steel sheets has just been issued by the Indian Standards Institution.

Zinc Coating or Galvanizing is a method of protection against corrosion applied to a greater tonnage of steel products than any other method of metallic finishing as it provides the most economical protection for products of the type to which it is properly applicable. The major established applications of zinc coating on steel products include roofing sheets, wire and wire products for all outdoor exposure, and articles fabricated from steel sheets such as cans, tanks, hardware for outdoor use, pipes etc. For proper protection of the steel, the coating should be uniform as well as sufficient.

There is as yet no single method by which both the weight of coating and uniformity of coating could be determined and hence, this standard gives two separate methods — the antimony chloride method for determining the weight of zinc coating and the copper sulphate dip test for determining the uniformity of zinc coating on galvanized iron and steel wires and sheets. A separate standard is under preparation for determining similar requirements in respect of galvanized articles other than wires and sheets such as bolts, nuts, malleable castings etc.

This standard has been prepared under the chairmanship of Shri J. S. Vatchagandhy of Tata Iron & Steel Co., with the assistance of nominees of Technical Development Establishment (Defence), Directorate General of Supplies and Disposals, Naval Headquarters, Indian Bureau of Mines, Roads Organization, Government Test House, Central Standards Office (Railways) & representatives of Indian Engineering Association, Engineering Association of India. The steel Re-rolling Mills Association of India and other important manufacturing interests.

* * *

The Indian Standards Institution has announced the publication of an Indian Standard Specification for Malleable Iron Castings.

Malleable iron castings are useful where the duty conditions call for a material which has resistance to shock, is ductile and is easily machinable. These castings, while not strictly malleable, are soft and can be bent by pressure or hammering without fracturing. Depending upon the process of their manufacture, malleable iron castings are known as white heart or black heart castings.

This Indian Standard covers the requirements for both black heart and white heart malleable iron castings, classified into three grades. It has been recommended that castings of Grade 1 be ordered where it is necessary to withstand pressure as in water and steam fittings; of Grade 2 for general purposes and of Grade 3, which are comparatively expensive to produce, for exceptionally high duty work. It is prescribed that ordinarily Grade 2 castings will be supplied except when castings of the other two grades are specifically required.

This standard has been propared by the ISI's Basic Ferrous Metals Sectional Committee under the chairmanship of Shri J. S. Vatchagandhy of the Tata Iron & Steel Co. Ltd. The Committee includes nominees of Army's Technical Development Establishment, Roads Organization, (Ministry of Transport), Central Standards Office (Railways), Directorate General of Supplies and Disposals, Naval Headquarters, Indian Bureau of Mines, Ministry of National Resources and Scientific Research, as also representatives of Indian Engineering Association, Engineering Association of India, the Steel Re-Rolling Mills Association of India and other important manufacturing interests.

* * *

An Indian Standard Specification covering special qualities of steel sheets has just been issued by the Indian Standards Institution.

This standard covers the requirements for Panel Sheets, Deep-drawing Sheets, and Enamelling Quality Sheets, with and without draw.

Steel sheets are now in increasing demand for a number of purposes many of which cannot be adequately covered by the commercial quality material ordinarily manufactured. A need has, therefore, been felt for an Indian Standard specifically covering steel sheets for use in special applications and this Standard covers the requirements for the material required for panelling, ordinary deep drawing work and for enamelling purposes, with and without draw. It does not, however, cover the extra deep-drawing quality material as it is generally understood since capacity for the manufacture of this type of sheets does not exist in the country as yet. Provision has been made in this Standard for the supply of steel sheets in any of the four finishes, namely cold rolled, roller levelled, stretcher levelled and oiled. Galvanized finish has already been covered by another Indian Standard and a separate Indian Standard is under formulation for tin plates.

Steel sheets are used for a variety of purposes and special quality steel sheets are available in a number of types and finishes. The manufacturers are, therefore, at times not in a position to supply the right type of material for want of adequate information from the fabricators of sheet metal products. The purchaser can get the material best suited for his purpose by furnishing the manufacturer with the fullest possible information on the purpose for which the sheets are required. In this connection, and Appendix has been included in the Indian Standard giving the particulars which would generally be of assistance to the manufacturers in deciding the type and finish of material most suitable for a specific application.

This standard has been prepared by the ISI's Basic Ferrous Metals Sectional Committee under the Chairmanship of Shri J. S. Vatchagandhy of Tata Iron & Steel Co. Ltd. The Committee includes nominees of Army's Technical Development Establishment Roads Organization (Ministry of Transport) Central Standards Office (Railways), Directorate General of Supplies and Disposals, Naval Headquarters, Indian Bureau of Mines, as also representatives of Indian Engineering Association, Engineering Association of India, Indian Institute of Metals, the Steel Re-Rolling Mills Association of India, and other important manufacturing interests.

* * *

STANDARD CODE FOR INSULATION AND OPERATION OF COLD STORAGES

The Indian Standards Institution has prepared and circulated for the purpose of eliciting comments a draft Standard Code for Insulation and Operation of Cold Storages.

Construction and operation of cold storages involves a number of problems among which are the economic running of the cold storage and the safety of the workers who would be moving in and out of the cold storage. At present the cold storage industry in this country is dependent upon technical data obtained from abroad and certain thumb rules for the construction and insulation of the cold storage. The operation of the cold storage industry is governed by provisions of the Factory Act to ensure the safety of the workmen.

The Refrigeration and Air-Conditioning Sectional Committee felt that a code of practice giving broadly the directions with regard to the construction, insulation and operation of cold storages would help the cold storage industry in following good practices and therefore has formulated this Code. The Code deals with terminology, insulation requirements, ventilation of the space below floor, of low temperature rooms and also the safety of workers in cold storage rooms and is one of a series of codes and standards being published by the same Committee to cover the refrigeration and air-conditioning fields comprehensively.

* * *

Standard Methods of Sampling Coal and Coke are contained in a standard just published by the Indian Standards Institution. For Coal this Indian Standard prescribes methods of sampling from coal seam in *situ*, normal consignments and large stacks; while for Coke, it prescribes the methods of sampling only from normal consignments.

The weight of gross sample to be drawn according to the size of the material and the weight and number of increments in which the sample is to be drawn are prescribed in the Standard. Also included is the method of reduction of gross sample from a bulk, which may be of the order of 1500 lbs., to the various individual samples for determination of moisture, ash fusion and other tests including laboratory analysis.

It is felt that further investigations on a statistical basis have to be carried out over a long period to achieve greater accuracy in the drawing of representative samples characteristic of Indian Coal and Coke. The Standard has, therefore, been classified as *tentative* and will be reviewed at the end of a 3-year period in the light of practical experience gained and the intensive investigations which are planned by the Fuel Research Institute, Jealgora.

* * *

A standard giving the methods of sampling and testing of refractory materials has been published by the Indian Standards Institution.

This standard is one of a series of Indian Standards for refractory materials and deals with the methods of sampling, chemical analysis and physical tests for fireclay and silica refractories and fireclay mortar. The general requirements for these items were laid down in standards published earlier by the ISI.

The methods for testing fireclay refractories were included first in the Indian Standards for the three

grades of fireclay refractories published in 1949 and revised last year. For convenience in handling, these test methods applying to fireclay refractories have now been published in a separate standard along with methods for testing silica refractories and fireclay mortar. As and when Indian Standards are issued for other types of refractory materials the additional methods of tests which might be necessary would be incorporated in this standard.

The Refractories Sectional Committee which was responsible for preparing this standard appreciated that as the service conditions varied from industry to industry, it would be necessary to conduct detailed surveys of these conditions before specific requirements to be met with by the refractories for different applications could be laid down. Such surveys, it was felt, would take a long time to be completed and therefore for the present it is emphasised in the standard that though a number of tests have been prescribed, yet all the tests need not be conducted in each case since by a judicious application of some of the tests it should be possible to assess the quality of the material in a given lot. However, the tests to be conducted in each case would depend upon the service conditions for which the material is intended.

To guide testing authorities and suppliers, the minimum size of sample and the minimum quantity of test material have been specified in the standard.

The general principles involved in the sampling of refractory materials and finished products are contained in an appendix to the standard.

The Refractories Sectional Committee which has prepared this standard includes refractory makers, users and testing organizations.

* * *

INDIAN STANDARD SPECIFICATION FOR DOMESTIC WATER METERS

The Indian Standards Institution has prepared for circulation and comments a draft Standard Specification for Domestic Water Meters.

Domestic Water Meters are used to measure supply of water to houses and factories and are mostly imported from U. K., U.S.A. and the continental countries. Only one factory in India manufactures half inch water meters.

The variety in design, performance and accuracy of imported water meters has caused difficulties for purchasing departments in evaluating comparatively the efficiency of these meters. ISI's standard has been prepared to help purchasing departments by indicating specific requirements for materials and construction of the meters as also by detailing their performance requirements. The standard covers meters for $\frac{1}{2}$ in., $\frac{3}{4}$ in., 1 in., $1\frac{1}{2}$ in. and 2 in., pipe lines.

Among performance requirements the Indian Standard specifies hydrostatic test, nominal capacity, continuous running capacity, metering accuracy at lower limit of flow and permissible error at continuous running capacity. It also specifies details of Type Tests and Acceptance Tests, among which is included a Life Test which requires the meter to operate continuously for a period of 60 days without showing any sign of deterioration at the end.

PUSH-BUTTON SHUNTING CUTS OVERHEAD COSTS

A revolutionary British automatic system of handling trains of wagons in marshalling yards has been developed which, it is claimed, reduces the cost of installation to one-third and makes running costs very much lower. The first installation of its kind in Britain — and, it is believed, in the world — was recently set up at the British Electricity Authority's power station at Leicester by the manufacturing company which designed it. A similar installation has been laid out at the National Coal Board's plant at Dalkeith, Scotland, for coal preparation.

Mr. F. G. Mitchell, chairman of the company, originally thought of the idea during the war, when he was grappling with the problem of handling wagons in the black-out. Since then, his company has developed the system to handle coal at 1,000 tons or more an hour — a rate of delivery needed by the big power stations now being planned, and virtually unattainable by the use of conventional man-handling methods. There is no limit to the size or capacity of this system, which can be designed for factories, steel works, mines, power stations, dockyards — in fact, anywhere there are marshalling yards or incoming trainloads of wagons.

Main advantages claimed for the new system are: it can cut by half the site area are required, thus reducing the cost of sidings and their maintenance, and reducing the length of track required; it eliminates man-handling, and can be operated 24 hours a day in all weathers; and it saves manpower.

RAILWAY OFFICIALS' GAZETTE

NEW GENERAL MANAGER OF WESTERN RAILWAY

We welcome the new General Manager of the Western Railway, Shri P. N. Saxena and wish him success in his present assignment.

"Well, I think Saxena will be a better selection; he certainly has the dash and the push; anyway, I don't think he will be fishy".

These were prophetic words, for the events that have followed since the occasion that gave rise to these words, have proved the intrepidness of Saxena who has now been for some years running the administration of the Indian Railways from the chair of the Director of Establishment, Railway Board. Establishment matters are perplexing ones, and even the keenest brain of an engineer would sometimes be baffled, and so, Saxena is no exception to it. The zonal re-grouping has added greater complexity.

The spider-like railway systems and routes in this vast land, have to be kept constantly flowing with goods and passenger traffic; the variety of human minds that have to be tackled, and all the rest of it; these present difficulties, and the fact that since the partition of the railways, Saxena has played a great and important role in shaping the destinies of the millions of railwaymen, whom he has managed to keep firm in their saddle, is further proof of the talents, capacities and industry possessed by him.

If, in the history of the Indian Railways, there was an occasion to remind its workers of their past tradition, conduct, achievement and enterprise, it is now when a retrospect and prospective appraisal has to be done.

When Saxena was called upon to take charge of the personnel branch of the then East Indian Railway, many thought that he would not acclimatise himself to the tentacles that faced him. It was a peculiarly difficult time. Mother India was in the throes of a childbirth; division of the country was clearly visible in the horizon; the communal carnage had only partly subsided; the option of many technicians to Pakistan meant a void that could not be filled; the Pay Commission recommendations had just come in for implementation; and labour problems were assuming immense proportions; in short the entire railway system was so to say in pell-mell.

Saxena with his ingenious brain of an adept engineer decided that he must make history and applied himself to the task before him sedulously and courageously. Soon he found that success was on his side, for, he had as his chief one of the ablest General Managers whose behest it was that the time-honoured tradition of delay and denial in personnel matters should be done away with. Suffice it to say that Saxena was full up to the game.

When the Central Pay Commission's recommendations had to be implemented it was his brain that thought of a short-shrift to the entire new pay structure and within a few days Saxena prepared a chart—and named it as Saxena's Chart which was hailed as a ready reckoner.

Shri P. N. Saxena.

Similarly, when it came to the question of tackling the railway unions and its Federations in their regular and special meetings, as also at the Joint Advisory Committee discussions, Saxena would face the assembly fully armed with all weapons, and while he would calmly listen to the hot discussions, he would fain proffer unwittingly any remark, but, in the end when his turn came he would pounce upon his prey with vehemence, and naturally, victory was his.

It was a strange coincidence—and perhaps not a happy one—Saxena who was responsible for expanding the grainshop facilities to the railwaymen, had at a later date also to curtail those very facilities as a member of the Grainshop Enquiry Committee. It was an irony of fate that what he gave with one hand he had to take away with the other hand.

Shri P. N. Saxena who has taken over charge as General Manager, Western Railway was born in Jhansi on 29th January 1901. After a brilliant academic career having stood first in the University in the Intermediate Examination and securing first division in B. Sc., he joined Thomson College, Roorkee in 1921. He took his civil engineering degree in 1924 with high distinction. He secured two gold medals for first place in Mathematics and Mechanical Engineering.

Joining the Indian Railway Service in 1924 after a brilliant academic career, Mr. Saxena was posted on the Oudh and Rohilkand Railway which was subsequently merged with the East Indian Railway. He spent his first few years with the railway mainly on projects and construction works. In 1931 he completed a referesher course at the Dehra Dun Staff College, standing first among Officers of various Railways in India.

In 1938 he took charge of the Office of Superintendent, Way & Works, and subsequently worked as Divisional Personnel Officer for four years from 1941. In November, 1945, he was promoted Deputy Chief Engineer and some time later was appointed Deputy General Manager (Grainshops). He took charge as Deputy General Manager (Personnel) in November, 1947, and two months later he was selected as Divisional Superintendent, Howrah, and worked in that capacity at Howrah and Moradabad upto July, 1949, when he was promoted as Director, Establishment, Railway Board which post he held till his appointment as General Manager of the Western Railway in succession to Mr. K. P. Mushran, who is now a Member of the Railway Board.

Mr. Saxena was a member of the Joint Advisory Committee for two years. He has also worked on the Gadgil Committee appointed by the Government in 1952 to go into the question of merging dearness allowance of Government employees with their salaries.

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SHRI GHANANAND PANDEY, CHAIRMAN OF THE RECONSTITUTED RAILWAY BOARD

We welcome the appointment of Shri Ghananand Pandey, Chairman of the newly reconstituted Railway Board.

Shri G. Pandey.

Shri G. Pandey graduated in Science from the Muir Central College, Allahabad University in 1922 and later obtained a Degree in Civil Engineering from the Roorkee Thompson Civil Engineering College.

Starting his early career as an Apprentice Engineer on the East Indian Railway in November, 1926, Shri G. Pandey was confirmed as an Assistant Executive Engineer, Open Lines, in 1929 which post he held till 1932. During this brief period he was also actively associated with the Rishikesh Karanprayag Railway Survey. Recognising the talents in him to deal with Staff matters the East Indian Railway Authorities entrusted him with the work of the Assistant Personnel Officer in 1932 which post he held till 1934. Again he was transferred to the Open Lines as Assistant Executive Engineer. Between 1940 and 1947 he held various offices as Superintendent, Way & Works, Allahabad, Moradabad and Dinapore, Personnel Officer (Senior Scale), Asansol and Head Quarters Office, Executive Engineer, Construction & Doubling, and ultimately as Deputy General Manager (Planning) in the East Indian Railway.

In recognition of his valuable services rendered to the East Indian Railway Administration in various capacities and for displaying commendable originality in tackling several engineering problems, he was promoted as Joint Director, Civil Engineering, Railway Board and later as Director, Civil Engineering, Railway Board, New Delhi.

Subsequently he was posted as Engineer-in-Chief, Ganga Bridge in 1948-49 and later again transferred to the Railway Board as Director, Civil Engineering.

On 1st October, 1950 he was appointed as General Manager of the then O. T. Railway with Head Quarters at Gorakhpur and subsequently he was appointed as the General Manager of the North Eastern Railway, Gorakhpur, when this zone was formed under the Integration and Re-organisation of the entire Railway Systems in the country, on 15th April, 1952, which post he held till 28th August, 1953 when he was given charge of the 16-Crore Project at Mokameh as General Manager and Chief Engineer.

Shri Pandey's work at the Mokameh project had been commendable and he solved many engineering problems that nad cropped up at the project and this has been due to his valuable engineering talents and administrative experience which had been very helpful in forcing the pace of progress.

We wish Shri G. Pandey all success in his new assignment as Chairman of the Railway Board and hope he will bring into display all his valuable engineering talents and administrative experience to help the Railway Minister, Shri Lal Bahadur Shastri in pushing forward several big expansion schemes drawn up under our National Development Plans, with the co-operation of his colleagues who have also been drafted on the Board from their erstwhile positions on various zonal Railways.

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SRI W. P. NIYOGI

Sri Wooma Prasad Niyogi was born of a middle class family of Hooghly district in West Bengal in 1919 and was educated in the Hare School and St. Xavier's College of Calcutta. On completion of his academical education he joined the then Bengal and Assam Railway as an apprentice in 1937 at the Kanchrapara workshop. He finished his training in Railway Carriage building and started serving the B. A. Railway from [illegible]42 and continued to serve the E. I. Railway, on the former being amalgamated with the latter due to the partition of India.

Having shown his special interest in learning his job, he was granted special leave to proceed to U. K. in 1951, to obtain advanced training in Carriage and Wagon building on modern methods. He had a specialised training in Steel Coach constructions at Messrs. Metropolitan-Cammell Carriage & Wagon Co. Ltd., Birmingham, England for two years and now he is working as

Sri W. P. Niyogi.

an Engineer with Messrs. Waggonfabrik Talbot, Aachen, Germany for the past one year to gain experience in modern production methods carried out in that country.

Very recently he has been selected by the Indian Government to proceed to Switzerland to obtain a specialised training in Integral Coach building at Messrs. Swiss Car & Elevator Manufacturing Corporation Limited, Schlieren, Zurich for six months. On his return to India, he will be posted at the Integral Coach Factory, Perambur, Madras.

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