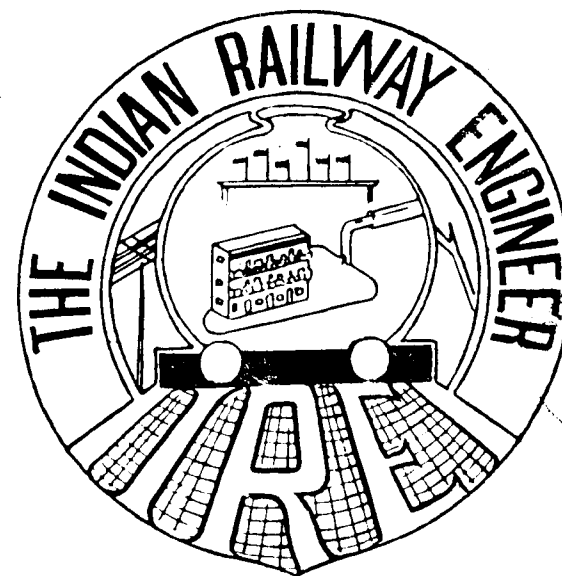
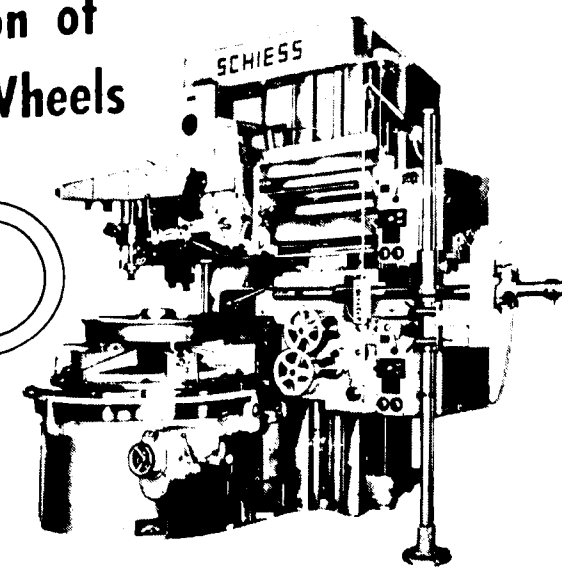
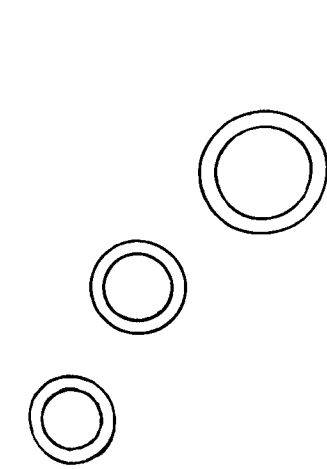


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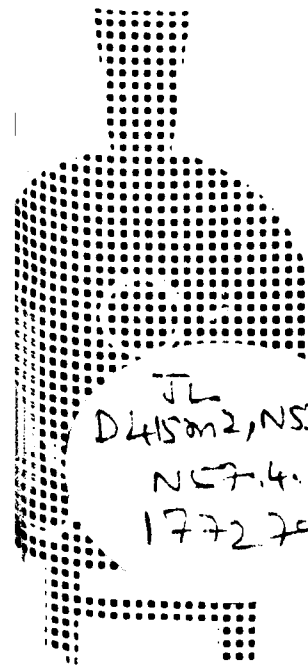


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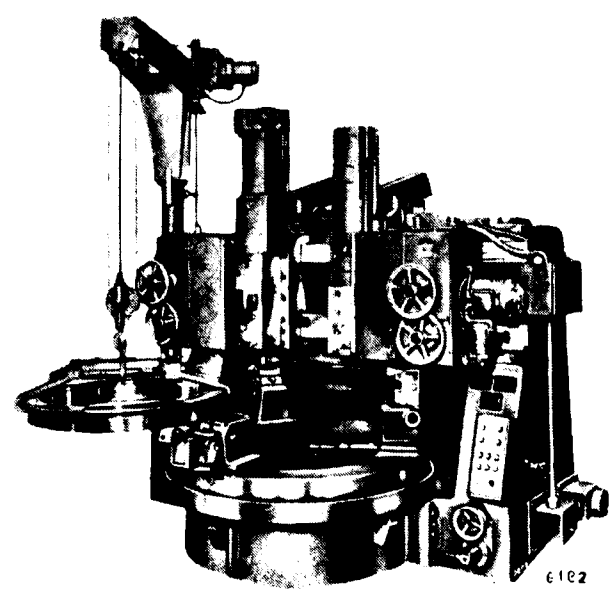


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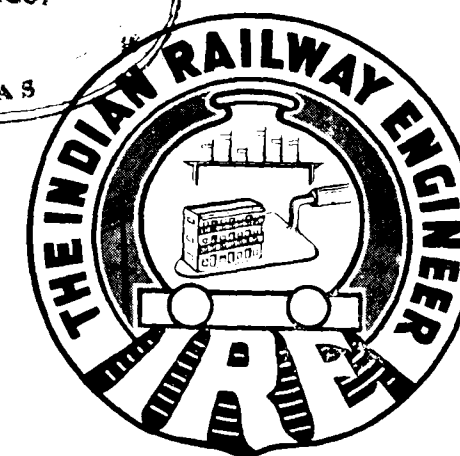


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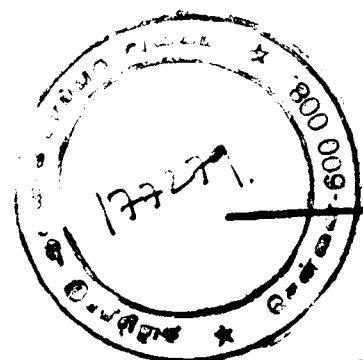
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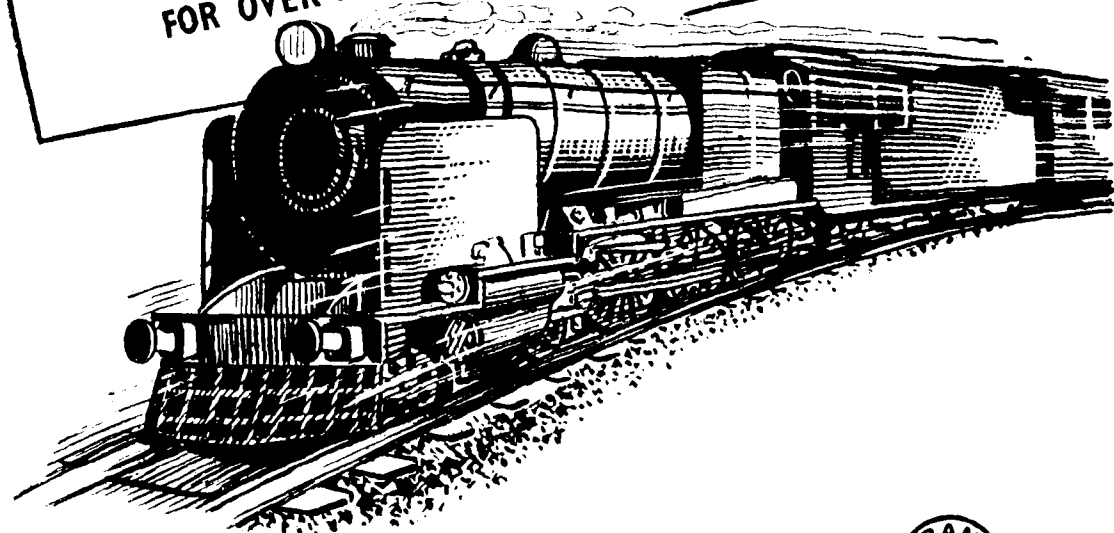
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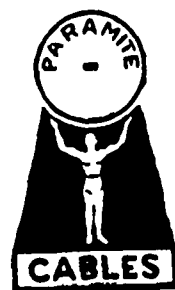


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A Search for Improvements on Railways

INDIA has been dubbed an Industrially Backward Country. Though we do not deserve that sobriquet as far as our Railways are concerned, we certainly cannot afford to indulge in complacency.

Periodically foreign railways carry out a sort of a heart searching in their efforts to effect improvements and it would not be out of place if our Railways did the same thing in the New Year now started.

A recent American Survey carried out in search of measures to force the pace of improvements indicates the following avenues towards which the attention of our Railway staff in the higher rungs of the ladder may be directed.

CONTINUED MODERNISATION

If we are to keep abreast of Railways abroad it is necessary to focus our attention towards Modernisation. We must study and put into use as far as possible :

- (a) The tremendous improvements made by the French Railways, with their locomotives, steam, diesel and electric.
- (b) The phenomenal increases in speeds (achieving the high figure of 205 miles per hour).
- (c) The techniques which are incorporated in the task of maintaining their tracks to a high degree of perfection, thus permitting those high speeds.
- (d) The modernisation of machinery, plant and equipment in the shops whereby production is increased and repairs performed in record times.
- (e) Modernisation in offices, by the use of card punching systems, computing machines, tape recorders of conferences, quicker filing and recording systems, whereby, by means of cross references, the required information can be turned up in minutes instead of hours, simplification and general mechanisation of a larger amount of paper work.

MORE ECONOMIC MAINTENANCE

Locomotives, Carriages, Wagons, Tracks, Bridges, Buildings, Signalling equipment etc. all require maintenance. Any methods which can be devised which would reduce maintenance costs, without sacrificing safety and efficiency should be introduced without loss of time. A saving of a few rupees here and a few rupees there can soon amount to lakhs in a big organisation like the Railways.

Hot boxes are a constant source of loss in earnings and a ceaseless attack on this problem by which minimum stock is put out of commission appears to be called for.

INCREASED TRAIN SPEEDS

Foreign Railways are continuously increasing their train speeds, by better track maintenance, improved signalling, more powerful locomotives, roller bearing axleboxes and such devices. We cannot say that we have come to the pinnacle of our achievement. If rail roads of America can run their freight trains at average speeds of 35 miles per hour, surely we can push up our average speeds a couple of miles higher. Higher speeds means more freight trains disposing of goods and merchandise faster and adding to railway revenue. French Railways using Electric Locomotives on their main lines can run their passenger trains at much higher average speeds than a few years ago, because there is no loss of time at watering stations in taking water and cleaning fires and loading more coal.

IMPROVED MARSHALLING YARDS

Although much improvement has been made in pushing out more goods trains from our marshalling yards there are still bottlenecks which have to be liquidated. Better control from a central cabin by the introduction of retarders, causing less damage to wagons by violent impacts, and the resultant shifting of loads and damage to consignments for which railways have to pay in claims would be steps worth pursuing. The speed of marshalling could certainly be improved by using modern devices of communication between the central cabin and others spread out by which messages are transmitted without loss of time.

INCREASING LINE DENSITY

Foreign countries by the use of the most modern types of signalling devices have been able to increase their line density, that is more trains per track mile. So much has been achieved in this direction that instead of adding tracks which are most expensive in prime cost and then on maintenance, existing tracks have been uprooted as being redundant to traffic needs. Better control of goods trains and shorter intervals apart both in time and distance would mean more trains. The quicker turn round of wagons and their intensive usage to deal with the increasing demand to more goods and merchandise must be constantly in the mines of our Railway Transportation Departments. Greater co-ordination and co-operation between Railways of the various groups which are all now under a unified head, the Government, would make for better efficiency. The handling of repairs at the nearest workshop or shed wherever the failure of the rolling stock occurs instead of long leads to parent workshop or sheds would all help to accelerate the operation of trains and intensify their usage.

TRAINING OF PERSONNEL

A Railway can only be as efficient as the staff manning it and if this principle is appreciated the need for a greater accent on training at all rungs of the ladder will be conceded.

Apprentice mechanics and trade apprentices must be given sound basic training of their trades, both in theory and practice. The training imparted to these lads should not be left to

chance but there should be supervisors from experienced and retired tradesmen who will be able to impart to these raw lads some of their knowledge and skill. Before putting these retired tradesmen as instructors, they should be given an intensive training and their faults should be corrected. Once they are put in charge of lads learning a particular trade, they should be with the lads all the time, instructing them, showing them the best methods, correcting faults etc. These instructors should submit weekly progress reports and comment of each lad's ability to absorb the instructions given.

Training in foremanship and supervision must be given in the form of courses laid down by the T. W. I. Organisation. These courses well learnt will improve the standard of supervision and help supervisors to get a greater output from the same number of men as he had under his control originally.

Courses must be made available in Management to which all officers should be encouraged to attend as far as their respective work is concerned.

Refresher courses should be always available in a central place to which all staff in batches should be permitted to go to keep in touch with the advances made in their respective works and techniques. Examinations should be conducted at all levels and those who pass should be made eligible for promotion.

MINIMISING OFFICE WORK

As far as possible office work should be minimised. Instead of writing long letters encouragement should be given to telephone conversations and brief notes concerning them. Conferences should be had on important matters and tape recordings should be made of policy decisions. Standard forms should be introduced, the failing of which will either ask for or obtain the desired information in a nut shell. Comptometers, tabulating machines, dictaphones etc., should find a ready place in a modern office. Proper recording and filing systems in keeping with modern practice should also be introduced.

COMMERCIAL SIDE

Better relations with the public using the railways should be established. As far as humanly possible, merchants should be assisted in the transport of their goods and materials. According to their needs wagons should be put at their disposal and should be handled expeditiously. Damage to consignments by improper packing and loading should be, as far as possible, reduced so that the claims for damage of goods or their loss in transit should be brought down to the lowest level.

Courtesy to passengers by staff of every grade should be ingrained into every railway-man so that it becomes a part and parcel of his life. Like the boy scout his motto should be to help a passenger without even being asked as often as he can. Doing his job without fear or favour and without the expectation of any remuneration should be a guiding principle in railway-man's life.

The business of every railwayman is to sell transport and he should take every opportunity of his contact with people outside the railway world to place before them advantages of rail travel for passengers and goods transport for goods and merchandise.

ELIMINATION OF UNPROFITABLE TRAIN SERVICES

Many times unprofitable train services whether for goods or passengers cause a serious drain of the railways revenues. Such services particularly on branch lines should be under regular scrutiny and from time to time decisions should be taken to eliminate the unprofitable ones. Before eliminating these services, however, every attempt should be made to improve traffic by analysing the prevailing position and by introducing judicious propaganda to entice more traffic. The closing of the service should be the last resort.

These are just a few of the avenues along which a search should be instituted. There may be many others which will strike Railwaymen in their own spheres of activity.

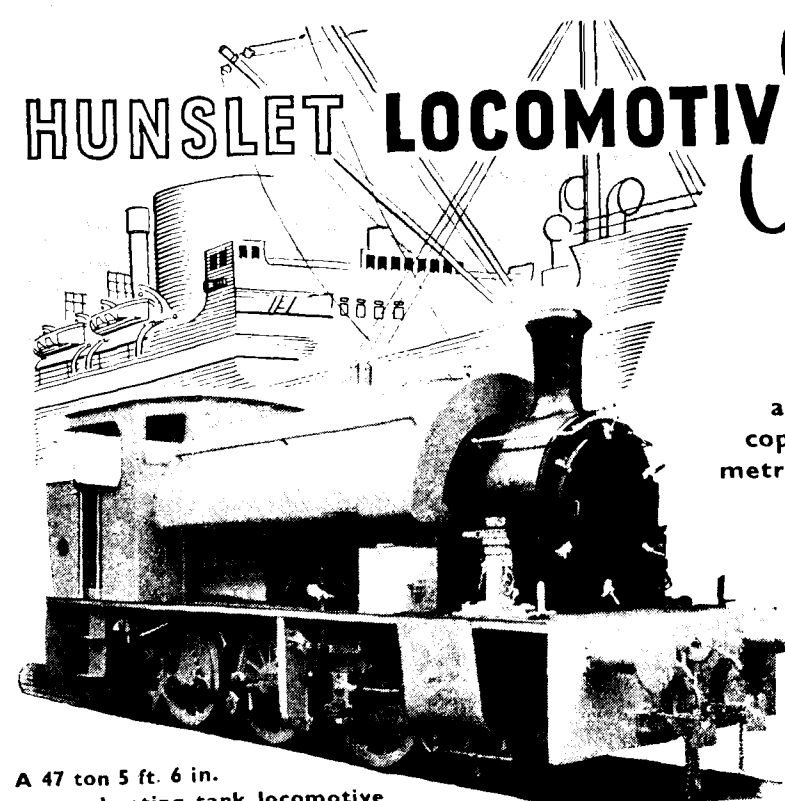
SOUTHERN RAILWAY LINE TO BE DOUBLED

The construction of an additional line between Chinnaganjam and Kadavakuduru on the Bezwada-Madras line of the Southern Railway has been sanctioned by the Railway Board at a cost of Rs. 9.5 lakhs.

The Bezwada-Bitragunta section of the Bezwada-Madras line, on which Chinnaganjam and Kadavakuduru stations are situated, is one of the heaviest single line section on the Southern Railway so far as density of traffic is concerned. Traffic is likely to increase considerably during the second Plan period. This has made the doubling of the Chinnaganjam and Kadavakuduru portion, a distance of two and a half miles, necessary.

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Studies in Impregnation of Brick-Tile with Road Tar No. 3 and Structural Properties of Unimpregnated and Surface Impregnated Brick-Tiles

★ By H. L. Uppal, M.Sc., Ph.D., F.N.I., Director

and

Mohinder Singh, B. Sc., (Hons.) M.Sc., Asstt. Research Officer

SYNOPSIS

EXPERIMENTS were carried out on the determination of the rate and quantity of penetration of road tar into brick tiles and the comparison of structural properties of these impregnated brick-tiles and ordinary well burnt normal brick-tiles. The properties studied were :—

1. Rate and quantity of penetration of road tar.
2. Permeability.
3. Adhesion to cement sand mortar.
4. Compressive strength.
5. Absorption.
6. Density.
7. Durability against action of salts in Soil and in solution.

It was noticed that except for adhesion strength with cement sand mortar and density there was a substantial improvement in other properties of impregnated brick-tiles with road tar over ordinary brick-tiles.

During study of action of sulphate in soil on the impregnated brick tiles it was noticed that the impregnated brick tile appeared immune from the action of salts in the earlier years but the long time study revealed that failure in this case also happened.

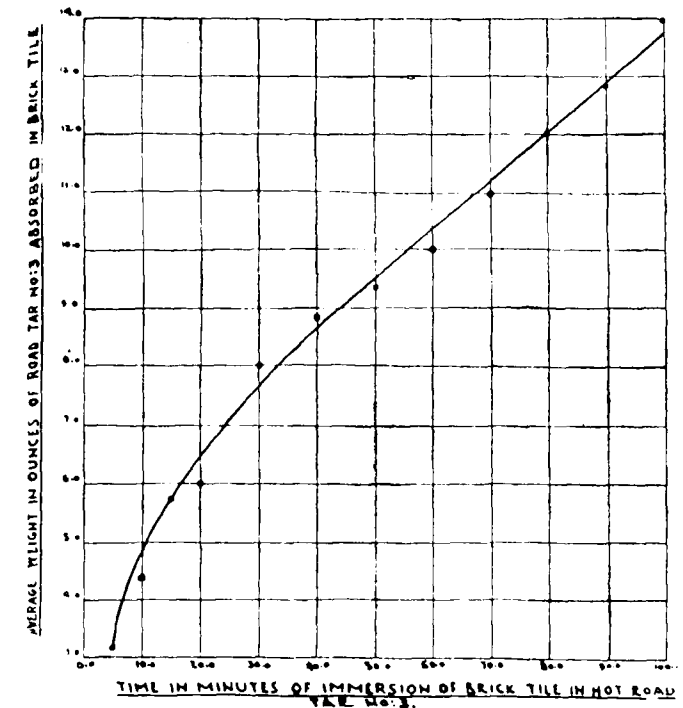
INTRODUCTION

An ordinary brick-tile is very porous. It is also not very strong structurally for large loads under compression and is subject to disintegration by the action of sulphates in water and soil. As the brick-tile had been adopted for use in the lining of Irrigation Channels in India it was considered necessary to study its different properties as such and after impregnation or coating with tar or bitumen. The expectations were that the brick tile would be made impermeable and immune against the action of salts. All these points, together with penetration of the material required detailed investigation. These are briefly described below :—

★ Irrigation and Power Research Institute, Punjab, Amritsar.

CURVE SHOWING THE ABSORPTION OF ROAD TAR NO. 3 IN A BRICK TILE (12X6X2)

TEMPERATURE OF ROAD TAR DURING IMMERSION OF BRICK TILE = 220° F. TO 260° F.



STUDIES No. 1

Rate and quantity of penetration of road tar into brick tiles.

The brick-tiles selected were normal well burnt of sizes 2" x 6" x 12". To avoid presence of any moisture in the tiles, freshly burnt brick-tile from a kiln were purchased. Road tar No. 3 was heated to a temperature of 260 F. The brick-tiles which were previously weighed in lots of six brick-tiles were completely immersed in tar in the drum. The brick-tiles were allowed to remain in the bitumen for five minutes for the first lot and 10, 15, 20, 30, 40, 50, 60, 70, 80, 90 and 100 minutes respectively for the next consecutive lots. The temperature during the period of immersion was kept between 220 F and 260 F.

The lot of six brick-tiles was taken out of the tar after desired period of immersion and the extra tar allowed to drip into another pan. The brick-tiles were placed on two rods kept at a suitable distance on the top of the pan. After the brick had cooled down and extra tar dripped these were weighed in order to get the weight of tar soaked into these brick-tiles.

To measure the depth of penetration, the bricks were then broken and depth of tar soaked measures at various points. The depth of penetration was taken to a point to which colour change of the brick-tile was brought about by the dark colour of the tar.

The results of penetration of tar into the brick-tile of size $2'' \times 6'' \times 12''$ are tabulated in Table 1. The weight of tar absorbed by the brick-tile at various intervals of time is given in Figure 1.

CONCLUSION

It would be noticed from the Table No. 1 that :—

- (i) The rate of penetration of Road Tar No. 3 into the brick tile was higher in the initial stages and slowed down with increase of time.
- (ii) A brick-tile of $2''$ thickness was not completely penetrated in a period of continuous immersion of even 100 minutes in road tar No. 3 in hot condition. An unpenetrated core of size about $0.3'' \times 4'' \times 10''$ was left in the centre of the brick tile of size $2'' \times 6'' \times 12''$. The volume penetrated was 108 cu. inches out of total volume of 144 cu. inches of the brick-tile. 36 cu. inches were left unpenetrated in 100 minutes of immersion in hot tar.
- (iii) The weight of Road tar penetrated in period of 100 minutes was 14 oz. The full penetration of brick-tile of the size $2'' \times 6'' \times 12''$ would require about 18 oz. of the tar.
- (iv) The voids in the brick into which tar had penetrated were seen not to have been completely filled up with tar when examined on breaking and noticing with naked eye.

No. 2. PERMEABILITY

The following are the results of tests on permeability of ordinary unimpregnated brick-tile of impregnated brick-tile :—



Fig. 2. Condition of deeply tar impregnated brick-tile about a month afterwards of the first appearance of cracks at the top end.

1. Unimpregnated ordinary well burnt brick-tile of $1\frac{1}{2}''$ thickness (brick size $1\frac{1}{2}'' \times 4\frac{1}{2}'' \times 9''$) at a head of $6''$ of water—2 to 3 cusecs. million sq. ft. wetted area.
2. Tar impregnated brick-tile of $1\frac{1}{2}''$ thickness (impregnation done of brick-tile as available) under 5 ft. head of water—0.25 cusecs./million sq. ft. wetted area.
3. Tar impregnated brick-tile of $1\frac{1}{2}''$ thickness (impregnation done of brick-tile after drying in an oven for 24 hours at 105° and then immediately dipping in tar) under 5 ft. head of water—0.08 cusecs/million sq. ft. wetted area.

The above results indicate that there is substantial improvement in making the brick impermeable by impregnation with tar.

No. 3. ADHESIVE STRENGTH WITH CEMENT SAND MORTAR

The ordinary normal burnt brick-tile were joined with 1:3 and 1:5 mortar and were cured for seven days and one month in water. Similarly impregnated brick joined with 1:3 and 1:5 mortar were cured in humidity chamber. The following are the results of adhesion tests :—



Fig. 3. Condition after $4\frac{1}{2}$ years of action.

Adhesion strength of 1:3 and 1:5 cement sand mortar to unimpregnated and tar impregnated brick-tiles.

ADHESION STRENGTH IN POUNDS PER SQ. INCH

S. No.	Mix. of mortar.	Unimpregnated brick-tile after curing in water for			Impregnated brick-tile after curing in humidity chamber for 6 months.
		7 days.	1 month.		
1	1:3	16.8	22.2		5.8
2	1:5	12.0	16.2		3.4

The adhesion of brick-tile to mortar is considerably lowered when they are impregnated with tar as compared to that with ordinary brick-tile.

No. 4. CRUSHING STRENGTH

The results of crushing strength of unimpregnated ordinary well burnt brick-tile and impregnated brick-tile with tar are as follows :



Fig. 4. Photograph showing the condition of ordinary normal burnt unimpregnated and tar impregnated brick-tiles after about 7 months of their placing in soil containing 5 per cent sodium sulphate on its weight. The brick-tile showing white efflorescence are unimpregnated brick-tiles.

COMPRESSIVE STRENGTH OF BRICK-TILES IN POUNDS PER SQ. INCH

S. No.	Area under compression.	Height under compression.	Height thickness under compression ratio.	Average Compressive Strength of 20 bricks		
				Impregnated brick-tile.	Unimpregnated brick-tile.	
				Dry	After 24 hrs. immersion in water.	
1	9 × 1.5"	4.5"	3	1078	1460	1170
2	2 × 12"	6.0"	3	1067	1173	992
3	4.5 × 1.5"	9.0"	6	1128	1080	929
4	2 × 6"	12.0"	6	1082	1008	896

The completely impregnated brick-tile, flowed under compression and did not have an abrupt break as with normal brick-tile.



Fig. 5. The same as in 4 after 18 months of action.

The above results indicate that the compressive strength of brick-tile is improved by impregnated with Road Tar No. 3 over that of unimpregnated wet brick.

No. 5. ABSORPTION

Impregnated and unimpregnated brick-tile were completely immersed in water for 24 hours and absorption of water by brick-tile determined.

- (i) Average absorption by unimpregnated brick-tile after 24 hours immersion in water—11.5% on the weight of dry brick.
- (ii) Absorption by impregnated brick-tile—0.005%.

The unimpregnated brick-tile after immersion in water for 24 hours was further boiled in water for 5 hrs. and its absorption determined which was 15.2 per cent on the weight of dry brick.

Absorption after 24 hours to that after 5 hours boiling of unimpregnated tile 65.6 per cent.

No. 6. DENSITY

The density of the impregnated and unimpregnated brick-tile were determined and the results were as follows :—

- | | |
|--|------|
| (i) Tar—Impregnated brick-tile | 2.07 |
| (ii) Unimpregnated brick-tile (Immersed in water for 24 hours to expell air bubbles. | 2.26 |

No. 7. DISINTEGRATING ACTION OF SODIUM SULPHATE ON TAR IMPREGNATED AND ORDINARY UNIMPREGNATED BRICK-TILE WHEN PLACED—PARTIALLY EMBEDDED IN SALTY SOIL

In order to compare the disintegrating action of sodium sulphate (i) Unimpregnated well burnt brick-tile (ii) brick-tile just dipped to cover only the surface to maximum of 1 to 2 with tar and (iii) brick-tile sufficiently impregnated at least 7 to 10 mm. in depth with tar, were placed partially embeded in a soil containing 5 per cent Sodium Sulphate on the weight of the soil. Figures 2, 3, 4, 5, 6, 7, 8 and 9. The moisture variations were from 5 to 20 per cent except when during rainfall.

Visual observations of these specimens of unimpregnated and brick-tiles with road tar No. 3 for a continuous period of four and a half years revealed the following :—



Fig. 6. The same as in 4 and 5 after over 2½ years of action of soil containing 5% sodium sulphate. The brick showing disintegration at the top end was a brick-tile just dipped in tar to penetrate 1 to 2 mm.



Fig. 7. The same as in 4 and 5 after over 2½ years of action of soil containing 5 per cent sodium sulphate. The brick showing disintegration at the top end was a brick-tile just dipped in tar to penetrate 1 to 1 mm.

- (i) The ordinary unimpregnated well burnt brick-tiles placed partially embeded in soil containing 5 per cent Na_2SO_4 were the first to be attacked. The salt began rising and the brick-tiles were practically completely engulfed by white efflorescence in a period of about six months. The brick-tile began disintegrating into flakes which were not more than 1 to 2 mm. thick. These fell down in different sizes from the outer surface first till whole of the outer 1 to 2 mm. layer was peeled off. One round of this complete peeling off of outer layer took about 18 months. Further disintegration continued.
- (ii) The brick-tile just dipped in tar to give a penetration of 1 to 2 mm. did not show any effect outwardly for the first 18 months of its placing partially embeded in soil containing 5



Fig. 8. Photographs showing condition of the brick-tile after about 3½ years of their partially embedding in soil containing 5 per cent sodium sulphate when viewed from different angles. The other deeply tar, impregnated brick-tile showed cracking of the upper top end.

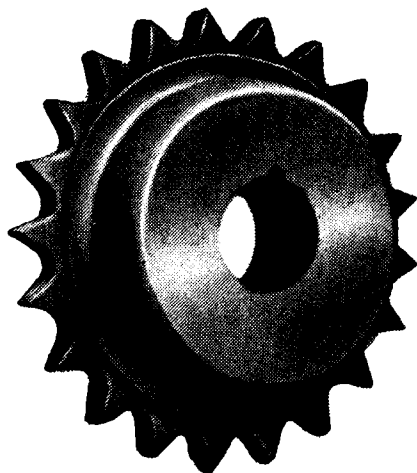
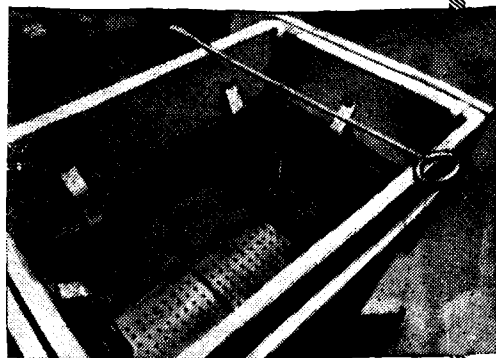
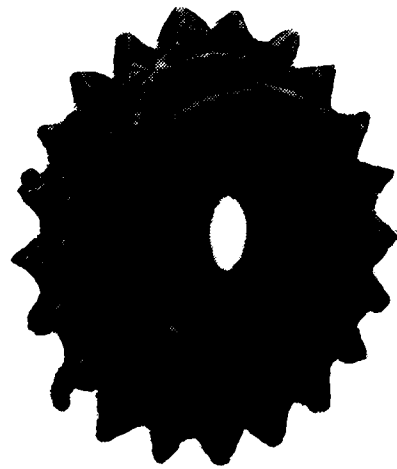
per cent Na_2SO_4 on the basis of the weight of the soil. After 18 months some two to three small patches of white efflorescence appeared on the upper end of the brick-tile. This has since resulted in disintegration of the brick-tile at the upper end.

- (iii) The brick-tile deeply impregnated with Road tar No. 3 and placed partially embeded in a soil containing 5 per cent Na_2SO_4 on the basis of its weight did not apparently show any sign of disintegration at any point visible for three and a half years. Then it suddenly disintegrated at the top end resulting in falling off of the impregnated layer and disintegration of the unimpregnated core of the brick-tile.

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Fig. 9. Photograph showing condition of the brick-tiles after about 3½ years of their partially embedding in soil containing 5 per cent sodium sulphate when viewed from different angles. The other deeply tar-impregnated brick-tile showed cracking of the upper top end.

CONCLUSIONS

The surface impregnation of brick-tile with tar only delays the action of salt on the brick for a certain time but does not totally make it immune from attack of Sodium Sulphate.

No. 8 STUDY OF BRICK-TILE WHEN PLACED IN 10 PER CENT Na_2SO_4 SOLUTION IN DIFFERENT POSITIONS

Normal well burnt brick-tiles of size $2'' \times 6'' \times 12''$ were placed in a 10 per cent Na_2SO_4 solution (i) two brick-tiles were completely dipped (ii) two were placed with one flat face $6'' \times 12''$ fully exposed and rest part dipping (iii) two were placed with 2" part immersed and 10" height exposed.

The following observations were noticed during the 60 months study of these brick-tiles in 10 per cent Na_2SO_4 solution (Figures 10 and 11).

- (i) The brick-tiles in completely dipping position in 10 per cent Na_2SO_4 solution did not show any sign of disintegration in the 60 months of study in this position.

- (ii) No disintegration of the brick-tiles placed with one flat face exposed and rest dipping in 10% Na_2SO_4 could be noticed. Only crystals of Na_2SO_4 were observed on the exposed surface without any disintegration of the brick-tile.
- (iii) No disintegration of the brick-tile with 2" part immersed in 10 per cent Na_2SO_4 solution and the rest 10 inches exposed to weather could be noted. Only crystals of Na_2SO_4 were seen deposited in thick layers on its outer surface especially in winter seasons without any disintegration of the brick-tile.

No. 9 COMPARISON OF ORDINARY BRICK-TILE IN No. 7 AND No. 8

The ordinary well burnt brick-tile in Study No. 7 placed partially embedded in soil containing 5 per cent salt and a max. of 20 per cent of moisture was seen to badly disintegrate while the similar brick-tile placed in partially immersed condition in 10 per cent Na_2SO_4 solution did not show any sign of disintegration after 60 months of action due to excessive availability of moisture not allowing any crystals to form in the pores of the brick. This observation indicates that :—

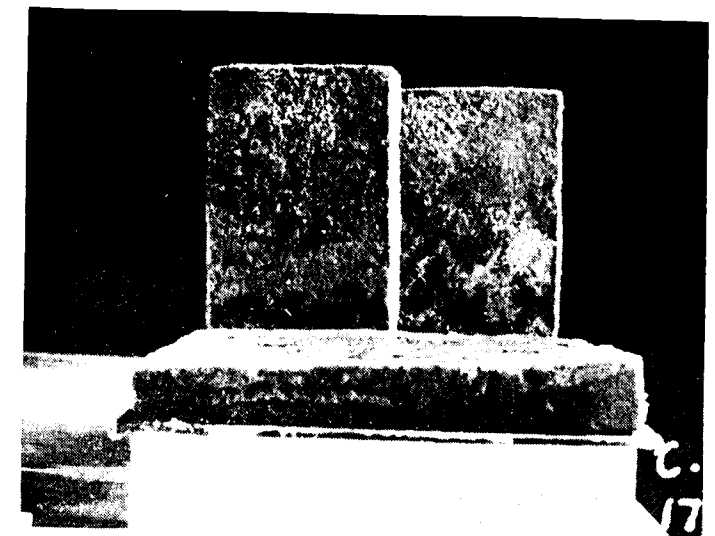


Fig. 10. Ordinary unimpregnated normal burnt brick-tiles after (-) two weeks of their placing in 10 per cent sodium sulphate solution. Only white efflorescence was observed on the exposed faces while no disintegration of the brick-tile was noticed under these conditions.

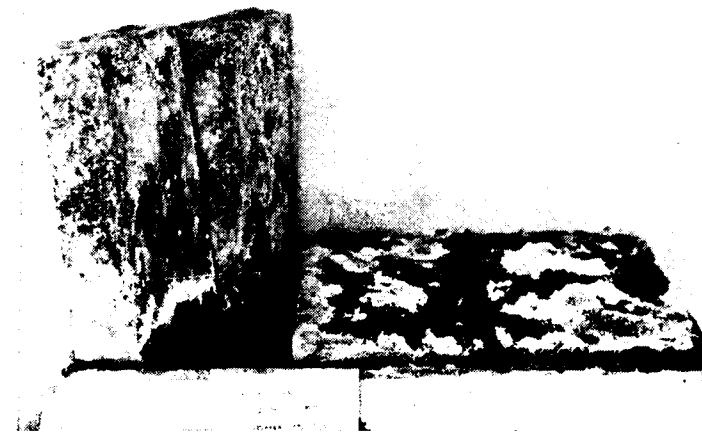


Fig. 11. Ordinary unimpregnated normal burnt brick-tiles after 32 months of their placing in 10 per cent sodium sulphate solution. Only white efflorescence was observed on the exposed faces while no disintegration of the brick-tile was noticed under these conditions.

- (i) The disintegration of the brick-tile with Na_2SO_4 was not due to chemical interaction of Na_2SO_4 with compounds of brick.
- (ii) The brick disintegrated due to expansive force caused by the crystallisation of Na_2SO_4 in higher hydrated form from lower form near the surface.
- (iii) Unless crystallisation of Na_2SO_4 takes place inside the brick. No disintegration is possible. Crystallisation on the outer surface does not matter.
- (iv) As long as moisture in sufficient amount is available not to allow Na_2SO_4 to crystallize inside the bricks, on deterioration of brick-tile is possible.

TABLE I GIVING THE PENETRATION OF ROAD TAR NO. 3 IN A $12'' \times 6'' \times 2''$ BRICK-TILE

S. No.	No. of brick-tiles taken.	Collective weight of brick-tile before impregnation lbs. / oz.	Duration of Impregnation minutes.	Collective weight of brick-tile after impregnation lbs. / oz.	Collective increase in weight of tiles lbs. / oz.	Temperature of Tar during immersion $^{\circ}\text{F}$	Average penetration of tar per brick-tile.	
							Weight.	Depth.
1	6	54-0	5	55-4	1-4	220-260	3-1/3 oz.	0.1"
2	6	53-12	10	56-6	1-10	do.	4 1/3 oz.	0.15"
3	6	54-6	15	56-8	2-2	do.	5-2/3 oz.	0.2"
4	6	53-4	20	55-8	2-4	do.	6 oz.	0.25"
5	6	54-2	30	57-2	3-0	do.	8 oz.	0.3"
6	6	54-4	40	57-8	3-4	do.	8-2/3 oz.	0.35"
7	6	56-4	50	59-12	3-8	do.	9-1/3 oz.	0.4"
8	6	56-12	60	60-8	3-12	do.	10 oz.	0.45"
9	6	57-8	70	61-10	4-2	do.	11 oz.	0.55"
10	6	57-8	80	62-0	4-8	do.	12 oz.	0.65"
11	6	57-0	90	61-12	4-12	do.	12-2/3 oz.	0.75"
12	6	57-8	100	62-12	5-4	do.	14 oz.	0.85"

TUBE RAIL SCHEME

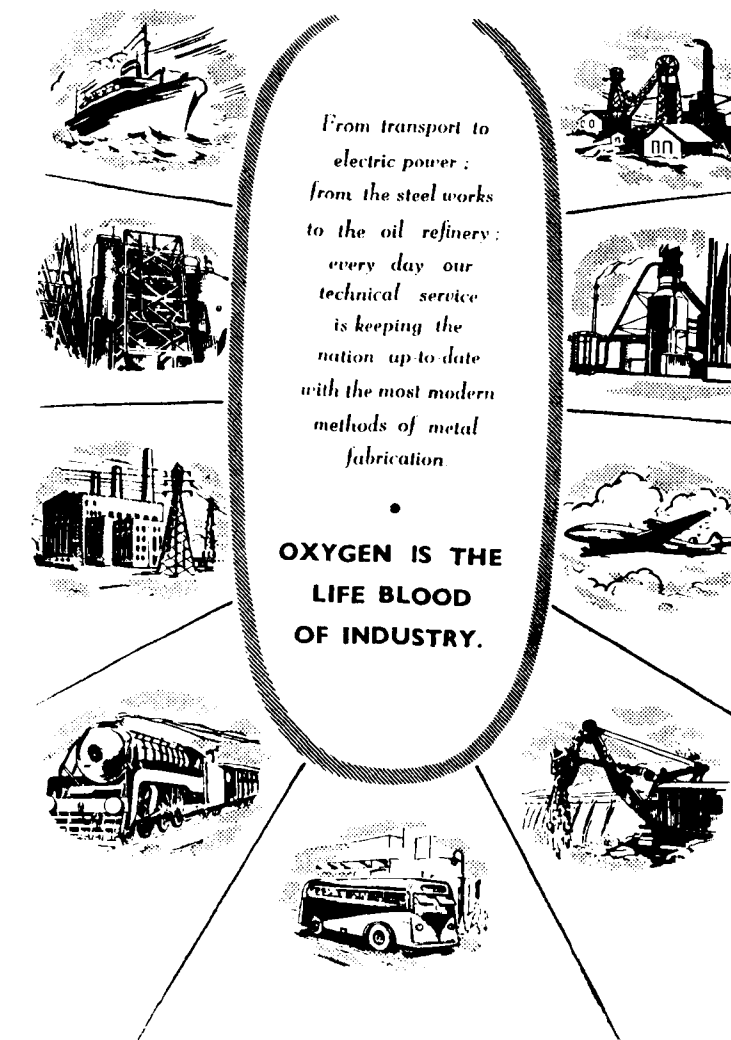
Nine foreign firms have submitted tenders for investigating the possibility of an underground railway system in Bombay city, the General Manager of the B. E. S. T. Undertaking, Mr. M. G. Monani, told press representatives. He, however, made it clear that the Undertaking was in no way committed to the subway scheme. The actual investigation work was expected to be undertaken by about July next year and a final decision on the project would be taken a year hence.

"The criticism that has appeared, in the main, is due to an insufficient appreciation of the aims and objects of the proposal," he added. He said there were no two opinions in regard to the seriousness of the present traffic congestion in the city roads and the necessity for finding a satisfactory solution at economical cost, not only to relieve the present congestion but also to meet the growing traffic requirements for the next 10 or 20 years.

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Castable Refractories in the Railway Workshop

By Dr. Hammond

Lafarge Aluminous Cement Co., Ltd. London

INTRODUCTION

ONE of the most striking advances of the post-war years in refractory usage has been the increased applications of refractory and insulating concretes which, to the furnace and maintenance engineer, offer the main advantages of concrete construction enjoyed up to comparatively recent times only by the civil engineer and the building industry.

Recent developments have now made it possible to employ castables in furnace construction and the like, to operate at temperatures up to 1600 C. and so, by the monolithic method of construction, eliminate innumerable joints. As is well known, the latter are usually the weak "link" in a refractory structure and, apart from the unavoidable leaks, failures of units such as doors or arches, etc. may be due initially to displacement of only one or two bricks. The casting of refractories is even more invaluable where there is a shortage of skilled bricklayers or masons, since there is no expense in cutting and fitting the brickwork. In addition, any special shapes such as burner blocks, etc. can be easily cast in suitable moulds. Finally, from the economic standpoint, it is obvious that a saving in time and cost of installation can be achieved.

PROPERTIES

Refractory concretes consist essentially of a suitable graded refractory aggregate bonded by high-alumina cement (Ciment Fondu, Lumnite, etc.). Although the properties of a refractory concrete are governed to some extent by the type of aggregate, the main properties depend, of course, on the essential constituent—high-alumina cement. This type of cement contains no free lime and is completely stable up to its melting point. Portland cements cannot, of course, be used for refractory purposes because on heating they chemically decompose with the liberation of the free lime which augments the amount already present in the cold. The absence of free lime in high-alumina cement up to full working temperature confers on it the additional useful property of being resistant to many dilute acids and this resistance tends, if anything, to increase at high temperatures. The third important characteristic of high-alumina cement lies in its rapid hardening qualities since all refractory concretes attain full cold strength and are ready for service 24 hours after casting.

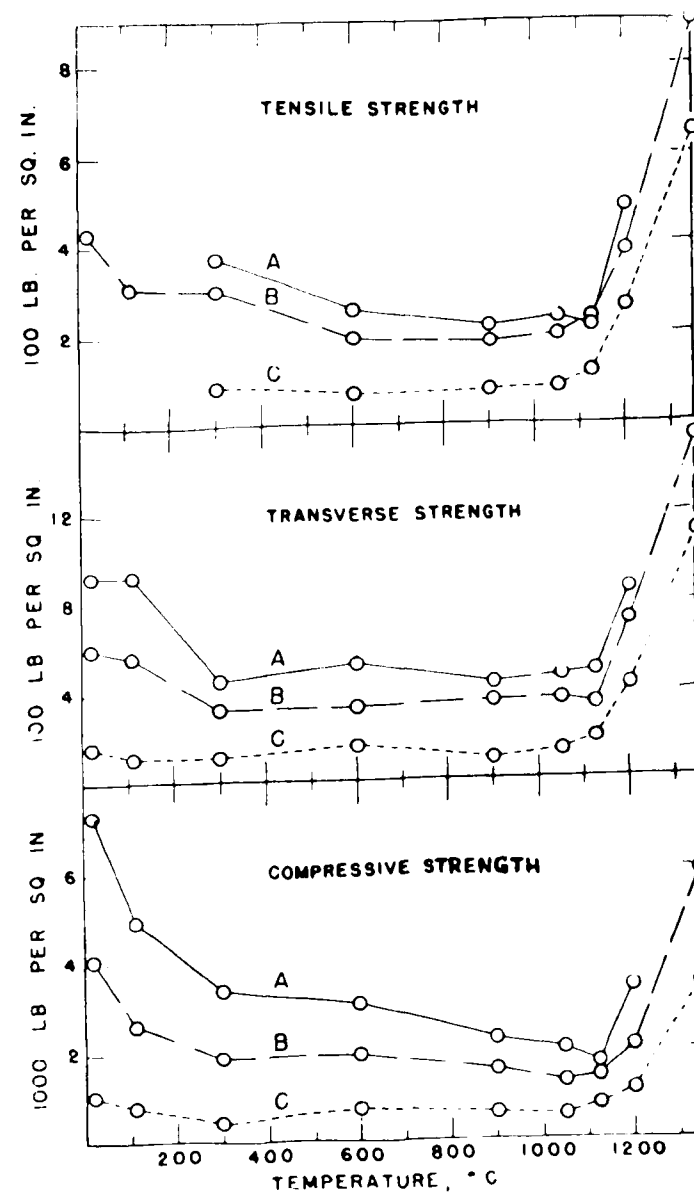


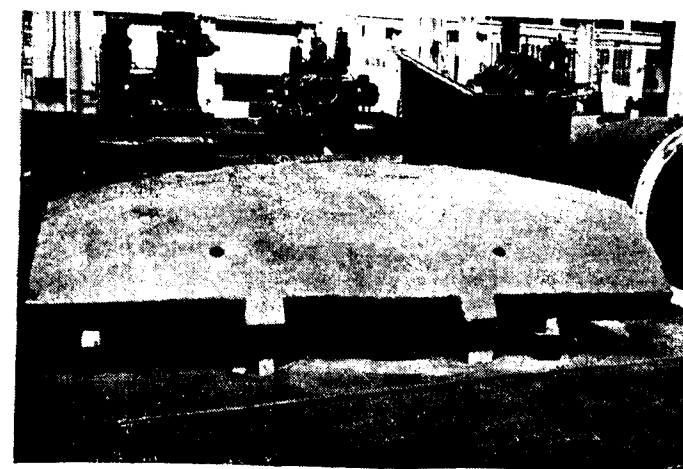
Fig. 1. Comparison of strengths of refractory concrete (firebrick aggregate) containing various percentages of high-alumina cement after the following heat treatments:

24 hrs. at 20°C., 24 hrs. at 110°C., 4 months at 300°C., 4 months at 600°C., 5 hrs. at all higher temperatures indicated (a) 30% cement (b) 20% (c) 10%.

The unqualified term "refractory concrete" normally refers to one in which a crushed aluminosilica firebrick of good quality is employed as the aggregate, and the normally recommended mixes are given in Table I.

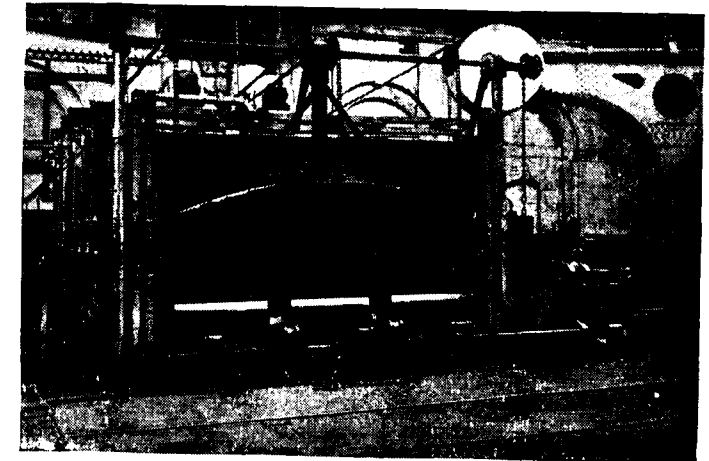
The concrete is capable of withstanding temperatures up to 1350°C. under normal service conditions. When a greater temperature or slag resistance is required, other aggregates such as chrome, sillimanite, corundum, etc. may be employed as shown in Table II. Similarly, insulating concretes may be made by using materials such as vermiculite, diatomite, foamed slag or crushed insulating brick as aggregates. These concretes are normally employed where the primary consideration is heat conservation but they are naturally not as strong or as resistant to abrasion or slag attack as concretes made with the normal denser refractory aggregates. They do, however, possess adequate strength for many purposes and are capable of operating at temperatures of 1000°C. or above. When the conditions of temperature etc. are considered too severe for the employment at the hot face of insulating concretes, it is the normal practice to use them as a backing to a concrete made with the denser type of refractory aggregate.

The general characteristics of refractory castables have been summarized elsewhere and Heindl and Post have published⁽¹⁾ a report of an exhaustive investigation on the properties of these materials. The curves of Fig. 1, taken from this report, illustrate the effect of temperature on the strengths of concretes made with different cement contents. The cold strength is partially lost as the temperature increases, due to the gradual elimination of the hydraulic bond of the cement. Before this can occur completely, however, a ceramic bond is formed which increases both with time and temperature such that, at the higher temperatures, a fired strength is obtainable which may often be superior to the high cold strength. It is apparent from these curves that with units operating at comparatively low temperatures of the



Refractory concrete door of plate-heating furnace

Fig. 2. (a) Replacement door.



Refractory concrete door of plate-heating furnace

Fig. 2. (b) In service.

order of 600-1000°C., and where strength and abrasion resistance are prime considerations, it is an advantage to use a concrete with a cement content greater than that in the normally recommended mixes. It should be remembered, however, that the service temperature limit of a concrete tends to decrease with greater cement contents⁽²⁾, as shown in Table III.

The thermal properties of refractory and insulating concretes have been recently investigated⁽³⁾ and approximate values are summarized in Table IV. The low heat capacities and thermal conductivities of these materials naturally lead to low heat losses and, in intermittent furnaces, shorter times are necessary to attain working temperature.

Another feature of refractory concrete is its very low spalling tendency (i.e. high resistance to thermal shock). This may be attributed to some extent to the supposed "elastic" nature of the cement bond. Consequently, although a firebrick of high spalling tendency may be employed as aggregate, a refractory concrete made with it will possess a high thermal shock resistance. This property has proved very valuable in locations where extreme temperature fluctuations are experienced such as, for instance, where a hot concrete may be sprayed with cold water. A further advantage of refractory concrete arises from its unique expansion characteristics. In the manufacture of firebricks and other refractory materials it is generally aimed at producing in the firing operation a brick or shape which is practically fully shrunk. Consequently, in the design of furnaces and flues etc. liberal provision has to be made for expansion joints of appreciable thickness since, when the structure is operated at temperature, the expansion is often quite large. With refractory concrete,

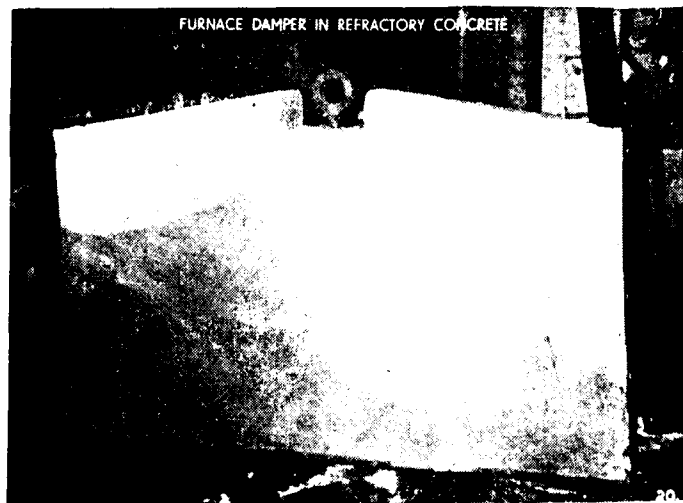


Fig. 3. Precast damper of refractory concrete for reducing furnace volume when heating smaller stock.

however, thin butt joints are quite sufficient since the cast dimensions of a cold unfired unit are, for all practical purposes, equal to the dimensions at the operating temperature. This is because the initial shrinkage of the cement bond on first firing is approximately equal to the inherent thermal expansion of the concrete between ambient and service temperature. On cooling, normal thermal contraction naturally occurs and the linear dimensions of the cooled unit when it is out of service are slightly less than the cast dimensions. These small contraction gaps disappear when the unit is put back into service and a butt joint is again obtained. The magnitude of the linear changes which may be expected are indicated in Table V.

INSTALLATION

If the best results are to be obtained with castable refractories, it is essential that the basic principles of making ordinary concrete should be followed. For instance, the maximum size of the aggregate is governed to some extent by the minimum thickness of the unit or concrete being placed (see Table I). Similarly, the aggregate should be evenly graded throughout the size range and the amount of fine material passing B. S. 100 sieve should not exceed about 10-15%. Aggregate with a deficiency of fine material is equally undesirable, since the mix tends to be "harsh" with poor water-retention properties which leads to compaction difficulties and a tendency to "bleed".

Apart from the main exception of silica brick, a variety of refractory or semi-refractory materials may be employed as aggregate. They should, however, be free from impurities such as slags or jointing materials which

may chemically affect the hardening properties of the cement or result in an excessive amount of fine material. It is, therefore, sometimes convenient to use one of the various proprietary castables which consist essentially of suitably graded aggregate mixed with the correct amount of cement and merely require the addition of water. Premixes of this type are distributed by many reputable refractory manufacturers.

Most of the commonly used refractory and insulating aggregates are, of course, porous and should be soaked in clean water, preferably overnight, before being mixed with the cement, when it is often found that very little additional water is necessary to achieve the required workability. The period of soaking is naturally dependent on the size of the aggregate, and with proprietary castable mixes which normally incorporate the smaller size range, an ample mixing time achieves the same result as a preliminary soaking. If dry aggregates are employed, water is withdrawn from the unset cement after the concrete is placed and inferior strengths are obtained.

For a similar reason, "bleeding" from joints in formwork and moulds should be prevented, and any porous material on which the wet mix is placed should be either given a preliminary soaking or covered with water proof paper. After the mix has set, all exposed surfaces should be kept cool and wet for a further 24 hours if maximum strength and best service are to be obtained. In many cases of emergency, however, satisfactory results have been obtained when the concrete has been put into service only a few hours after placing. The first firing should preferably be fairly slow to allow

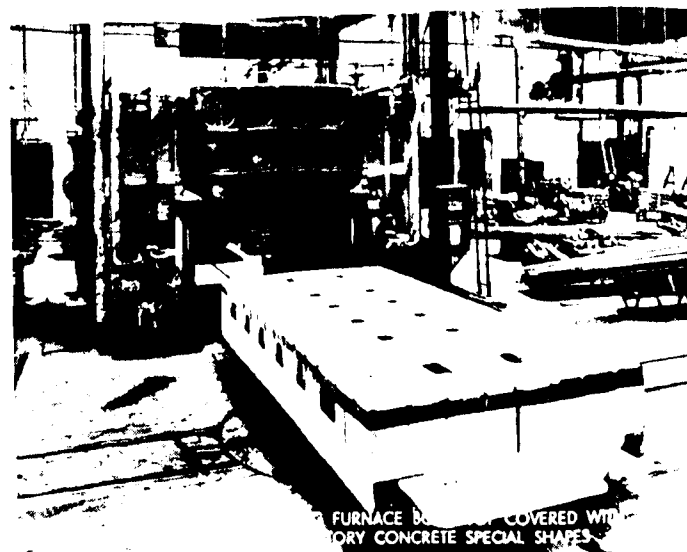


Fig. 4. Bogie top of refractory concrete precast units.

for the expulsion of water but this is, of course, not necessary with subsequent heating and cooling cycles. When steel reinforcement is used in refractory concrete it should be located in a zone where the temperature is not expected to reach much over 400°C. Above this temperature the differential expansion of the concrete and the steel has to be considered and the strength characteristics of the steel itself rapidly deteriorate.

APPLICATIONS

Furnaces

The advantages of castable refractories in the construction of re-heating and heat-treatment furnaces, similar to those found in railway workshops, is now gaining wide recognition in the metallurgical industries. Although several large furnaces have been constructed solely of refractory concrete, often with a backing of insulating concrete this is, so far, unusual, as such a departure from traditional methods is naturally not taken lightly. It is, therefore, common to find that in one particular shop, refractory or insulating concretes have only been used for certain parts of the furnaces such as dampers, arches, hearths, bogie tops, foundations and flues, etc. or, in fact, for any part of the unit.

Doors and Dampers

A typical example of a refractory concrete furnace door employed very satisfactorily in a railway workshop is shown in Fig. 2(a). This door is 12' long, 4'4" high at the centre, 2'10" at the sides, and it is installed on a plate-heating furnace [see Fig. 2(b)] operating at a temperature of 1100°C. Previously, a firebrick door gave a service life of only 2 months but the first refractory concrete door lasted 2 years and the second is still giving good service after a similar time. The refractory concrete was placed in-situ in one lift to a depth of 9½" using mix B (see Table I) and a crushed firebrick aggregate. Reinforcement was provided by 5" x ¾" bolts, with 2" washers on the heads, which were welded on the door frame at approximately 1 ft. intervals. The bolts and washers were coated with bitumen before the concrete was placed, to allow for differential expansion.

The type of castable employed in door construction is naturally governed to a large extent by the operating temperature of the furnace. For instance, at the comparatively low temperatures of annealing, tempering and hardening furnaces, an insulating concrete is often employed to achieve greater heat conservation. At the higher temperatures operative in re-heating furnaces, it is customary to employ a refractory concrete which may, of course, be backed by insulating concrete. The simplest method of door construction is to cast the wet

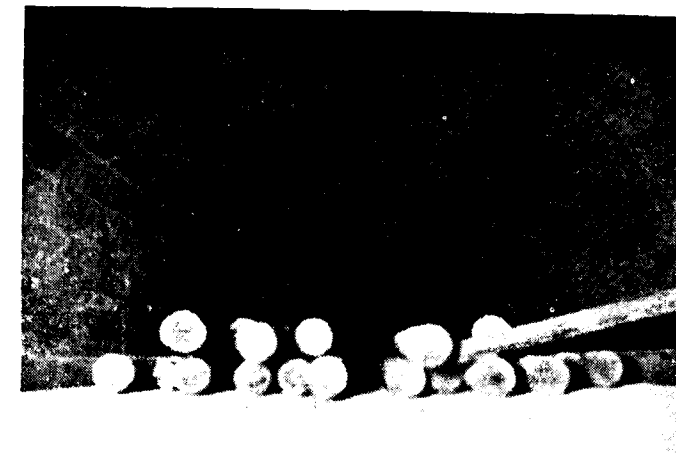


Fig. 5. Monolithic topping of tempering furnace hearth in refractory concrete.

mix in the door frame or casing which, in the case of the large doors, may be provided with stud bolts as keys, as described above, and sometimes with reinforcement. Alternatively, the doors are sometimes constructed of several large precast shapes. As with doors, castables prove very suitable for making dampers. An illustration of a very economic and rather novel use of a refractory damper is shown in Fig. 3. This damper is suspended in the arch of a re-heating furnace and, when lowered, reduces the effective size of the furnace thus enabling more economic heating of small stock.

Hearths and Bogie Tops

A smooth surface for hearths and bogie tops, undisturbed by partially displaced bricks, is of major importance in the handling of stock in and out of the furnace. Although a monolithic concrete bogie top is more often constructed, several users favour the employment of large precast shapes often designed with interlocking joints. The bogie top shown in Fig. 4 is of this type and is used in the furnace of a railway workshop for heat-treating 6' long waggon coupling rods. The overall dimensions of the bogie are 14'3" x 6' and the holes at the top and sides are to facilitate the passage of hot gases round the stack and so obtain uniform heating. In the same shop, the bogies of several small furnaces are provided with monolithic refractory concrete tops.

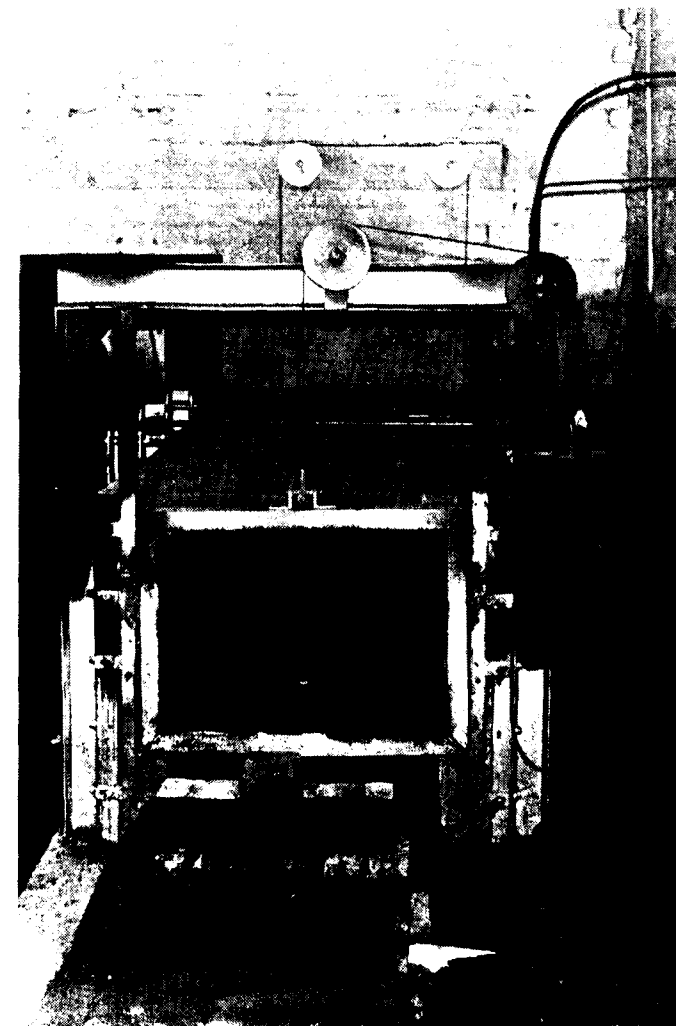


Fig. 6. Cast-in-situ arch and door of oil-fired annealing furnace—insulating concrete employed.

An example of a monolithic topping of the hearth of a tempering and hardening furnace is shown in Fig. 5. The 2" thick topping of refractory concrete was applied to protect the rebated tiled hearth. Previously the tiles were easily dislodged due to the rebates being broken off during the handling of the stock. Normally the topping is 4" or more thick and, as in bogey tops, is often placed on a sub-hearth of insulating concrete which, of course, lowers the heat capacity and promotes more economical and uniform heating. Here again, however, some users prefer a hearth constructed of precast slabs. For instance, one annealing furnace floor, on which heavy castings were dragged, had only a six weeks life when constructed with standard firebricks. A much improved life was obtained by topping the floor with large precast refractory concrete units 4' x 1' x 4" thick. Slabs of this type should be laid on a flat level base to avoid "proud" joints with all edges in contact so that the joint thickness is negligible.

Where attack by scale may be expected, it is advantageous to employ a chrome or chrome-magnesite aggregate. Monolithic hearths of this type of concrete have been found to give improved service lives in reheating furnaces of both the rotary hearth and pusher type. In one furnace of the latter type, operating at 1200—1300 C. and heating bars and ingots up to 50 cwt. in weight, it was found that a hearth of chrome-magnesite concrete lasted twice as long as a brick hearth. On the other hand, a refractory concrete incorporating a good quality firebrick aggregate (40/42% alumina), was employed for the complete construction of a small furnace (hearth area approximately 20" x 30") operating at 1200° C., and gave excellent service. In fact, the life of the furnace, which was used for softening chair bolts, was improved from 3 months to 3 years.

Arches, Covers and Lids

As in other applications, both the monolithic in-situ method and precast units have been employed. For example, the former method was favoured for the arch of a rivet rod heating furnace constructed solely with castable refractories. The 9" thick refractory concrete arch of span 4' 10" was backed by 3" of insulating concrete. Similarly, the cast-in-situ method was employed for the insulating concrete arch of the oil-fired annealing furnace shown in Fig. 6. The arch is approximately 8' long, 3' 6" wide, and the thickness of the concrete is 9" in the centre and 12" at the side, i. e. the top of the arch is flat whilst the inner hot face has the normal rise. A crushed insulating brick was employed as aggregate and a similar mix was used for the door, which is also shown. In the same shop, however precast refractory concrete ribs were preferred for constructing the complete arch of an oil-fired furnace,



Fig. 7. Precast refractory concrete arch units and insulating concrete hearth of pit arch recovery furnace.

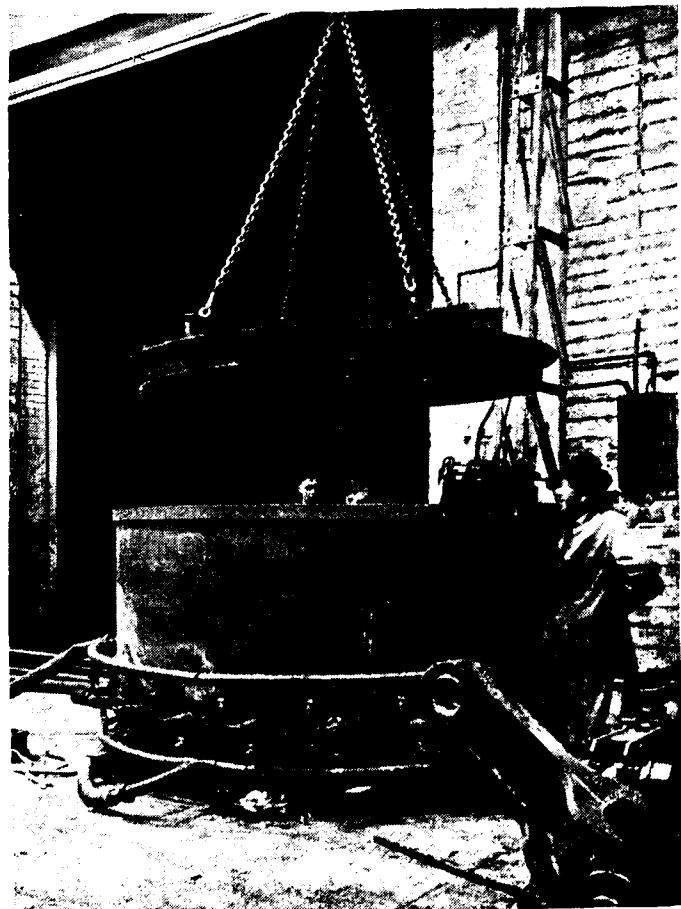


Fig. 8. Steel tyre heating furnace completely lined with refractory and insulating concretes.

operating at 1200°C. for the recovery of steel mine arches of rail-track section, although a castable employing crushed H. T. insulating brick aggregate was used for the hearth and the flues incorporated in it. The arch ribs were approximately 2' thick and 2' wide with a 6' span (see Fig. 7). Even larger ribs, weighing over 3 tons each, have been used in the arch of one big annealing furnace. It is also now common to use refractory concrete springers in orthodox brick arches. An interesting development of this principle was incorporated in a re-heating furnace where the springers consisted of 12' long steel ducts running the furnace length which were encased in refractory concrete and served as pre-heaters. An obvious application of refractory concrete, and, more particularly, insulating concretes, is the backing or topping of the arch to obtain increased heat conservation and, if necessary, a flat surface. In addition to the in-situ and precast methods, insulating concretes have been gunned on to the top surface of arches.

In flat arch construction the incorporation of reinforcement is naturally necessary for large spans and a successful method has been described⁽⁴⁾. This consists

essentially of casting angle-iron or channel-iron claws in the cooler zone of the refractory concrete. The claws are attached to R. S. Js., which may be partially embedded in the concrete. Special refractory anchors may be used near or at the hot face⁽⁵⁾. For smaller spans reinforcement is not necessary but wire mesh can often be incorporated with advantage in the colder zone. With the normal sprung arch, reinforcement is, naturally, not necessary even for large spans⁽⁴⁾.

Castable refractories are often used in the form of precast slabs for covering small furnaces, such as non-ferrous crucible melting furnaces, and a concrete lining in the covers of top-hat annealing furnaces is a very suitable application. It is usual to use insulating concrete cast monolithically for furnaces operating at annealing temperatures, but a lining of precast shapes, made with a castable incorporating firebrick aggregate, was preferred for the lid of the furnace shown in Fig. 8. This gas-fired furnace is about 8 ft. diameter, operates at a temperature of approximately 800°C. and is used for expanding metal tyres before they are fitted to the wheel castings. The hearth was lined in a similar manner to the lid with refractory concrete blocks, although insulating concrete was preferred for lining the walls.

Brick Setting

Unlike raw fireclay, a mortar consisting of a mix of high-alumina cement and a crushed refractory aggregate (e. g. mix C), gives a high cold strength. In addition,

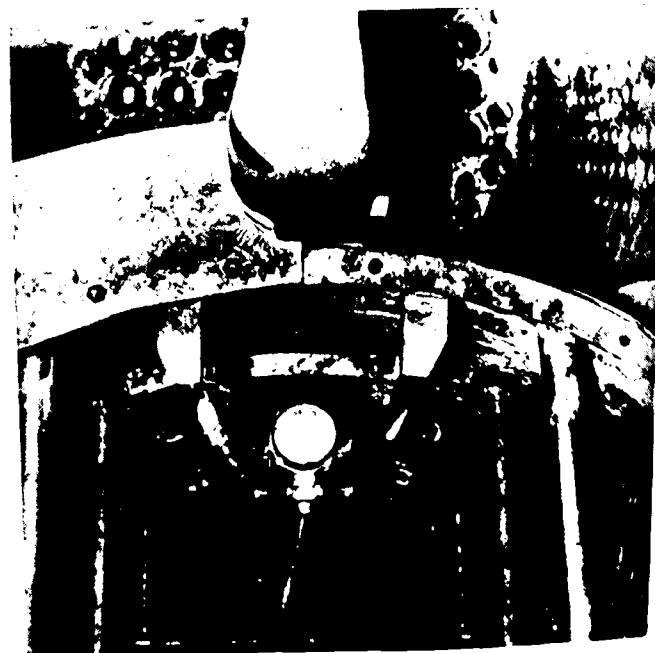


Fig. 9. (a) Types of shuttering employed when casting in-situ refractory concrete locomotive arches—French.

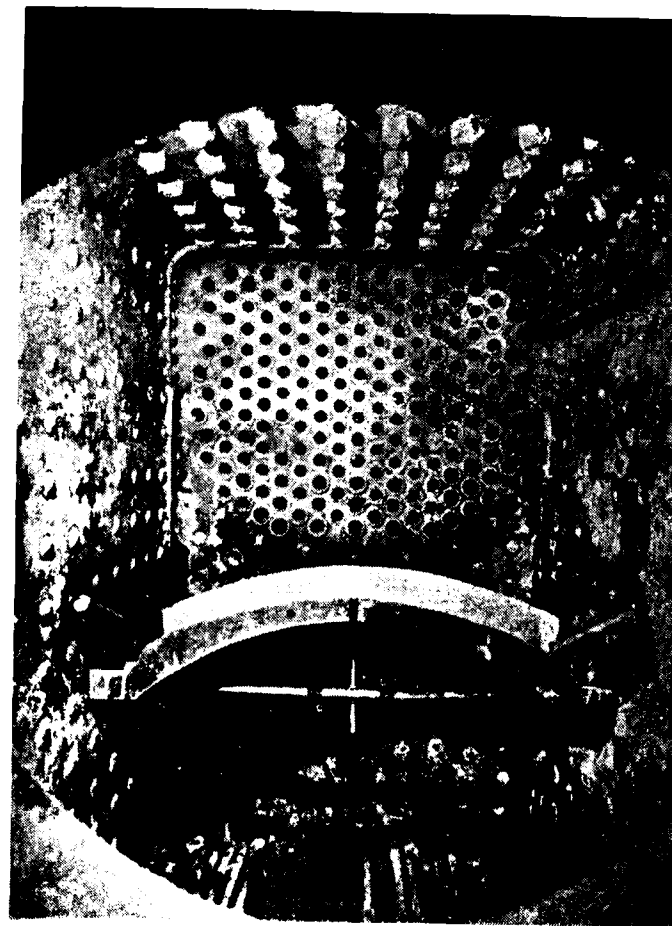


Fig. 9. (b) Types of shuttering employed when casting in-situ refractory concrete locomotive arches—British.

the risk of leaks is minimised since, compared with a fireclay joint, there is practically no shrinkage. Consequently, the thin rubbed joint commonly employed in refractory brickwork is not necessary and, in fact, not advisable. A thickness of joint similar to that employed in ordinary brick construction is suitable.

A refractory mortar of this type is harsher than a fireclay cement but this can be largely overcome by the addition of raw fireclay, which is often included in the many proprietary incorporating high-alumina cement. From about 10—15%, fireclay by weight of cement may be added according to the workability desired. If maximum strength is to be obtained, it is advisable to ensure that the minimum of water is allowed to escape from the mortar before it is fully hardened. The bricks should, therefore, be soaked in clean water before laying and the joints kept moist for 24 hours by means of damp sacks, etc. When a fireclay joint is preferred it is now common practice to achieve a compromise by an admix-

ture of a certain proportion of high-alumina cement. By this means a stronger cold strength is obtained. Furthermore, the cement admixture causes the fireclay to frit at a lower temperature so that, apart from the improved fired strength of the bond, the latter is attained at operating temperatures where a pure fireclay might be expected to crumble.

LOCOMOTIVE FIREBOXES

Coal-burning

Refractory concrete is now widely used, particularly in the U. K. and France, for the firebox arches of many types of coalburning locomotives. Although an arch made with standard firebricks is normally quite satisfactory from a purely refractory standpoint, the dislocation of one or two bricks by mechanical shock caused by raking, poking and particularly vibration, or by the tremendous draught set up when skidding occurs on starting, is often followed soon after by the complete collapse of the arch. It is for this reason that a refractory concrete arch shows improved service life in many locomotives since it can be placed monolithically or suitably keyed precast units may be used. The latter, of course, have the advantage that no special shuttering is required, a better quality concrete is usually obtained due to easier working conditions, the units can be made in slack periods for storage until required and, above all, a much quicker turnround is possible.

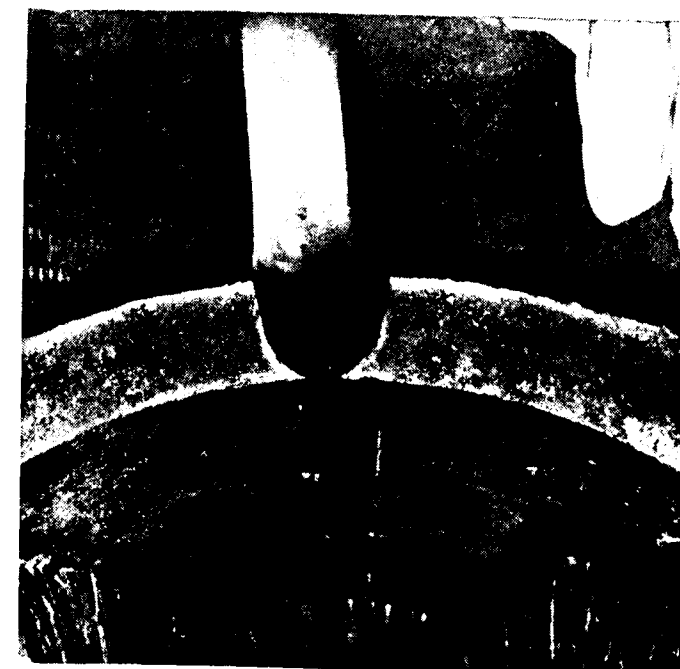


Fig. 10. (a) Refractory concrete locomotive arches—French.

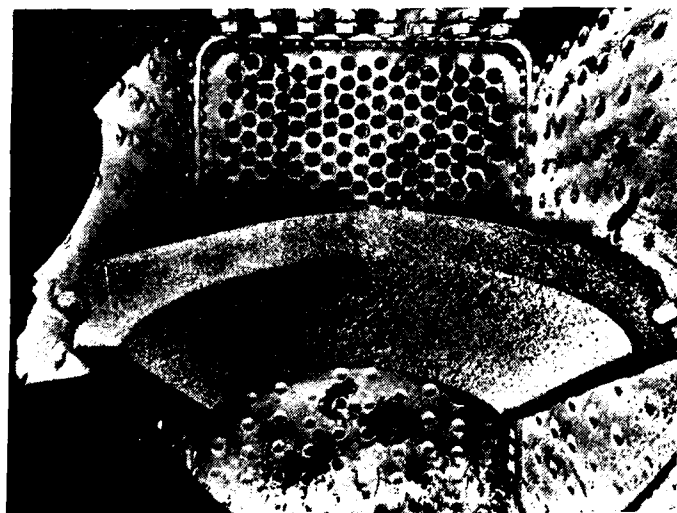


Fig. 10. (b) Refractory concrete locomotive arches—British.

The in-situ method has, however, been so far preferred by both the French and British Railways, and Figs. 9(a) and 9(b) illustrate respectively the best types of shuttering to employ. It will be noticed in Fig. 9(a) that the arrangement includes a vibrator to ensure optimum consolidation of the wet mix, which usually corresponds approximately to mix A (Table 1). In the British method, a similar mix is normally used and equally satisfactory results seem to be obtainable with efficient hand compaction. The condition of the two types of arches when put into service is shown in Fig. 10(a) and Fig. 10(b).

The service life obtained with refractory concrete arches varies naturally with the class of locomotive and, no doubt, is affected by the type of fuel, since the degree of slag attack will be governed to a large extent by the amount and fusion point of the ash. Nevertheless, from an analysis of a large amount of data of the service lives obtained in British and French locomotives, it is apparent that, in general, a refractory concrete arch installed in a shunting or small goods locomotive normally lasts two years or more, corresponding to a mileage life of, say, 70,000 miles. Under similar conditions an arch made with standard firebricks usually has a working life of about 6 months only. As the size of locomotive increases, the refractory concrete arch still retains its superiority although this is gradually reduced until, with the fast passenger or goods engine the life obtained is similar to that of a firebrick arch. For instance, on a locomotive hauling a fast passenger train between Manchester and Glasgow, a life of about 5 weeks is usual which is hardly better than that expected from a firebrick arch. On the very fast express locomotives, such as Class 7 and 8 of British Railways, a life of 1—3 weeks is common with a firebrick arch and this cannot be

improved by using refractory concrete. This is obviously due in part to the tremendous vibration set up at high speeds, the excessive temperatures and draught attained at the very high firing rates, and the severe corrosion attack by the high velocity molten ash particles. On railways systems where speed regulations are enforced, such as in India, these extraordinarily severe conditions are probably not experienced and it, therefore, seems that there may be no reason why the whole range of locomotives could not be advantageously fitted with refractory concrete arches.

Oil-burning

A castable refractory, corresponding roughly to mix A, is widely used as precast shapes in the fireboxes of oil-burning French locomotives of types similar to Class 141R. The shapes are, at present, employed for constructing the wall and quoils at the burner end, and the spy-hole in the wall which separates the firebox from the footplate. The condition of the refractory concrete after a service life of about 12,000 miles is shown in Figs. 11(a) and 11(b) at the burner end and spy-hole ends respectively.

This use will, no doubt, be extended further in the near future since recent trials have shown that excellent results are obtained with refractory concrete sidewalls and hearths. The type of pre-cast shapes employed for the side walls are shown in Fig. 12.

The above results are, perhaps, to be expected, since it was reported some years ago by the Australian Railways that refractory concrete hearths, installed in Class D. 55 oil-burning locomotives, gave a longer service life



Fig. 11. (a) Condition of refractory concrete precast shapes in oil-burning locomotive firebox after service life of 12,000 miles—wall and quoils at burner end.

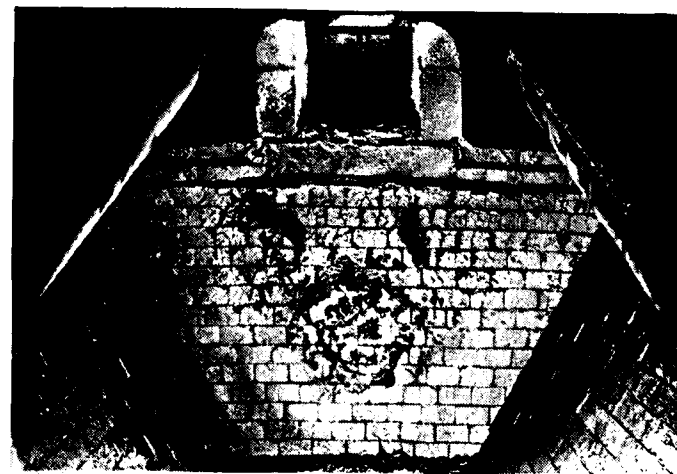


Fig. 11. (b) Condition of refractory concrete precast shapes in oil-burning locomotive firebox after service life of 12,000 miles—spy-hole in wall separating firebox from footplate.

than the brick hearths formerly employed. In addition, the disadvantages of the obstruction and deviation of the flame path previously caused by loose bricks was eliminated.

Reverting to Fig. 11(b), it is obvious that the firebrick wall below the spy-hole suffers severe attack from flame impingement. Trials are therefore now in progress with this wall constructed of a castable refractory incorporating a special high-alumina cement⁽⁶⁾ of high purity and alumina content and is therefore capable of withstanding extraordinarily high temperatures.

CUPOLAS

The conditions in the melting zone of cupolas are too severe for refractory concrete but it has been shown to give very good service as a lining of the upper zone. In order to obtain the best life, the lining should be cast in between the cupolas and internal shuttering and not just plastered on. Perhaps the most common application, however, is the refractory concrete lining of the spark arresters, which have been installed as precast segments, by casting in-situ and by gunning. Additional applications are for charging door linings and as a base slab of the cupolas about 6" thick and, of course, covered with sand.

Apart from the other uses in foundries described later, refractory concrete has also been employed for making precast receiver covers and for lining casting pits.

CORE AND MOULD DRYING STOVES

The lowest operating temperature of core and mould-drying stoves is usually about 300°—350°C. which must

be considered as rather high for an aluminous cement concrete employing the normal sand and shingle siliceous aggregates. Nevertheless, flat roofs of this type of concrete have been installed on drying stoves and have given satisfactory service. Refractory and insulating concretes have, however, been the types mainly employed for floors, doors, bogey tops, and, of course, flat arches (see Fig. 13). In fact, several refractory concrete flat arches installed on drying stoves are still giving good service after 15 years. Apart from, perhaps, a topping of refractory concrete on the floor and bogey top, insulating concrete would appear to be ideal material, however, for the complete construction of drying stoves.

FLOORS AND FOUNDATIONS

Increasing use is now being made of aluminous cement concretes employing suitable heat-resistant aggregate for foundations and base slabs of all types of furnaces, cupolas, etc. By this means a flat foundation is obtained which also has a higher heat insulating value than the same thickness of firebrick.

The industrial hazards of rough and uneven furnace shop and foundry floors, caused by displaced bricks or disintegration of ordinary concrete exposed to high temperatures or metal spillage, and the dangers of silicosis occasioned by sanded floors, is a major problem. The proven ability of refractory concrete to withstand these severe conditions without an overlay of sand, which is now receiving official recognition, accounts for the increased use being made of this material for laying floors in foundries and in the vicinity of furnaces.

The durability of refractory concrete vis-a-vis the disintegration of ordinary Portland cement concrete is

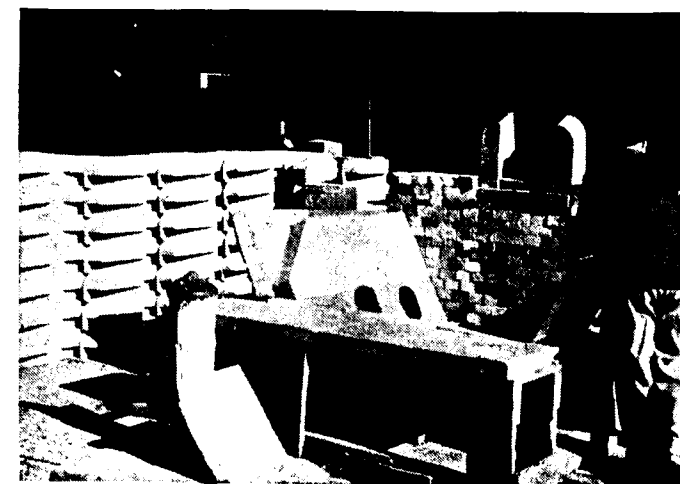


Fig. 12. Precast refractory concrete shapes for sidewalls of oil-fired locomotive.

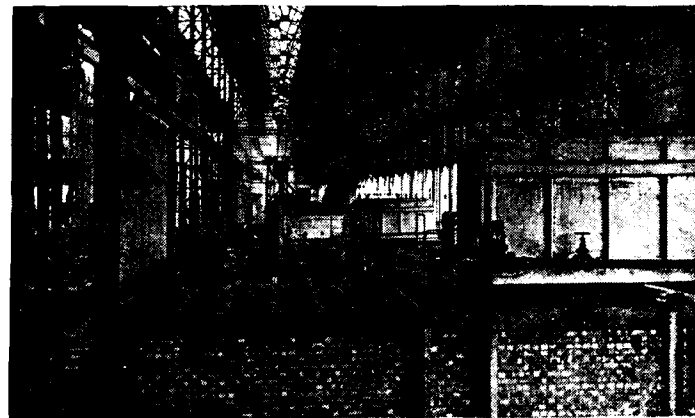


Fig. 13. Flat roof of core stove (17 ft. x 24 ft.) cast-in-situ in insulating concrete.

indicated in Fig. 14 which shows the condition of a floor, of both types of concrete after spillage of molten metal.

FLUES AND STACKS

Although a monolithic refractory concrete underground flue naturally minimises the loss in draught due to leakages, etc. the most outstanding advantage perhaps arises from the speed and simplicity of construction. The method adopted is to first lay a 6" thick base of refractory concrete in the previously dug trench. When this has set, additional concrete is placed and consolidated around a suitably shaped formwork covered with waterproof paper (see Fig. 15) which is centred in the trench. The refractory concrete is sufficiently strong in a few hours for the formwork to be pulled along when the next section is placed. The construction is completely monolithic since no joints are necessary. Castable refractories are naturally used widely for other types of flues, and precast flue covers are a very common application.

The conditions occurring in stacks and chimneys make it essential that the outer casing of steel, Portland cement concrete or jointing mortar should be adequately protected from the temperature and acidity of the flue gases, particularly in the zones where condensation of the sulphurous acids occur. These conditions are very satisfactorily resisted by the special properties of high-alumina cement, which is therefore extensively employed for this purpose.

A monolithic lining of castable refractory, which sometimes incorporates an insulating aggregate, is frequently installed now-a-days by the gunning technique.⁽⁷⁾ The more orthodox methods of rendering and casting are, of course, also employed and in brick linings it is usual to employ a high-alumina cement mortar as the jointing material. In the zones where the temperature is in excess of about 250°C. a suitable heat-resistant

aggregate or crushed firebrick should be employed (mix C) but a sand mortar is quite suitable at lower temperatures.

ASH PITS

Any material used for lining the pits into which locomotives discharge hot ashes and clinker, which are often immediately quenched with cold water, must be capable of withstanding high temperature, severe thermal shock, appreciable abrasion, and chemical attack by dilute acids. It is, therefore, not surprising that refractory concrete has been used for this purpose in many countries. The lining may be cast-in-situ using, say, Mix A, (Table I) as shown in Fig. 16 or precast slabs 2"—3" thick and of suitable size can be made using Mix B. As in all applications where abrasion is a primary consideration, it is preferable for the cast face of the slab to be the working face.

For similar reasons, refractory concrete has been employed for the copings of pits made of other materials, and for way-blocks which rest on top of the side walls of the pit. These were 2' 8" long, 12" wide and 11" deep, and were reinforced by 3½" diameter bars at the top and bottom. Two pieces of boiler tube plugged with hard wood were set vertically in each block and the rail and sole plate were held down to the blocks by spikes driven into the wood. It is also often found that hot ashes which have been held up in the firebox fall on the track in the vicinity of the pit and set fire to wooden sleepers. This has been prevented by using concrete sleepers for about 10 yards beyond each end of the pit.

CONCLUSION

It will be appreciated that, in one comparatively brief article, it is not possible to describe the full scope and details of the diverse uses of castable refractories in

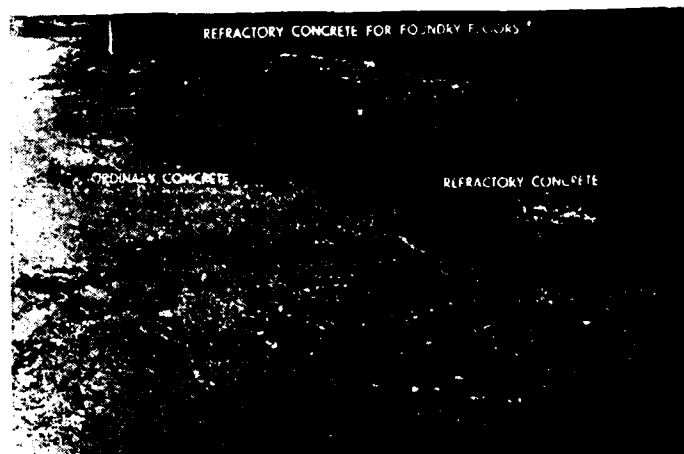


Fig. 14. Condition of ordinary concrete and refractory concrete after spillage of molten material.



Fig. 15. Construction of monolithic refractory concrete underground flues.

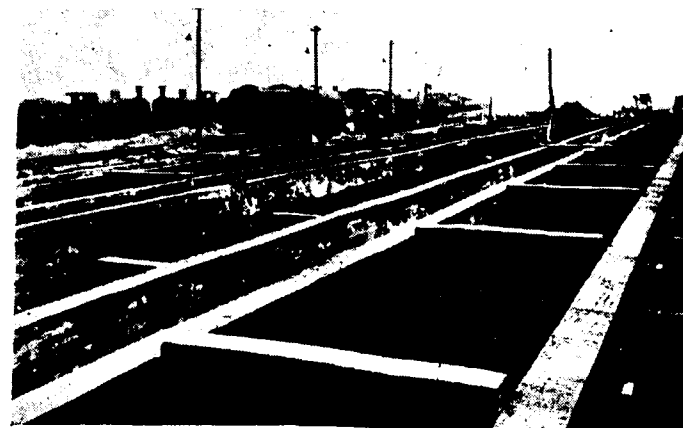


Fig. 16. Refractory concrete ash pits.

furnaces, foundries, etc. found in railway workshops. The above has, therefore, been necessarily confined to a description of normal methods adopted in selected application, employing typical mixes. Slight modifications of the latter are, however, desirable in some

applications and, in these cases, the user is well advised to seek the opinions of the manufacturers of the high-alumina cement, aggregate, or pre-mix.

TABLE I

TYPICAL MIXES FOR CONCRETES MADE WITH CRUSHED FIREBRICK, COMMON BRICK, TILES, ETC.

Mix Designation.	High-alumina cement.	Proportions by volume			Thickness of concrete or mortar.
		Fine brick (½" to dust)	Medium brick (¾" - 1½")	Coarse brick (1½" - 2½")	
A	1	2	-	3	6" or over
B	1	2	2	-	2" - 6"
C	1	2½	-	-	2" or less

TABLE II

SERVICE TEMPERATURE LIMITS FOR HIGH-ALUMINA CEMENT CONCRETES MADE WITH VARIOUS AGGREGATES

Aggregate.	Type of Concrete.	Maximum Temperature.	
		°C	°F
Siliceous gravels and sands	Structural	250	480
Traprock and whinstone	Heat-resisting	900	1650
Crushed building brick or engg. brick	Heat-resisting	1000	1830
Vermiculite	Insulating	1000	1830
Diatomite	Insulating	1000	1830
Expanded clay (e. g. Haydite)	Insulating	1100	2010
High temp. insulating brick	Insulating	1300	2370
Firebrick	Refractory	1350	2460
Sillimanite	Higher refractory	1450	2640
Chrome or chrome-magnesite	Higher refractory	1500	2730
Corundum	Higher refractory	1550	2820

NOTE:—The above temperature limits are dependent on the quality of the aggregate and are applicable for the normal recommended mixes. When richer mixes are employed to obtain increased strengths, the above temperatures are slightly reduced.

TABLE III
EFFECT OF CEMENT CONTENT ON THE REFRACTORINESS OF
CONCRETES INCORPORATING FIREBRICK AGGREGATE OF
36% ALUMINA CONTENT

% high-alumina cement	10	20	40
Pyrometric cone equivalent (Seger cones)	27(1610)+	17(1480)+	12(1350)+
+ corresponding temperature °C.			

TABLE IV

THERMAL PROPERTIES AT A MEAN TEMPERATURE OF
1000°F. OF PRE-FIRED REFRACTORY AND
INSULATING CONCRETES

Aggregate	Mix by volume (Cement/ Aggregate)	Density (lbs./cu. ft.)	Thermal Conductivity (BTUs./hr.) (sq. ft.) (°F. in.)	Specific Heat (BTUs./ (cu. ft.) (°F.)	Thermal Diffusivity (sq. ft. hr.)
Vermiculite	1:6	30	1.0	8.0	0.011
	1:4	35	1.2	9.0	0.011
Diatomite	1:6	50	1.5	13.0	0.010
	1:4	55	1.7	14.0	0.010
H.T. Insulat- ing Brick	1:6	75	2.5	19.0	0.011
	1:4	80	2.8	20.0	0.012

Haydite	1:6	85	3.2	21.0	0.013
	1:4	90	3.5	22.0	0.013
Firebrick	1:6	110	5.4	28.0	0.016
	1:4	115	5.8	29.0	0.017

TABLE V

EXPANSION AND CONTRACTION OF REFRACTORY CONCRETE.

	Length.
At room temperature—as cast	100 cm.
At 1000 C	100.1 cm.
At room temperature—after cooling	99.6 cm.

REFERENCES

- (1) Heindl, R. A. and Post, Z. A., J. Amer. Cer. Soc., 37 No. 5, 206-216, (1954).
- (2) "Refractory Concrete", Lafarge Aluminous Cement Co., Ltd.
- (3) Hansen, W. C. and Livovich, A. F., J. Amer. Cer. Soc., 36, No. 11, 356-362, (1953).
- (4) Robson, T. D., British Clayworker, 62, No. 741, 302, (1954).
- (5) Witschey, R. A., Foundry, 77, No. 9, (Sept. 1949).
- (6) Robson, T. D., Refractories Journal, p. 203, (May 1954)
- (7) Robson, T. D., Modern Power and Engineering, p. 134 (Mar. 1954).

RESEARCH ON INDIAN RAILWAYS LUCKNOW CENTRE'S ANNUAL REPORT

Details of the progress made in research work on the Indian Railways are given in its annual report for 1955—56 published by the Railway Testing and Research Centre at Lucknow.

The Centre functions directly under the Railway Board, in charge of a Director, at present Shri S. L. Kumar.

Among the important investigations carried out at the Centre during the year were trials in connection with the running of high speed vestibuled air-conditioned train services on some trunk routes; development of cycle trolleys; use of loco. coal ash as building material;

performance of different types of sleepers in the track; formulations for compounds to prevent corrosion of rails; design and construction of better instruments for measuring forces exerted by locomotives, riding quality and comfort of coaches, pressure exerted by soils and development of paints and varnishes.

Successful designs of broad gauge and metre gauge trolleys capable of being pedalled without fatigue by one man at a time at a speed of 8 miles per hour when carrying a load of about 1,200 lbs. were finalised. Only two trolley-men would be required in place of four for running these trolleys, which are light enough to be removed off the track by two men without any difficulty.

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SPEED AND BRAKE APPLICATION RECORDER

Self-erasing disc which records against a distant base

A SPEED and brake application recorder, the R 1038 tachograph, developed by Hasler Limited, has been designed specially for those railways which for various reasons do not require a comprehensive record to be made of the speed, distance, and running and standing time for each journey made by their vehicles, but which desire records of speed and brake application against a distance base in the critical period immediately preceding any accident or incident in which locomotives or railcars may be involved.

SELF-ERASING DISC

To meet these limited requirements the manufacturers decided to produce an instrument which, while it functioned as a normal speed indicator with mileage counter, embodied a recording section needing no attention whatsoever until the recorded data were actually

required. As a complete record covering a whole journey or series of journeys was not required, it was possible to eliminate the use of paper diagram rolls, and to use instead a self-erasing recording disc which provides, on a large scale, records of speed and brake applications against a distance base of 1,820, 910, or 450 yd. only, all records previous to the selected distance being automatically erased.

The instrument is driven by flexible shafting or by the Hasler electric remote drive from a wheel of the vehicle. A periodic coupling measuring movement is employed which provides deflection of the pointer and of the speed recording stylus proportional to the speed. The pointer and stylus in their zero position are in the extreme left-hand side of the instrument, and as the pointer deflects clockwise towards its maximum, the stylus moves from left to right towards the centre of the instrument.

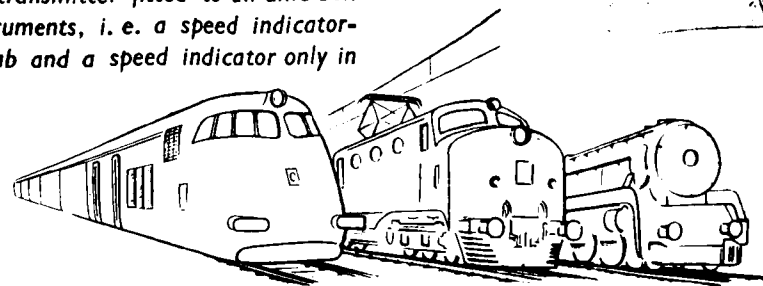
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Record: Hours, Speed, Distance.

Direction of Travel or Current "On" or "Off,"
Application of Brakes.

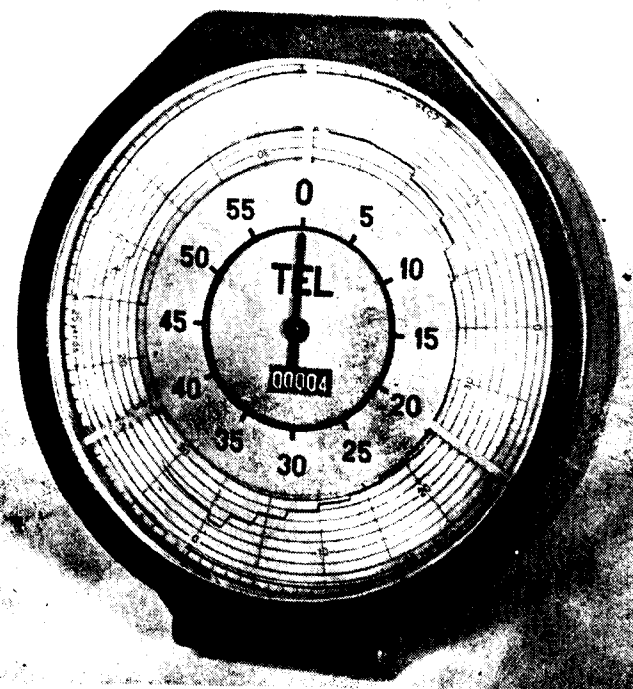
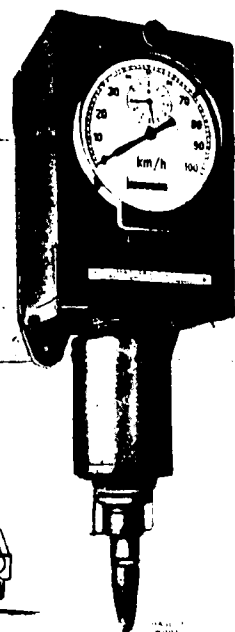
The drive can be by means of rigid or flexible shafting or "electric remote." The latter method is particularly suitable for vehicles driven from either end as one transmitter fitted to an axle box will drive two instruments, i. e. a speed indicator-recorder in one cab and a speed indicator only in the other.



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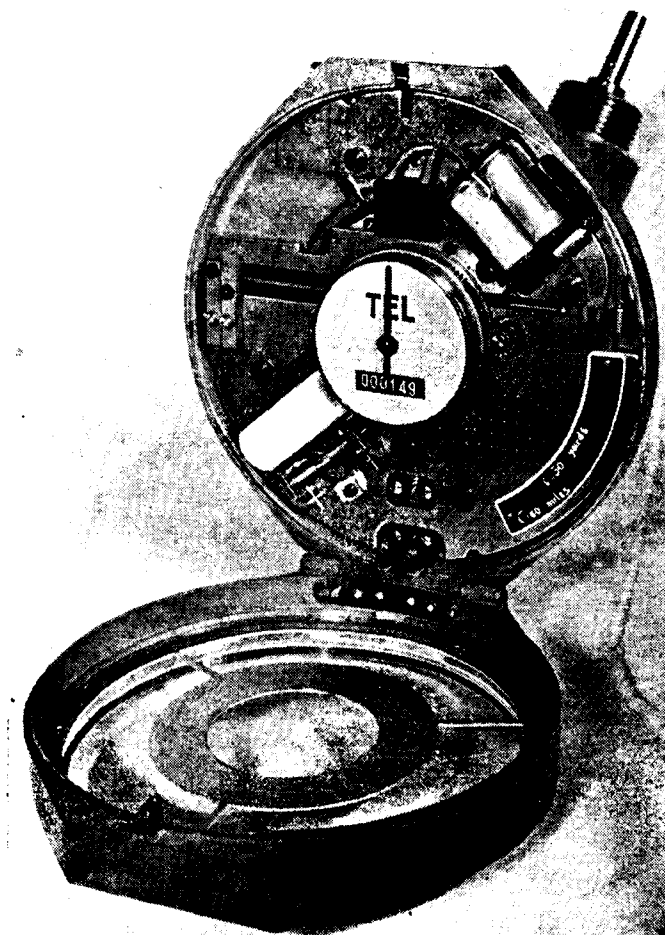
Recorder, showing speed pointer and scale. The recording disc can also be seen surrounding the speed scale.

Immediately beside the speed stylus is the brake record stylus operated by the electromagnets through a linkage, such that when the brakes are applied, the stylus moves outwards approximately $\frac{3}{16}$ in. The speed recording disc is mounted on a central boss which is driven by the pinion on its right-hand side at a speed proportional to the forward speed of the vehicle.

The disc is made of glass having speed and distance calibrations etched on its forward face. The rear face of the glass is coated with a white non-drying paint; so that if a line is made in this paint with, for example, a pencil point, the effect when viewed from the front of the disc will be that of a dark line against a white background, the position of the line being shown up against the etched calibration marks. If the white coating is re-applied the dark line will vanish, and this is the principle employed for the recording.

SPRING-LOADED PLUNGERS

When the disc is in position on the instrument, the two styluses, which are, in effect, spring-loaded plungers, press against the rear of the glass and as the disc turns they penetrate the white coating leaving dark lines behind them. If no other provision were made it is clear that after one complete revolution of the disc, the



Instrument with cover removed, showing electro-magnet; braking and speed styluses are on the left-hand side.

dark lines left during the first turn would become confused with those made during the second and subsequent turns.

FELT ROLLERS

To overcome this, a felt roller impregnated with the white paint is positioned as shown in the accompanying illustration, which presses against the rear face of the disc and re-applies the white coating, thereby deleting the lines. It will be seen, therefore, that the record will only appear on the disc between the position of the styluses and that of the roller.

To illustrate this, the accompanying diagram shows a disc with a record on it, which appears only between points G and A, which distance can be selected according to the calibration of the instrument to represent 1,820, 910, or 450 yd. It will also be seen that the radial

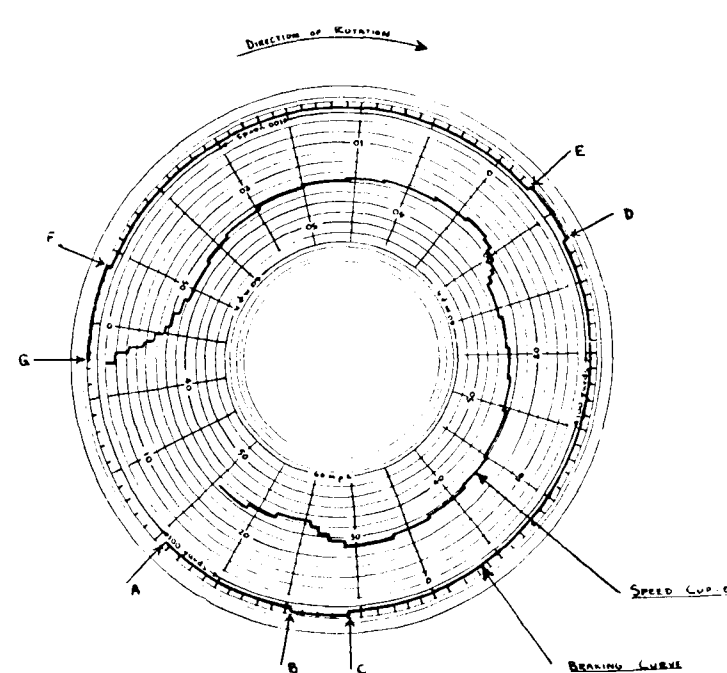


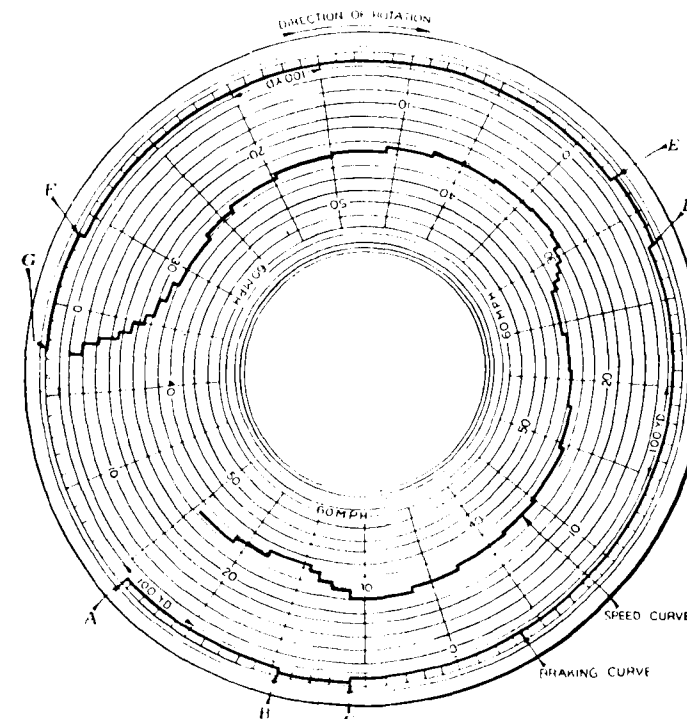
FIGURE 4
Used recording disc, showing speed and braking curves : radial lines represent the distance base, and the concentric give the speed graduation.

lines on the disc represent the distance base while the concentric circles give the speed graduation.

BRAKING STYLUS

Operation of the braking stylus can be seen between points G and F, E and D, and C and B, and it will also be seen that between these points the speed falls off due to the braking effect. The vehicle finally comes to a standstill at point G.

It will be seen that at point D, which is 890 yd. back from where the vehicle stopped, the brakes were applied



at a speed of 37 m. p. h. for a distance of just over 80 yd. and were released at point E, when the speed had fallen to 24 m. p. h. In normal usage the disc and roller arrangement can be left undisturbed for periods of up to 18 months and will continue to give a clear record. After this period a new reimpregnated roller can be fitted. The disc may be removed to provide evidence and a spare disc fitted without upsetting the calibration in any way. It will be appreciated that, whereas it would be possible to deface the record on the disc, it would be impossible to falsify it.

Hasler Telegraph Works, Ltd., whose address is 26, Victoria Street, London, S.W. 1., England, are represented in India by Messrs. Heatly & Gresham, Ltd.

BICC CHAIRMAN'S WORLD TOUR

Mr. W. H. McFadzean, Chairman and Managing Director of British Insulated Callender's Cables Limited, is leaving London on Saturday the 19th instant by air on a round-the-world tour and expects to be back in this country just before the end of March.

During this tour Mr. McFadzean will be visiting BICC Group Organizations in Pakistan, India, Singapore, Australia, New Zealand and North America. Mr. McFadzean has made many overseas visits in recent years and the extensive itinerary of his forthcoming tour is yet another indication of outstanding effort the BICC Group are taking under his leadership in the export field—the Group's direct and indirect exports from this country, together with the turnover of BICC Group Companies overseas, now amounts to some £55 million per annum.

High-speed Diesel Engines for Rail-bound Vehicles, and Planning of an adequate Production Programme by Messrs. Daimler-Benz Aktiengesellschaft

By Ing. O. T. Bräunche, Stuttgart

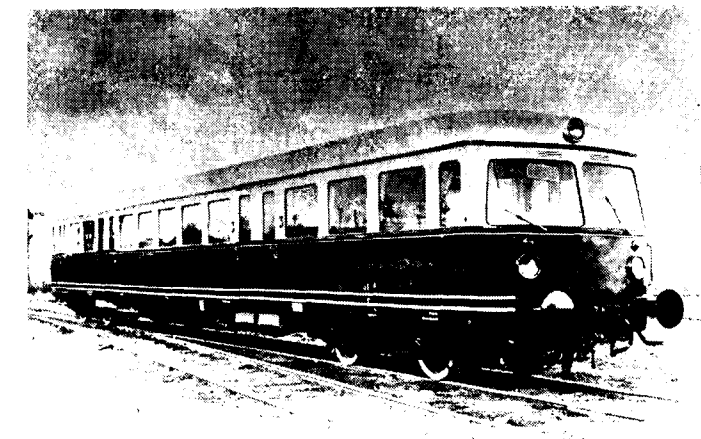
IMPORTANCE OF DIESEL ENGINES AS POWER UNIT OF RAIL-BOUND VEHICLES

THE development of the Diesel engine to relatively high performances, to power units, the compactness and weight of which permit their installation into railcars and locomotives of all sizes inevitably, led to transportation by means of Diesel locomotives, all the more since changing to electrically driven trains would entail much higher costs and Diesel engine driven vehicles incorporate the same outstanding qualities.

Besides the electric power transmission, hydraulic power transmission attained a state of perfection, which not only allowed Diesel traction in general, but Diesel hydraulic traction in particular, to be considered as an advantageous starting-point for the rationalization of uneconomic tracks.

Below we should like to mention the most important advantages of Diesel railroad transportation :

Smaller capital requirements, large radius of action without refuelling, no expensive workshops for servicing of locomotive, speeding up of transportation by providing for quicker service, and, in this way, elimination of steam engines, smoke-free operation, attractive styling and in this way vehicles that correspond to modern taste and are



Railcar of the German Railway Company Frankfurt/Main. Assembled with Messrs. Henschel & Sohn, Kassel with 2 MB 816 Bb Engines. Output : 300 HP./1500 r.p.m.

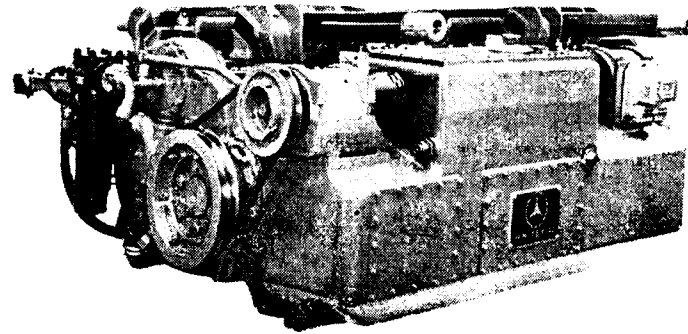
best suited for their purpose, better visibility for driving personnel, reduction of driving personnel as the second driver is usually unnecessary, improved safety and less strenuous work for driving personnel.

SHORT SURVEY ON THE DEVELOPMENT OF DIESEL RAIL-BOUND VEHICLES, AND THE IMPORTANCE OF THE HIGH-SPEED ENGINE FOR THE DEVELOPMENT OF THESE VEHICLES

Contrary to the steam-powered locomotives, the Diesel engine cannot directly drive the wheels, as it cannot be started when being under load. Therefore, in the beginning of its development its use in rail-bound vehicles was exclusively limited to those possibilities, to which it is open due to the mechanical power transmission units with clutch and transmission to compensate torque and speed of the vehicle. More than 30 years ago, the development of Diesel-driven vehicles with narrow-gauge and normal-gauge locomotives of small output for local services started, thereby using the transmission units as already known with road vehicles. Railcars of medium and high output could—in accordance with the development of the Diesel engine—be initiated only after appropriate power transmission units had been developed, which could give the vehicles the required torque and speed characteristics.



Diesel-locomotive, built by Krauss-Maffei, powered by a Mercedes-Benz Diesel engine MB 836 Bb.



Horizontal-Diesel-Engine MB 846 Bb
Output : 300 HP./1500 r.p.m.

The limits of the mechanical power transmission, which, it is true, has reached a high standing of development and which is nowadays still preferably installed in smaller railcar units, due to its excellent efficiency and low price, are clearly defined. The increasing demands on performance and driving characteristics of railcars have been fulfilled with the development of the electrical and hydraulic power transmission.

Whereas the electrical power transmission quickly made its way in America (USA), the hydraulic power transmission has been brought to a high standing especially in Germany due to reasons which cannot be discussed in this report. The absolutely different traffic conditions and the economical prerequisites of the two countries might have been the impetus for said development. To a certain extent the development of Diesel engines for railcars has been differently influenced by these two types of power transmission.

The pioneers of the hydraulic power transmission were inclined to use the high-speed Diesel engine already at an early date. The power of the converter transmission is a function of the input speed. The higher the speed of the converter impeller is, the higher is the output to be transmitted.

It is natural that due to this converter characteristic also driving engines with higher rated engine speed are used. Therefore, the German Federal Railways (Deutsche Bundesbahn) preferred to use high speed Diesel engines in the course of their plans to replace steam by Diesel, and had a decisive influence on the high standing of development of these engines as well as the vehicles equipped with Diesel-hydraulic drive.

The development of the Diesel-electric drive with Diesel engines of higher rated engine speeds might in the beginning have been hampered by commutation difficulties. Nowadays, however, the suitable electrical

equipment can be supplied and the electrical industry realized that the excellent results with Diesel-hydraulic large Diesel locomotives for vehicles of smaller dimensions and low axle load arose the interest of the Railway Companies.

Engines with higher speeds allow smaller and lighter generators, although their operational efficiency and durability are not inferior to the heavier models of earlier design. It is to utilize the advantages of the electrical equipment with regard to weight and space, a factor which can more than compete with the hydraulic power transmission.

Nowadays, we have overcome the ideas of excessive wear and short life of the high-speed Diesel engines. Knowledge and success in the field of the materials, the combustion, the bearings and the lubrication etc.—let us but remember the pioneering results with HD—oils—made the high-speed Diesel engine mature for an economical power unit for all fields of application.

To summarize, it can be said that high-speed Diesel engines made their way via the light-weight railcar to Diesel locomotives of all types of power transmission. They are the logical member in the development of Diesel railcars.

MERCEDES-BENZ ENGINES AT THE SERVICE OF THE RAILWAYS

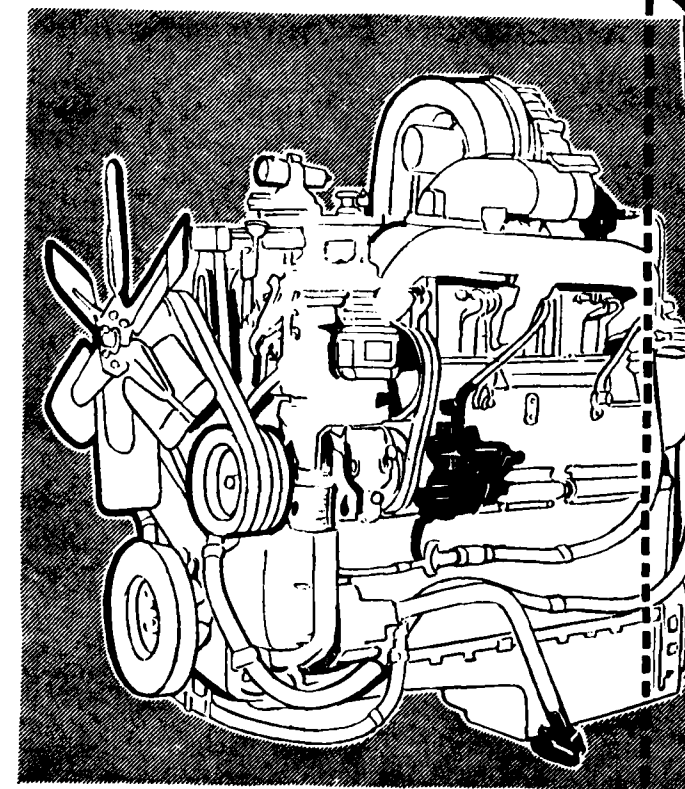
Ever since combustion engines have been constructed and used for industrial purposes, the firm Daimler-Benz has played a leading part in the development of efficient



Diesel-powered locomotive of the German Federal Railways equipped with Mercedes-Benz engines, model MB 820, fitted with supercharger. Assembled with Messrs. Krauss-Maffei, Munchen. Output : 2×1100 HP.

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high-speed combustion engines. Gottlieb Daimler not only invented the first high-speed engine in 1883, but also produced the first rail-bound vehicles equipped with combustion engines, among them the first locomotive engine of this kind with an output of 5.5 HP., which were brought out by his Daimler-Motoren-Gesellschaft in Bad Cannstatt in 1887. During this years which followed the first World War, numerous engines with a smaller output were then installed in rail-bound vehicles.

In addition to the development in the automotive field, the firm of Daimler-Benz has always remained faithful to its tradition as far as the construction of combustion engines, in particular, high-speed Diesel engines for rail-bound vehicles and other fields of application, is concerned. It has made valuable contributions to the development of modern engines with a high output and to their growing economy of operation.

At the beginning of the thirties developments led to the production of engines with outputs of 300 and 450 HP. without supercharging and of 650 HP. with exhaust gas turbo-charging (MB 816). Twelve-cylinder V-line engines and double-piston engines (underfloor installation in railcars) with speeds of 1400 and 1500 r. p. m. already ran 4000 hours at this period without requiring a basic overhaul. In particular, the performance of the engines MB 806 which rendered an output of 450 HP. at 1400 r.p.m. proved so satisfactory that the German Federal Railways decided to include a series of over 200 engines for Diesel railcars in their procurement programme. Unfortunately, the second World War then put a stop to these extremely promising developments.

The destruction of the productive plant and the much higher requirements the engines had to meet after the war as far as output, operation and application were con-

cerned did not permit the resumption of the production of these engines which had been interrupted for years.

Railway organisations everywhere were confronted with particularly difficult problems of transportation. All over the world it proved necessary to rationalise on a grand scale: the demand was raised for new more modern vehicles and thus for corresponding engines too.

As a start the firm Daimler-Benz used its experience with the successful construction of railcar engines, which were built before the war, and the knowledge acquired in the course of developing airplane and marine engines in order to design and build an engine with an output of 800 HP., the 12-cylinder Diesel engine MB 820 with a speed of 1500 r. p. m. This engine met the requirements of the German Federal Railways for their new railcars and locomotive engines. The designers solved the problems set by the partly contradictory requirements, such as:

Installation of the engines in two-axle light bogies

Simple maintenance

Easy access to the engine parts, the controls, the valves, pistons, cylinder sleeves

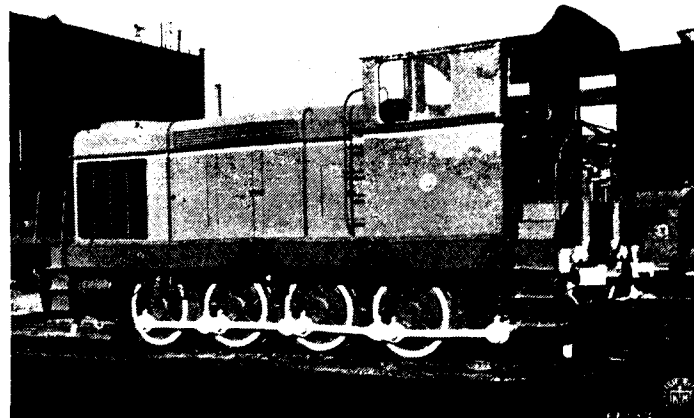
Possibility of exchanging the parts with simple tools—coupled with this, the engines were to be designed as small compact units which were to be as light as at all possible—

Maximum resistance against the shocks and stresses transferred to the engines by the bogies or parts of the carriages

Indifference to the frequent and large variations of load

High resistance to wear and tear

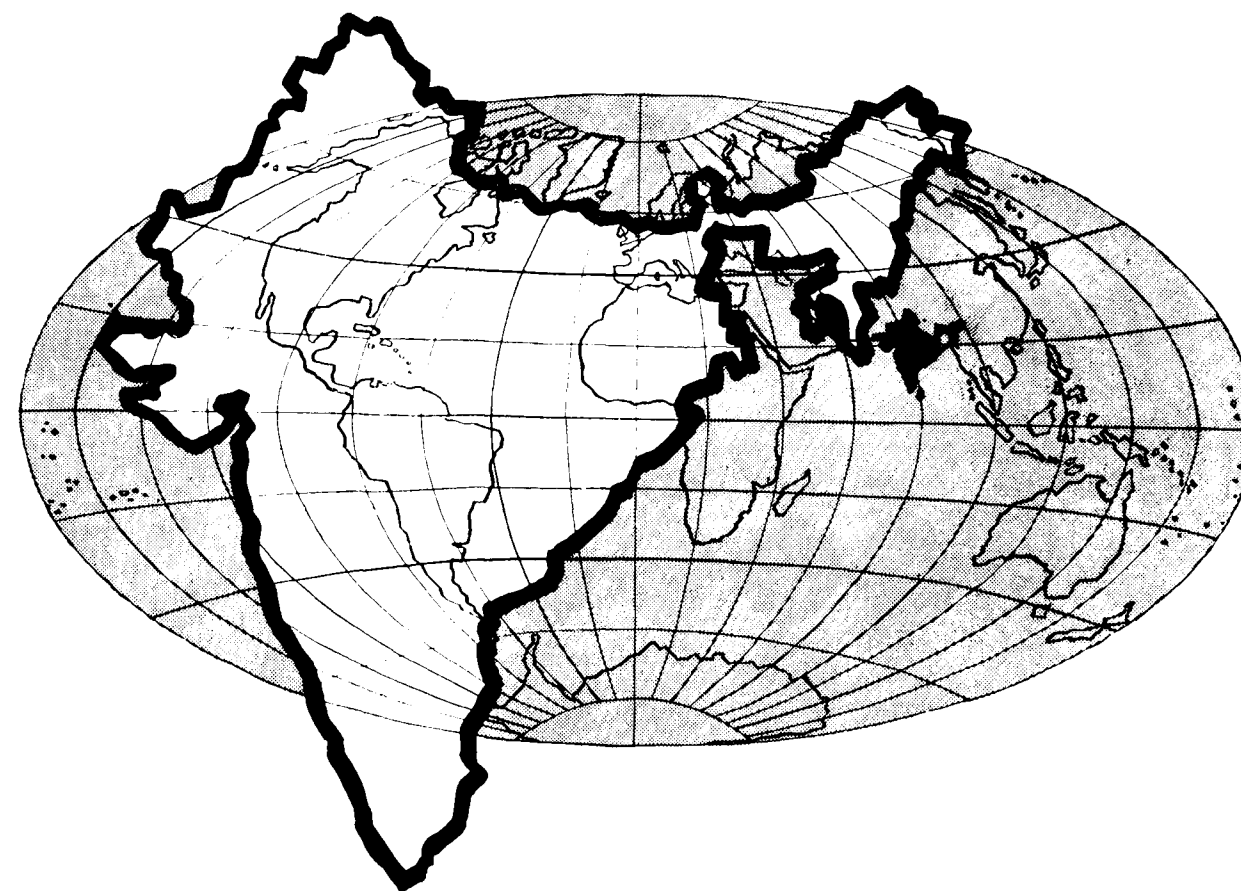
in an exemplary fashion in this Diesel engine with high output. The design proved just as satisfactory after the



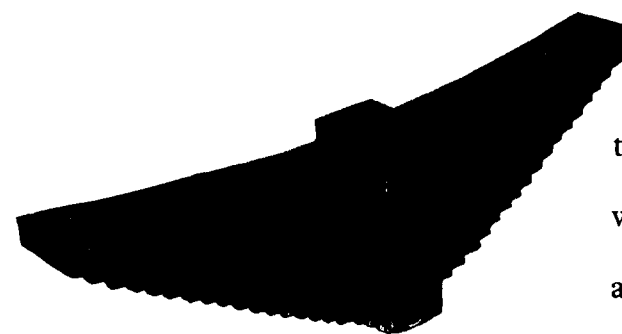
Diesel-Shunting Engine of Harbour-Railway Buenos-Aires. Assembled with: Messrs. Krauss-Maffei. Output: 700 HP. Diesel-Engine MB 820 B



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output had been raised to 1000 HP. at 1500 r. p. m. This engine has demonstrated its operational efficiency in the course of over 5 years' gruelling service with the German Federal Railways.

PLANNING OF A PRODUCTION PROGRAMME TO MEET THE REQUIREMENTS OF RAILWAY TRACTION AND OF VEHICLE DESIGN

After this start had been made, the growing motorization of the railways set the firm of Daimler-Benz the task of planning a production programme which would enable its customers, whether these were railways or industrial enterprises, to introduce power units of the same design in the main output categories. The consequent simplification in the keeping of spare parts, the basic training of skilled personnel and the uniform stocking of maintenance depots with tools and apparatus would result in very advantageous rationalization.

A) ENGINES OF THE DESIGN SERIES MB 820/MB 836 (350—1000/1100 HP)

The railways' aims which are to enjoy freedom of action with their rolling stock and to ensure satisfactory

operation at any time whilst keeping down expenditure, were carefully kept in mind by Daimler-Benz as they developed a series of engines for the range of output between 350 HP. and 1100 HP. and of twin-engined units up to 2200 HP.

The 12-cylinder V-line engine MB 820, which renders an output of 1100 HP. at 1500 r. p. m. and is installed in the heavy-duty Diesel locomotive of the German Federal Railways V 200, served as a model for the 6-cylinder in-line engine MB 836, the dimensions of whose cylinders and other parts subjected to special wear and tear are identical to that of the MB 820.

The two engine types MB 836 and MB 820 are built as suction-type engines with exhaust gas turbo-charging.

It is common knowledge that supercharging has the purpose of supplying compressed air to the combustion chamber by means of a blower and of raising the weight of the air in the cylinder. This means that more fuel can be burnt than would otherwise be possible. The specific engine output is considerably increased thereby.

The various engine designs have the following nominal outputs:

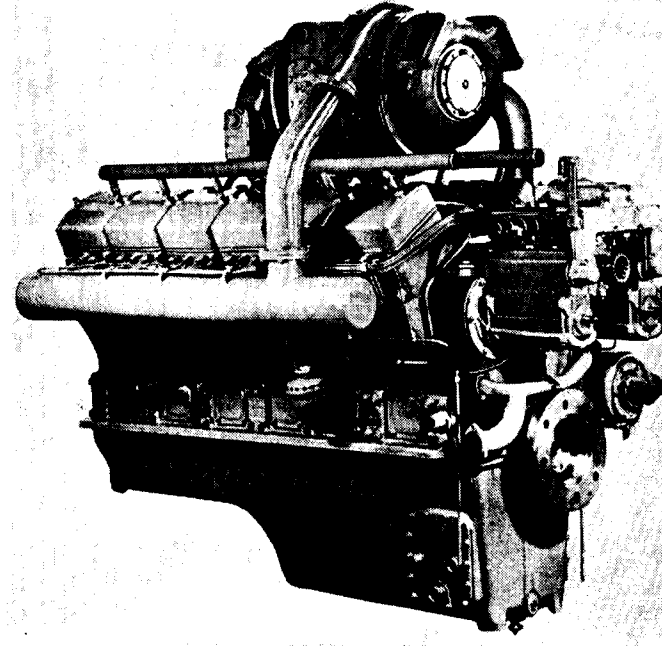
6-cylinder engine MB 836 B	without supercharging	350 HP./1500 r.p.m.
6-cylinder engine MB 836 Bb	with exhaust gas turbo-charging	500 HP./1500 r.p.m.
12-cylinder engine MB 820 B	without supercharging	700 HP./1500 r.p.m.
12-cylinder engine MB 820 Bb	with exhaust gas turbo-charging	1000 HP./1500 r.p.m.
	alternatively	1100 HP./1500 r.p.m.

In order to keep the weight down, all engines of this series have crankcases out of heat-treated silico-aluminium, whereby the housing is drawn up to the upper edge of the cylinder, thus endowing it with exceptional rigidity. Cylinder sleeves out of alloys have been inserted in the housing and care has been taken to ensure that they correspond to the light-metal pistons and piston rings, the first piston ring being chromium-plated.

The crankshaft out of special steel is of a sturdy and vibration-proof design and has been specially hardened to reduce wear and tear; it runs in steel bearing shells lined with lead bronzed. A thin lead layer has been electro-plated onto the lead bronze and serves as an anti-corrosive run-in layer. The piston rods also run on lead bronze bearings on the crankshaft pins. After the nuts of the cylinder head bolts have been loosened, the grey cast iron cylinder heads can be lifted without

removing the suction and exhaust lines to check the gaskets and valves in the shortest possible time and without using any lifting appliances—this is indeed the only possible way of carrying out maintenance jobs whilst the engine is installed in another unit. The valves are controlled by push rods. There are two suction and exhaust valves each which surround the pre-chamber which lies in the centre of the cylinder head.

Special attention has been paid to the development of the combustion process. Thanks to careful designing of the piston head of the pre-chamber, of the burner element with its side bores, of the injection nozzle, as well as to thorough investigation and study of the injection laws, it has proved possible to combine smoke-free combustion and a low engine fuel consumption with low thermal stress upon the piston.



Mercedes-Benz 12-cylinder Diesel engine type MB 820 with supercharger for railbound vehicles.

The temperature of the piston head which lies under 300°C even when subjected to very high mean effective pressure make a very small piston clearance possible—the bore of the cylinder being 175 mm. at the piston stem 0.24 and at the head 0.58 mm.—thus reducing wear and tear considerably and significantly increasing the period of operation until an overhaul becomes necessary.

B) ENGINES UP TO 350 HP.

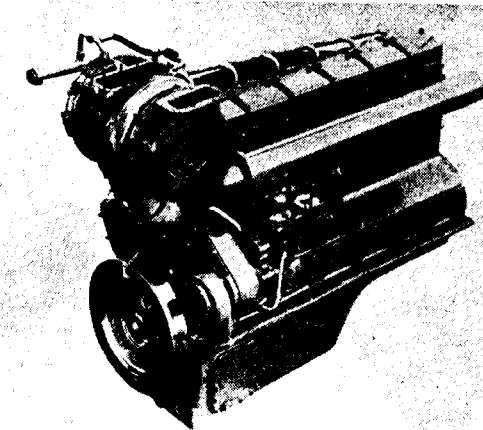
The large demand which exists for engines with a small and medium output provided the stimulus for widening the range of the output categories up to 350 HP. All Diesel engine types have been taken over from the road vehicle programme and have been adapted for railway operation. With a reduced continuous output up to 150 HP. these engines, which are considered as very economical in terms of space and weight, are especially suitable for light rail-bound vehicles, e. g. repair gang cars, small locomotives and railcars, in view of their high nominal speeds (1800 r. p. m. and 300 r. p. m. as the case may be). The characteristic features of these engines are actually highly-suitable for the operation of this type of vehicle. Rising torque coupled with falling engine speed over the main range of operation correspond to the operational conditions of these vehicles with their predominantly mechanical transmission of power. The fact that the spare parts for these engines which have been taken over from the automobile field are available in contract workshops for Mercedes-Benz Diesel vehicles which

span almost the entire world constitutes an advantage which should not be underestimated.

A design series of real industrial engines with nominal outputs up to 120 HP. and nominal engine speeds of 1200 r. p. m. was developed for those fields of application in which engines of a sturdier construction with smoother running and lower engine speed, as well as other equipment, are required. They can also be optionally equipped with compressed air starting instead of electrical starting and can be supplied with special equipment which is proof against firedamp for operation in mines.

An efficient 6-cylinder in-line engine with the type designation MB 846 closes the gap between the engines of the lower output range and the actual large engines (engines with high outputs). This engine renders an output of 225 HP. at 1500 rpm. without supercharging and an output of 300 HP. at 1500 rpm. with exhaust gas turbo-charging; in a special design which has been developed for the German Federal Railways it renders an output of 350 HP. at 1600 rpm.; it is constructed both in a vertical and a horizontal design (underfloor engine).

The importance of this engine for railcars with a moderate output, where the number of seats available and thus an increased economy of operation, in particular, for light railway wagons and auxiliary lines, is constantly growing. The output capacity of the engine MB 846 Bb with supercharging endows the vehicle with highly-advantageous qualities, because it is still able to operate at a respectable travelling speed after normal passenger train or goods train wagons have been coupled to the locomotive, or because a number of carriages can be



Mercedes-Benz Diesel-Engine MB 836 Bb with exhaust gas supercharging blower 500 HP./1500 r.p.m.

coupled between the end railcars. Until now engines with a vertical design had to be used to a large extent as power units with a higher output.

The robust design of the engine means that the power unit is not so liable to suffer from somewhat careless maintenance and from those external influences to which an underfloor engine which does not have a special foundation protection is necessarily exposed. As an engine with water cooling, its pleasant quietness of operation merits special mention. A glow plug system ensures quick starting.

The locomotives which are equipped with MB 846 engines of a vertical design are suitable for enterprises where one can hardly rely on trained operating personnel and for which the ideal engines are those which require a minimum of maintenance and technical training on the part of the personnel, whilst guaranteeing maximum resistance against the rough driving and shunting conditions typical of provisional railway installations.

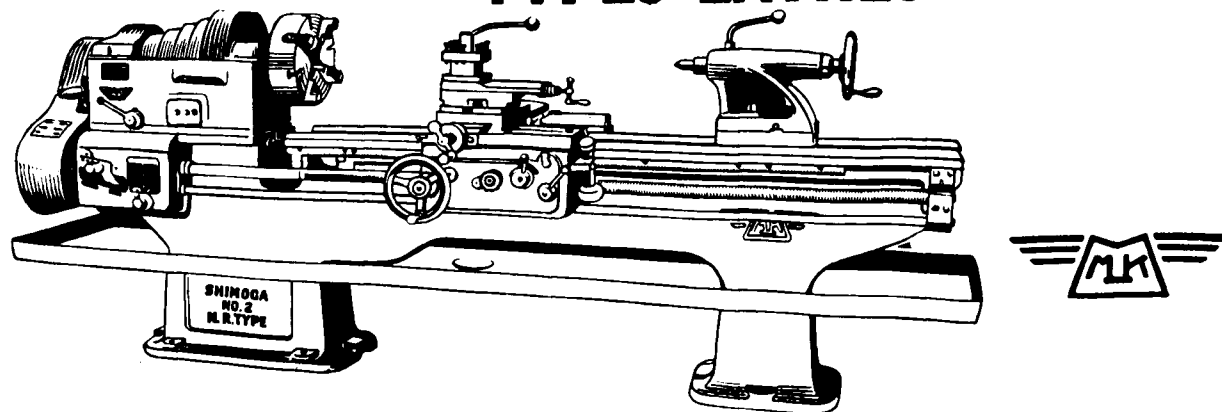
An engine, such as type MB 846, which offers the advantageous qualities of a heavy, robust engine and is

as manoeuvrable and responsive as a heavy-duty engine, whilst its construction makes it suitable for installation in compact vehicles with a very favourable range of vision, good axle loads, and driving conditions, combined with ease of operation, can be fairly said to represent a great advance and achievement in the development of motorization. Maintenance costs, service life and price of this engine compare favourably with those of a heavy low-speed engine of similar type. The quality of the service which it renders is undeniable.

THE PERFORMANCE OF DIESEL ENGINES UNDER OPERATING CONDITIONS BEYOND NORMAL AND THE IMPORTANCE OF THE SUPERCHARGER

The output of a Diesel engine must not be rated alone by the output required which results from the required tractive power to convey a pre-determined load, the desired maximum speed of the vehicle, the type of power transmission, its efficiency and the output required for the auxiliary units, but the operating conditions under which the Diesel engine is intended to work must be taken into consideration as well. The altitudes at

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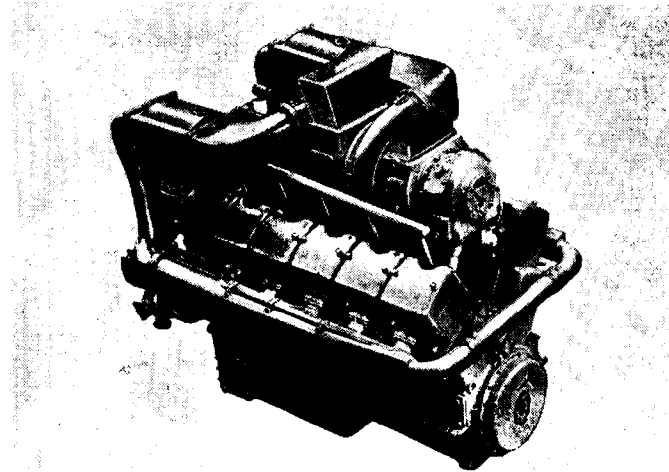
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C-19



12-cylinder Mercedes-Benz Diesel engine type MB 820 Db
with Heavy-Duty Supercharger.

which the vehicle has to be driven, the temperature of the intake air, and the air humidity are of decisive influence on the performance and may thus be of great importance for the selection of a Diesel engine.

With rising temperature the volume of the air increases, and the air quantity in the combustion chamber of the engine decreases correspondingly, which is then no longer sufficient to burn the amount of fuel required for obtaining the rated output of the Diesel engine. Consequently the engine must be fed with such a quantity of fuel as to ensure smoke-free combustion under unfavourable operating conditions. The obtainable output naturally lies below the rated output of the engine at normal operating conditions, and this is the output to be taken as a basis for driving the vehicle. The difference between rated output and the output available at the place of operation has been called "engine output loss", a fact which must be taken into consideration when rating the output of the engine.

There are generally valid charts which show the reduction in output of normal suction engines.

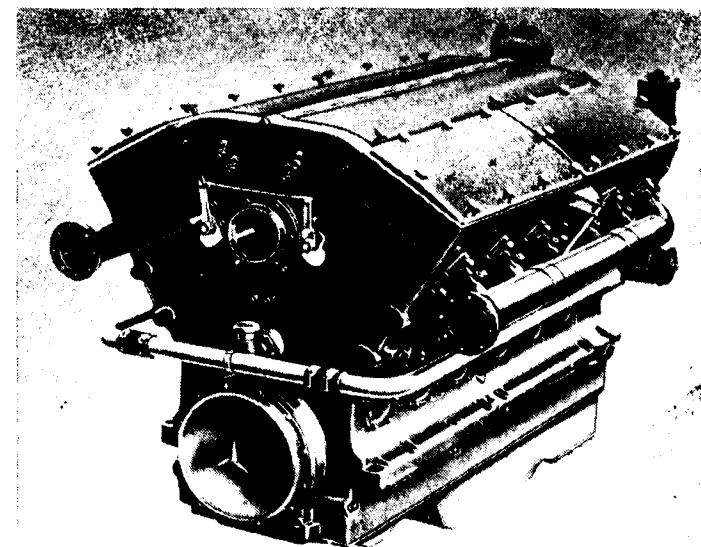
The specific output of a Diesel engine may be considerably increased by the use of a supercharger; especially the exhaust gas supercharger which uses the energy of the exhaust gases to drive the blower has gained great importance as a means to increase output with Diesel engines the mean effective pressure could be considerably increased.

The limits of the meps of the individual engines, considering the application of the engine, are essentially determined by the load which the moving parts and the

bearings have to accept and further by the expected life of the respective parts. Besides, the existing exhaust gas temperatures and their admissibility for the exhaust gas supercharger are playing an important part; exactly the exhaust gas intake temperature permissible for the turbocharger may be decisive regarding the rated output reduction of supercharged Diesel engines beyond the rate of normal losses due to high altitude and high intake air temperature when operated under higher ambient temperatures (intake air temperatures) and when operated in very high altitudes.

There is a fixed ratio between the intake air temperature and the exhaust gas temperature. The increase of exhaust gas temperature is a multiple of the increase of the intake air temperature. Thus the permissible limit of the supercharger inlet temperature may be quickly trespassed and the mep of the engine to reduce the exhaust gas temperature must be additionally decreased. Variations of the air conditions and the specific air consumption in high altitudes also entail variations of the specific fuel consumption and the exhaust gas temperatures and under circumstances also corresponding additional variations in output may be involved.

The numerous factors which determine the output loss or the necessary rated output reduction of supercharged Diesel engines, and which largely depend on the design of the Diesel engine, its range of operation below the smoke limit, its combustion system etc., make it



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thus impossible to draw up output reduction charts for general use. The output loss, however, is in general, considerably lower than in case of engines without supercharger.

A certain increase of the permissible mep can be obtained—without exceeding a certain temperature limit of exhaust gases—if the charging air is cooled, i. e., if the temperature of the combustion air which enters the cylinders is considerably reduced.

On boats, ships and stationary units, the charging air cooling can be simply effectively materialized by through-flow cooling with sea water or fresh water of low temperature. Railbound vehicles, however, require—due to their very limited water supply—circulation cooling for cooling the charging air. The engine cooling circuit is not suitable to re-cool the charging air due to the fact that the cooling water temperature must be kept to 70–80°C. For charging air cooling a second and separated cooling water circuit with an own air re-cooler is required. The necessary cooling surfaces towards the ambient air increase, if higher re-cooling is demanded and ambient temperatures rise. Consequently, the constructional and capacity requirements for the cooling increase. In any case it will be necessary to consider whether the potential output gain is compatible with the requirements for a larger cooling system or whether it is more reasonable to use larger or more power units.

The supercharger and especially the high-supercharger with charging-air cooler in connection with light-weight efficient high-speed Diesel engines, which spare space and weight for the additional cooling system, are gaining special importance, if Diesel railcars are to be operated in very high altitudes. They make it possible to rationally operate these vehicles also in those places, where hitherto the electric system alone represented by far the most economical type of operation. High-speed Diesel engines with their favourable unit power and their specifically small space requirements are promoting the development of efficient vehicles for high altitudes.

As a rule, the rating of the output of an engine is based on an equal maximum output of the vehicle for known climatic conditions and altitudes at which the vehicle has to be operated. The performance of the engine under the operational conditions must—after the output necessary for the auxiliary units has been deducted—be sufficient to give the required output available at the transmission inlet in accordance with the demanded tractive power and speed. All other procedures—if possible at all—require expensive and complicated control devices for the engine and therefore can hardly satisfy the demands.

EXPERIENCES GAINED DURING OPERATION, WEAR AND TEAR, REPAIR WORK

The operational conditions, to which the engine installed in rail-bound vehicles is subjected, its maintenance and upkeep are of the same vital importance for its longevity and economical operation as are the structural features. The control elements and safety devices, the preparation of the engine for driving and the selection and control of the fuels, lubricants, and coolants represent additional essential factors which must be taken into consideration to safeguard a proper operation of the Diesel engine at any time.

Exceptional importance should therefore be attached to the following principles:

- (1) The engine cooling water should be pre-heated.
- (2) The engine should not be started without having the proper oil pressure in front of the bearing elements and not at too low a cooling water temperature.
- (3) The cooling water should be controlled within a certain and, if possible, small operational temperature range. In order to obtain the proper operational temperature as quickly as possible, a thermostat with short-circuit should be provided.
- (4) The engine should be equipped with safety devices to protect it from exceeding the correct operational temperature reaching a lube oil pressure falling below the minimum permissible degrees, and exceeding a max. speed.
- (5) Suitable lube oil brands and fuels of low sulphur contents with a reduced tendency to coking and good filtering qualities should be selected.
- (6) The coolant should be controlled.

The experience gained has shown that the longevity of the engines can essentially be increased by reducing the wear and tear of the bearings and moving parts of the engine, when starting, as far as possible. We should therefore like to advise preheating the engines to a cooling water temperature of 35–40°C. Electrical or oil heating devices have shown very good results. We also recommend effecting the preheating process by auxiliary motors and by means of heat exchangers in the cooling water circuit. Blowing steam into the cooling water circuit will however encourage an acidification of the water (corrosion), clogging and scale deposits, so that this procedure should not be adopted.

Before starting the engine, the lube oil should be pressed against the bearing elements of the engine via a pre-pump (manually or electrically operated pump depending on the design), so that it can lubricate the bearings immediately when starting. The starting process can be shut off by a pressure control up to a certain min. oil pressure.

If the engine is running for a longer period at lower cooling water temperatures, the acidification due to the acid anhydrides of the combustion products of the Diesel fuel will be promoted and the wear and tear of the cylinder walls will be increased considerably. It is therefore necessary to ensure the proper operational temperature of 80—85°C (engine outlet temperature) as quickly as possible. Today correctly functioning thermostats are available everywhere, which short-circuit the external cooling water circuit (radiator) until the cooling water temperature required is obtained and set. In addition, perfected control devices for the control of the fan speed permit a most exact control of the coolant temperature at varying loads and different ambient temperatures.

The oil temperature, the degree of which is a decisive factor for the acidification at the cylinder walls, rises much more slowly with separate cooling of the oil than that of the engine cooling water. For this reason, separate cooling circuits for engine and lube oil heat exchanger have no longer been used with Mercedes-Benz Diesel engines for many years already. The oil heat exchanger is installed in the engine cooling circuit and contributes to heat up the lube oil more quickly during the starting period and to cool it down after the operational temperature of the cooling water has been reached.

Thus the oil temperature has been brought into close relation to the cooling water temperature. A separate control of the oil temperature can therefore be omitted.

The safety devices consist of shut-off elements, which electromagnetically or hydraulically pull the control rod of the injection pump to stop, when the control devices for temperature, oil pressure and max. speed respond to irregularities.

The selection of the lubricant decisively influences the service life of the engines and especially the period, during which the engines can be operated without checking the pistons.

The Heavy-Duty oils have proved their distinct superiority over the standard oils. The pistons are kept free from oil and combustion residues, the piston rings

move freely even after relatively long running periods, so that the check-ups of the pistons, which were previously prescribed in the maintenance schedules, can be omitted. Installation and removal or overhaul work of pistons can be effected in conjunction with procedures at the bearings and need not be done earlier. The extra costs for the HD oils compared to the lubricants without additives are more than made up for by the omission of the intermediary procedures. HD oil raises the economy of operation. Special stress shall again be laid upon the favourable influence which it exerts, owing to which the cylinder wear and the corrosion of the bearings is considerably reduced.

In order to prevent corrosion at the cylinders, cylinder head etc. it is advisable to check whether electrolytes have been produced in the cooling water system as an undesirable result of the varying electric potentials of the different materials used.

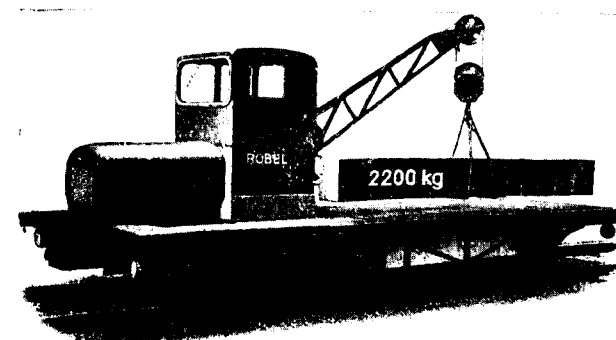
Frequently the fuel cannot be selected freely, since the economy of Diesel-engine driven vehicles presupposes the use of locally available fuel brands.

Preheating of Diesel fuel of higher viscosity, proper filtering, etc. represent measures, which can help to extend the range of suitable fuels.

Maintenance work schedules will contribute to guarantee a troublefree start of operation of the engine. The scope of work and the date on which certain procedures are due naturally depend on the stage of development of an engine design, which is constantly being improved thanks to the experience gained. Apart from the control of the lube oil, change of oil, cleaning of oil and fuel filters we should like to mention the checking of the valve clearance, of the injection nozzles, checking or replacement of gaskets, retightening of screw connections etc., which represent procedures, which can be carried out while the engine is set out of operation and which should, if possible, be combined with the respective work on other parts of the vehicle, e. g. on bogies, axles, etc.

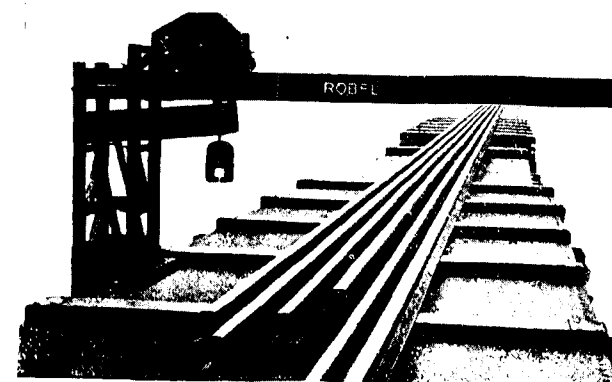
Short oil tests, have proved very successful for the early discovery of certain irregularities and for deciding whether an oil change is necessary. Flash point, viscosity, fuel and water content and finally the accumulation of combustion residues in the engine lube oil may be factors which serve to detect imminent dangers for the engine in good time and indicate the moment when remedial measures have to be taken. The reliability of the results depends essentially on whether the test samples have been taken under the same conditions.

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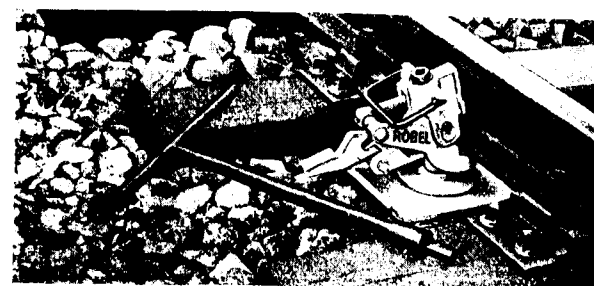
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The sample should be taken while the engine is running and before the fresh oil is filled in. The intervals for the oil changes have been considerably prolonged by the use of HD oils, too. On the basis of the oil test results the oil change interval which is most advantageous for the engine, can be fixed, i. e. at the moments when the soot-dissolving effect of the additives in the oil is no longer operative and carbon residues begin to settle in the engine. The degree of the combustion in an engine has a decisive influence on the accumulation of residues and on the oil change intervals and thus offers the advantage of economy of operation through longer oil change intervals.

The experience and results gained during the operation of the Mercedes-Benz Diesel engines of today's production have been exploited for the engines which are installed in rail-bound vehicles since 1951, and have contributed to the attainment of a high degree of perfection, especially of the engine designs MB 836 and MB 820. Both in line service and in hard and strenuous shunting service the first engines of this series have already proved most successful, as may be seen from the enclosed wear and tear data. The originally fixed operation periods until an overhaul becomes necessary were soon recognised as very cautious estimates in view of these random wear and tear results, which were only selected as an example. Operational periods of 8000 to 10000 hours of engines, which run up to 23 hours daily, and which average monthly periods of operation of more

than 600 hours, without requiring any repairs whatsoever, illustrate the rapid progress which has been made in the development of high-speed Diesel engines.

When considering the operational performance and economy of an engine one must not forget that the expenditure for overhauls, in particular the value of the spare parts needed for a basic reconditioning is generally lower for the smaller, lighter and more compact engines with higher speeds than for comparable slow-speed power units.

Experience, has shown that a basic overhaul of Mercedes-Benz Diesel engines involving a complete replacement of pistons, cylinder sleeves, connecting rod bearing, main bearings, nozzles and various components subject to special wear and tear, such as valves, burners, water pumps etc. including spare parts will probably cost about 10—12 per cent of the engines' initial price.

Replacement of the engine in the railcar can be effected without any difficulties and at great speed, a fact which contributes of an early resumption of operation. When comparing the economy of operation with that of other power plants one should take into account that an essential advantage of this kind of propulsion consists in its being almost invariably ready for operation, which results in increased revenue—Finally we should still like to mention the generally lower purchasing price of a vehicle with light-weight, high-speed engines.

WEAR AND TEAR DATA

(Average Values)

of the engine MB 820 Bb (1000 HP./1500 rpm.) after approx. 4600 hours of operation.

1. Crankshaft, main bearing, connecting rod bearing			wear and tear
Main bearing pins	dia. 140 mm.		0.009 mm.
Connecting rod bearing pins	dia. 125 mm.		0.010 mm.
Main bearing shell	dia. 140 mm.		0.010 mm.
Connecting rod shell	dia. 125 mm.		0.019 mm.
<i>Wear</i>	tolerance, connecting rod bearing	0.029 mm.	
	max. permissible up to	0.12 mm.	
<i>Wear</i>	tolerance, main bearing	0.019 mm.	
	max. permissible up to	0.11 mm.	
2. Piston, cylinder liner			wear and tear
	dia. 175 mm.		
Piston, upper edge tolerance	dia. 0.58 mm.		0.12 mm.
skirt	tolerance	dia. 0.24 mm.	0.03 mm.

Cylinder liner, TDC 1st ring			wear and tear
	centre of cylinder		0.03 — 0.06 mm.
<i>Wear</i>	tolerance, piston top/cylinder liner, top		0.015 — 0.03 mm.
	max. permissible		0.15 — 0.18 mm.
<i>Wear</i>	tolerance, piston bottom/cylinder liner, centre		0.19 — 0.25 mm.
	max. permissible		0.045 — 0.06 mm.
			0.16 — 0.21 mm.

3. Piston rings

wear and tear

Axial height	4 mm.	0.010 mm.	max. permissible	0.075 mm.
Tension loss		7—9 per cent		

WEAR AND TEAR DATA

(Average Values)

of the engine MB 836 Bb (500 HP./1500 rpm.) after approx. 5400 hours of operation.

1. Crankshaft, main bearing, connecting rod bearings

wear and tear

Main bearing pins	dia. 140 mm.		0.001
Conn. rod bearing pins	dia. 125 mm.		0.002
Main bearing shell	dia. 140 mm.		0.008
Connecting rod shell	dia. 125 mm.		0.005
<i>Wear</i>	tolerance, main bearing	0.009 mm.	
	max. permissible up to	0.11 mm.	
<i>Wear</i>	tolerance, conn. rod bearing	0.007 mm.	
	max. permissible up to	0.12 mm.	

2. Piston, cylinder liner

dia. 175 mm.

wear and tear

Piston, upper edge tolerance	0.58 mm.		0.08 mm.
skirt	tolerance	0.24 mm.	0.015 mm.
Cylinder liner, TDC 1st ring			
	centre of cylinder		0.01 — 0.02 mm.
			0.005 — 0.01 mm.
<i>Wear</i>	tolerance, piston top/cylinder liner, top		0.09 — 0.1 mm.
	max. permissible		0.19 — 0.25 mm.
<i>Wear</i>	tolerance, piston bottom/cylinder liner, centre		0.02 — 0.025 mm.
	max. permissible		0.16 — 0.21 mm.

3. Piston rings

wear and tear

Axial height	4 mm.	0.035 mm.	max. permissible	0.075 mm.
Tension loss		up to 3 per cent		

Hydraulic Power Transmission for Rail Vehicles

By Kugel.

Director, J. M. Voith, G. M. B. H., Heidenheim, Germany.

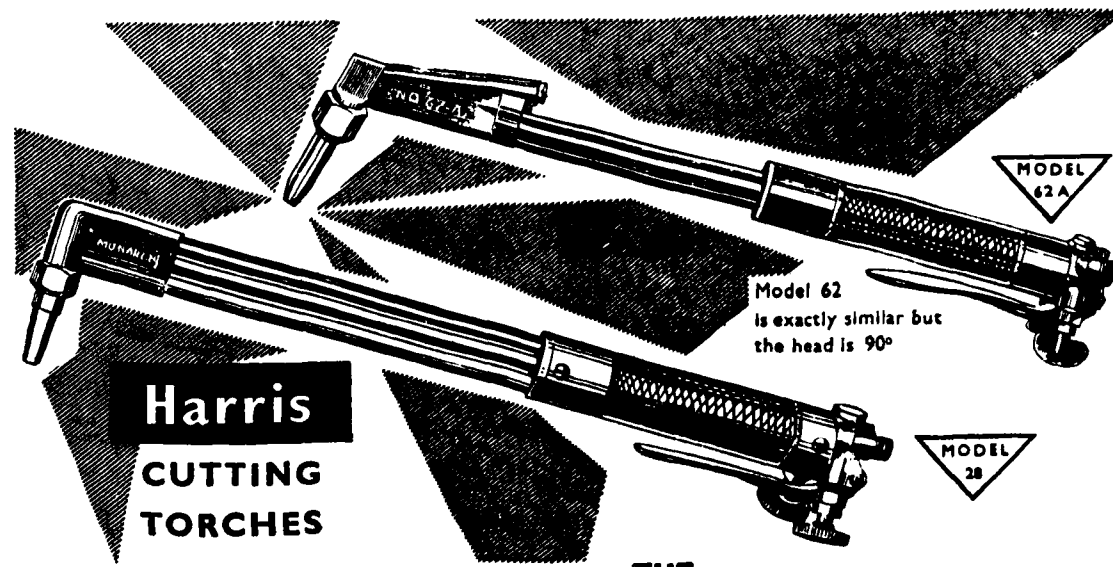
WITH respect to hydraulic transmissions it must be differentiated between hydrostatic and hydrodynamic power transmissions. In the case of hydrostatic power transmission the static pressure is used, while with the hydrodynamic system the forces are put to use resulting from the acceleration or deceleration of a fluid in movement. So far the hydrostatic system has not found a major application as drive of vehicles. Therefore only the hydrodynamic or hydrokinetic fluid power transmission system will be considered.

Fig. 2698 shows the basic arrangement of a hydrodynamic power transmission. At this stage, the schematic drawing in the center of this illustration is to be disregarded. With the arrangement as shown in fig. 2698, by way of example, a Diesel engine is assumed

to drive a centrifugal pump, which from a reservoir draws and accelerates a fluid. This calls for a torque which must be furnished by the engine. According to the law of Newton, by virtue of which force is equal to mass times acceleration, the mass is constituted by the volume of fluid in liters per second passing through the pump.

The fluid through a pipe is channeled to a turbine in which the fluid is decelerated, so that in return a torque is set up, which in the case under consideration is used to drive a screw propeller of a ship.

If for this transmission arrangement the efficiencies of the pump and the turbine are assumed to be each 0.85, and if the friction losses in the piping and in the reservoir are considered, the total efficiency will be at



Harris CUTTING TORCHES

Torches that operate on any kind of gas pressure—high, medium or low. They are made to last long and give efficient service.

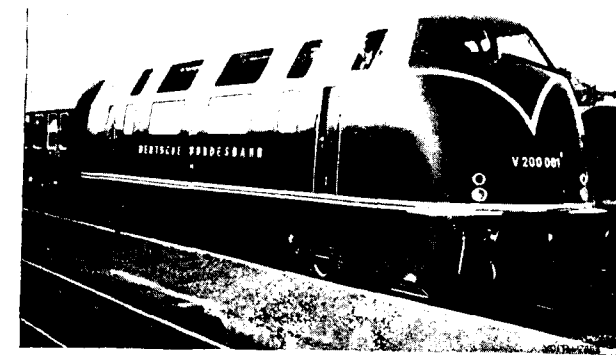
THE ASIATIC OXYGEN & ACETYLENE CO., LTD.
8, DALHOUSIE SQUARE EAST, CALCUTTA-1

Model 62 is exactly similar but the head is 90°

MODEL 62A

MODEL 28

AOAF 4-56



HIGH-POWER TURBO TRANSMISSIONS

1,900 and 2,000 HP Diesel locomotives equipped with fully hydraulic

VOITH TURBO TRANSMISSIONS

The ever increasing application of Voith Turbo Transmissions to high-power Diesel locomotives and railcars and our large deliveries for all outputs are attributable to the satisfactory practical experience gained in many years, the excellent performance of these transmissions and in particular to their unfailing reliability in operation.

Up to date, we have supplied 5,300 VOITH TURBO TRANSMISSIONS, with an aggregate output of 1.8 million HP, for the Diesel locomotives Kof, V 60, V 80 and V 200, the railcars VT 08 and VT 12 of the German Federal Railways and numerous other railroad companies and industrial users, both abroad and in Germany.

The accompanying pictures of high-power Diesel locomotives are evidence of the growing popularity of hydraulic transmissions for all jobs involving the handling of large outputs.

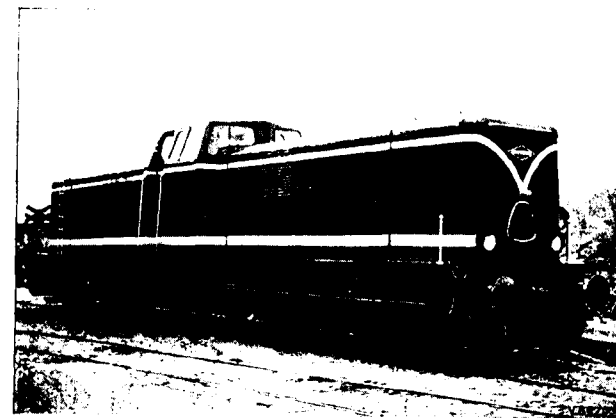
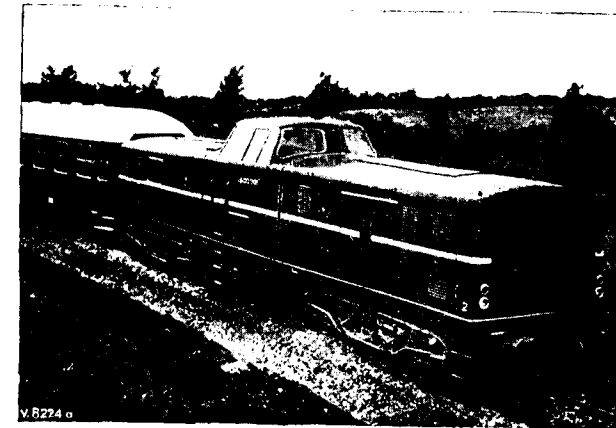
Illustrations (from top to bottom):

2,000 HP Diesel locomotive type V 200 of the German Federal Railways, built by Messrs. Krauss-Maffei and equipped with Voith Turbo Transmissions,

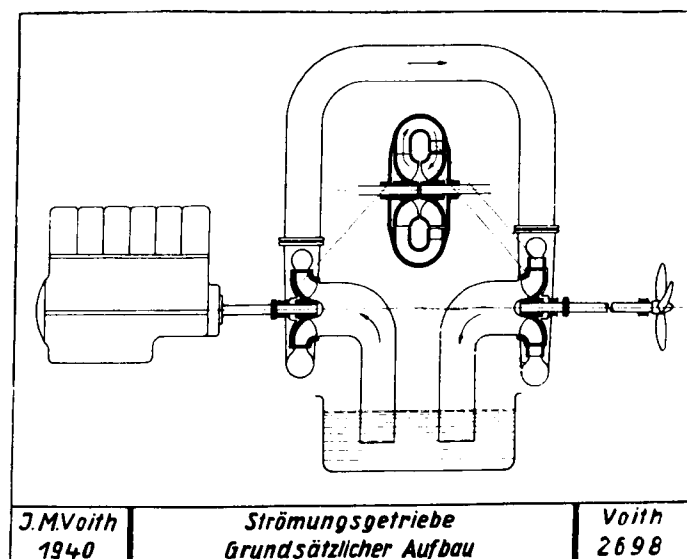
2,000 HP MaK-Diesel locomotive with Voith Turbo Transmissions,

2,000 HP Deutz-Diesel locomotive with Voith Turbo Transmissions,

1,900 HP Diesel locomotive for operation in Brazil, built by Maschinenfabrik Esslingen and equipped with Voith Turbo Transmissions.



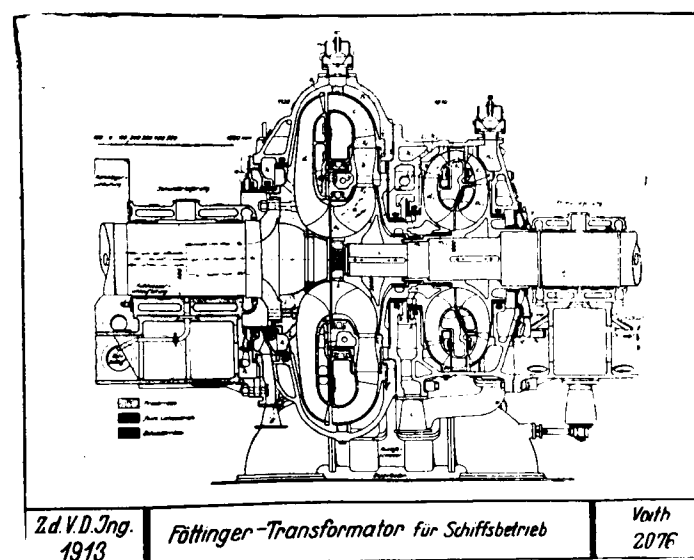
J. M. VOITH GMBH · HEIDENHEIM (BRENN) · GERMANY



Principle of hydrodynamic power transmission.

best 0.6, which for practical purposes would be too uneconomical. Furthermore, this drawback of low overall efficiency is aggravated by high weights and considerable initial costs.

This was the state of affairs when in 1905 the German engineer Föttinger came out with his invention, which—as shown in the center of this illustration—combined centrifugal pump and turbine in a closed circuit dispensing with all spiral cases, bends and piping and their inherent losses. It was by this invention that the hydrodynamic transmission has become an extremely useful and suitable equipment with respect to efficiency, space requirements and weights.

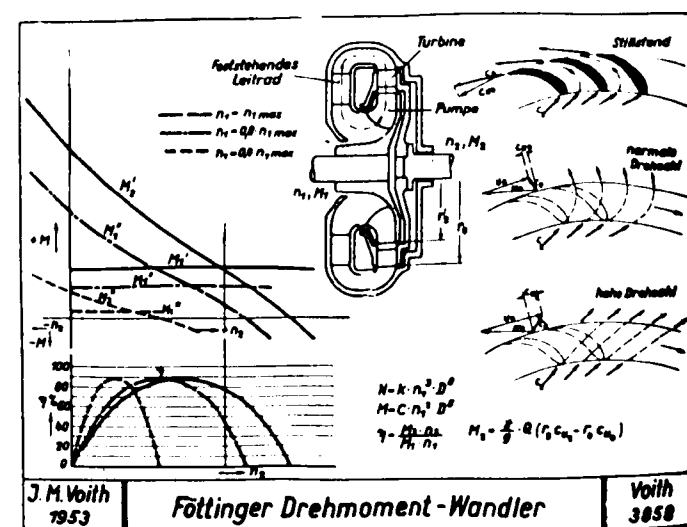


Föttinger converter for ship propulsion.

The so-called "Föttinger transformers" developed at the time were used to transmit powers as high as 50,000 HP. from a fast-running steam turbine to a slow-running ship screw propeller, as at that time it was not yet possible to manufacture gears for the high powers required in this case. Fig. 2076 shows such a "Föttinger transformer" incorporating a large torque converter rated at 16,000 HP. for forward running, the step-down ratio being between 1,000:180 rpm. The smaller torque converter, in which the direction of flow is reversed, is used for running astern. These torque converters are switched on and off by filling and emptying manoeuvres.

In the meantime the hydrodynamic power transmission system has been perfected to a very high degree, and today millions of HP. are transmitted all over the world by fluids in the most varied drives used in ships, locomotives, railcars, automobiles and many stationary machines.

The elements of hydrodynamic power transmission are torque converters and hydraulic couplings. In the torque converter the torque supplied by the engine is so converted that with a practically constant input a high torque is made available at the turbine shaft at low speed and a low torque at high speed. The hydraulic coupling, on the other hand, transmits the torque unchanged, but also permits of different speeds of the driving and the driven shafts. This different effect of these 2 equipments is of course caused by differences in their construction.



Föttinger Torque converter.

M_1' ; M_1'' ; M_1''' Input torque at various input speed n_1
 M_2' ; M_2'' ; M_2''' Output torque at various input speeds
input speed n_1 : efficiency η
output speed n_2

In order to obtain in the case of the torque converter a difference between pump and turbine torque, in addition to these two members a third member is required—a stationary guide wheel—which takes up the difference between these two torques. In the case of the hydraulic coupling, on the other hand,—as will be shown later—only two members are used: a pump and a turbine.

In order to illustrate the function of the torque converter the flow through the blading of the turbine runner is shown for various conditions: for starting, for normal and for runaway speeds. If it is assumed that the pump impeller is driven at constant speed, the impeller moves the fluid towards the turbine in the direction marked by arrows. As long as the turbine runner stands still, because of the blading being bent backward, the fluid is heavily deflected and therefore considerably slowed down in the peripheral direction, so that a large torque is set up at the turbine runner. This torque is many times larger than that of the pump impeller. Under the action of the torque thus set up the turbine runner starts revolving. As the speed of the turbine runner increases, the deflection and hence the deceleration of the liquid decreases until eventually, as may be gathered from the illustration to the right at the bottom, no deflection occurs at the runaway speed. The curves in the left-hand portion of the illustration show that as the turbine speed n_2 increases, the torque M_2 gradually decreases, dropping to "0" at the runaway speed. This torque curve has the same character as for instance that of a D. C. traction motor, in which the speed is automatically adjusted to the load to be handled.

The liquid coming from the turbine runner enters the stationary guide wheel with a velocity which varies considerably. In the case of the Voith converter, shown in the illustration, the liquid is returned to the pump impeller without any change in direction, because the stationary guide wheel is arranged directly before the pump. As a result of this, for the various operating conditions the torque M_1 absorbed by the pump also remains practically constant.

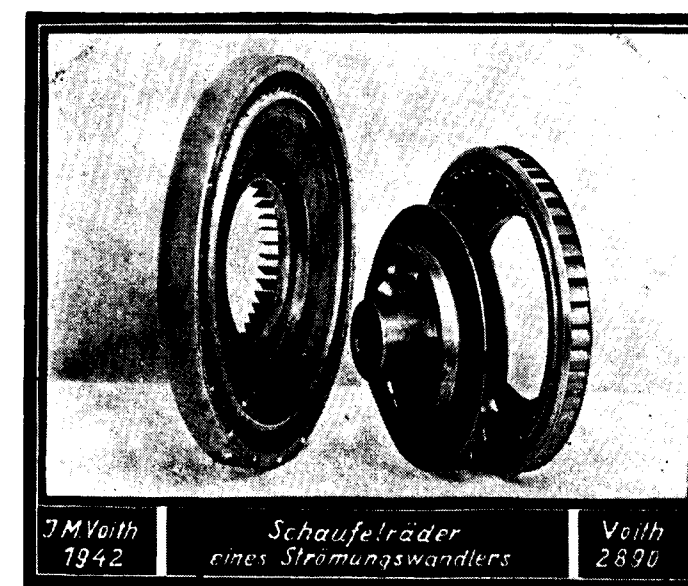
If a change in the pump speed occurs

- the power transmitted varies as the third power;
- the torque varies as the square;
- the speed varies as the pump speed.
- The efficiency remains practically constant but is shifted to another turbine speed that varies in direct proportion to the pump speed.

The illustration reproduces the torque curves for three different pump speeds: full speed, 2/3 and 1/3 full

speed. It can readily be seen that by varying the pump speed or the speed of the driving engine, the torque converter allows of operation over a very wide range.

As in the case of all hydrodynamic machines the efficiency of the torque converter is dependent on the dimensions, the finish of the blade surfaces and the viscosity of the working fluid. In addition to this, the ratio turbine speed: pump speed, for which the torque converter has been designed and which gives maximum efficiency, plays a major part. Depending on these factors, efficiencies as high as 90% may be reached.



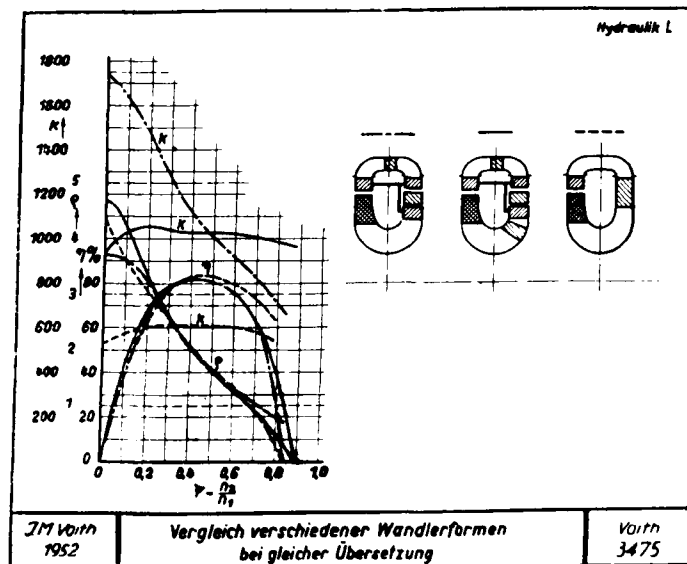
Vaned wheels of a torque converter

From left to the right:

- stationary guide wheel
- pump impeller
- turbine runner

Illustration 2890 shows the members of a Voith torque converter: from left to right—the stationary guide wheel, the pump impeller and the turbine runner.

The various torque converters, which have become known, differ with respect to the number of the rows of blades, the sequence of pump, turbine and guide wheel and with respect to the ratio turbine speed: pump speed for which the efficiency is an optimum (design point). In the technical literature it has often been claimed that in order to obtain a high, flat efficiency curve several turbine stages are required. However, this is only true, if in the direction of flow a turbine stage is provided ahead of the pump as shown in fig. 3475 a. With this arrangement, as the speed of the turbine part varies, also the direction of flow at the outlet of the turbine



Comparison of various formes of torque converters designed for the same speed ratio γ

From left to the right:

- 3 stage turbine converter with last turbine stage before the pump impeller.
- 3 stage turbine converter with a stationary guide wheel before the pump impeller.
- 1 stage turbine converter with a stationary guide wheel before the pump impeller.

K = specific input

η = efficiency

P = torque ratio (output torque : input torque).

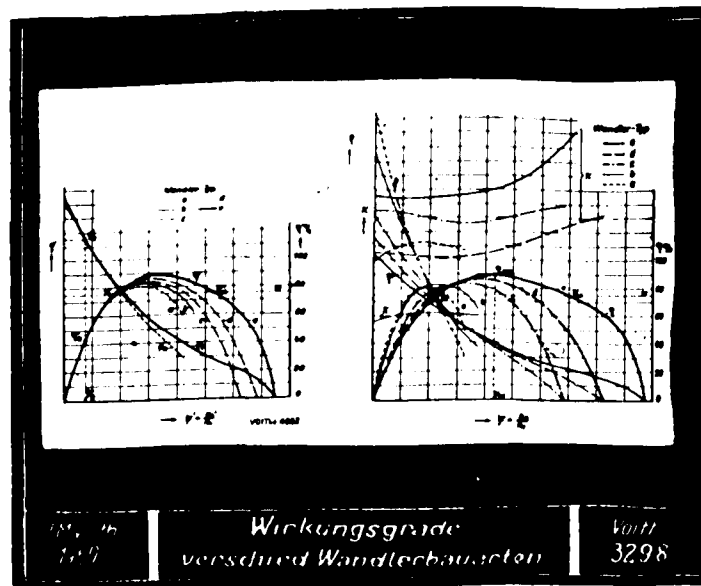
part and hence also at the inlet of the pump impeller so that, as a result of this, the input of the pump also varies. From the value K , which represents the input at constant pump speed, indicated for this arrangement, it may be gathered that the input steeply increases as the turbine speed decreases, which means that when a Diesel engine is used as driving machine, the speed of the engine heavily drops in the low rail-speed range. In order to obtain with such an arrangement a satisfactory increase in torque, or in other words, a flat efficiency curve, several stages must be provided in the turbine part.

If, however, as shown in fig. 3475b, a stationary guide wheel is interposed between the last turbine stage and the pump, for the input a K value is obtained that is practically constant.

Fig. 3475c shows a torque converter with one single turbine stage. As may be gathered from the curve, in this case, too, the input is practically constant, the only difference being that in comparison with the arrangement according to fig. 3475b the specific input is

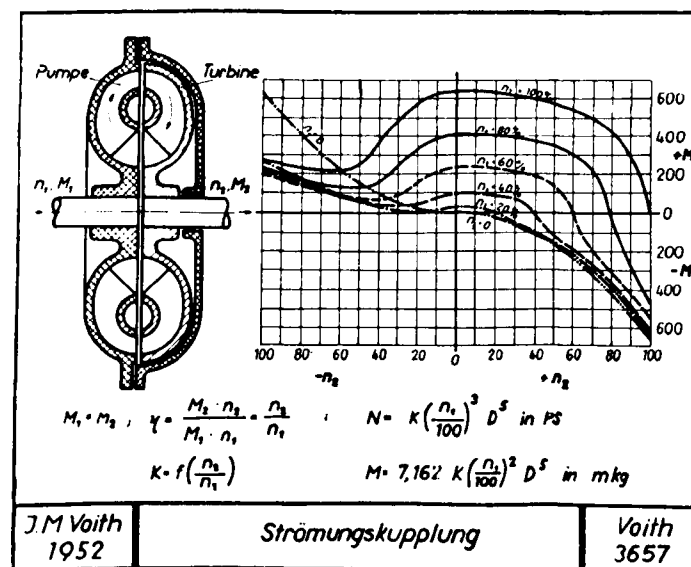
smaller as a result of the smaller number of turbine stages. This may readily be compensated by slightly increasing the diameter which is effective with the fifth power. The torque conversion and the efficiency are at least the same.

Fig. 3298 shows the influence of the design speed ratio on the efficiency and the torque conversion for the same single-stage arrangement. Fig. 3298b shows the torque conversion and the efficiencies plotted against the ratio of the turbine speed to the pump speed. It can readily be seen that with a smaller design speed ratio the efficiency and the flatness of the efficiency curve increase, but that at the same time the torque conversion decreases at starting. Often the quality of a torque converter is judged from the torque conversion at starting. However, such practice gives rise to erroneous conclusions and is only permissible, if at the same time the speed ratio is duly considered. For this purpose, behind each torque converter an imaginary step-down gear is assumed, which has such a ratio that behind this



Efficiency of various types of torque converter. (Wandler Type = type of torque converter)

step-down gear for all torque converters the same starting torque is available. In this way, fig. 3298a has been drawn up. Only under the above assumption, the converters can be compared in a fair way. As may be gathered from fig. 3298, e. g. that converter with the lower design speed ratio, which provides the lowest starting torque ratio, has actually the best efficiencies with respect to the absolute values and the flatness of the efficiency curve.



Fluid coupling.

Principle of design

Transmittable torque at various input speeds n_1 and various output speeds n_2

Input torque $M_1 = M_2$ output torque

input speed n_1

output speed n_2

Profile diameter D

The hydraulic coupling comprises 2 effective parts only: pump and turbine as shown at the left of illustration 3657. In view of this, the torque of the pump is at any time identical which that of the turbine. From this fact it may also be deduced that the efficiency of a coupling is given by the ratio turbine speed/pump speed. The difference in speed is called "slip", and the efficiency of the coupling in per cent can also be expressed by 100 minus slip. If it is assumed that the pump is driven at 100% speed, and that there is no load on the turbine runner, this runner will also revolve at 100% or, in other words, at synchronous speed. At such time the centrifugal pressure of the pump will be completely compensated by the counterpressure of the turbine of the same value, and, as a result of this, no liquid can circulate and no torque can be transmitted.

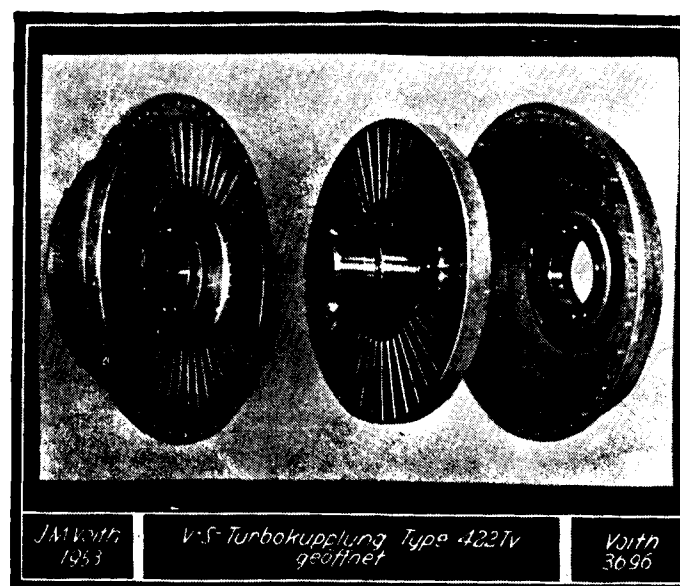
When load is put on the turbine runner, its speed decreases or, in other words, "slip" occurs. At such time a pressure difference is set up, and as a result the liquid is caused to circulate and torque can be transmitted. As may be gathered from the curves, the torque M increases as the speed of the turbine decreases (the slip increases) and when the runner comes to a complete standstill (100% slip), this torque reaches its maximum value.

For the dimensioning of a hydraulic coupling it is considered that the normal torque is transmitted at 2—3% slip or, in other words, with an efficiency of 98—97%.

The illustration also shows the torques for pump speeds below 100%. It can readily be seen that the torque—as in the case of the torque converter—decreases rapidly as the input speed is decreased. For this reason, if it is not possible to overload or stall a Diesel engine, since the transmission of power is discontinued when the engine speed drops.

Contrary to the torque converter, the hydraulic coupling can transmit power in either direction, thus also negative torques ($-M_2$). Power is always transmitted from the part running at the higher speed to that revolving at the lower speed.

Illustration 3696 shows the blading of pump impeller and turbine runner of a hydraulic coupling.

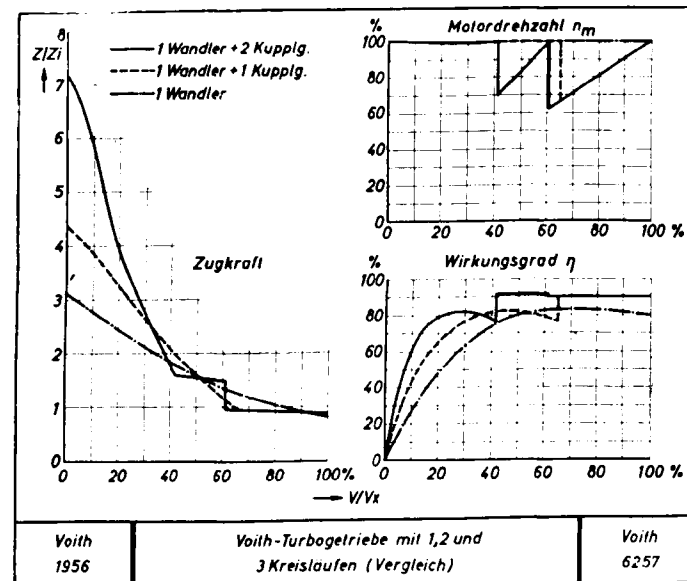


Blading of a fluid coupling.

From left to right:

- pump impeller
- turbine runner
- casing

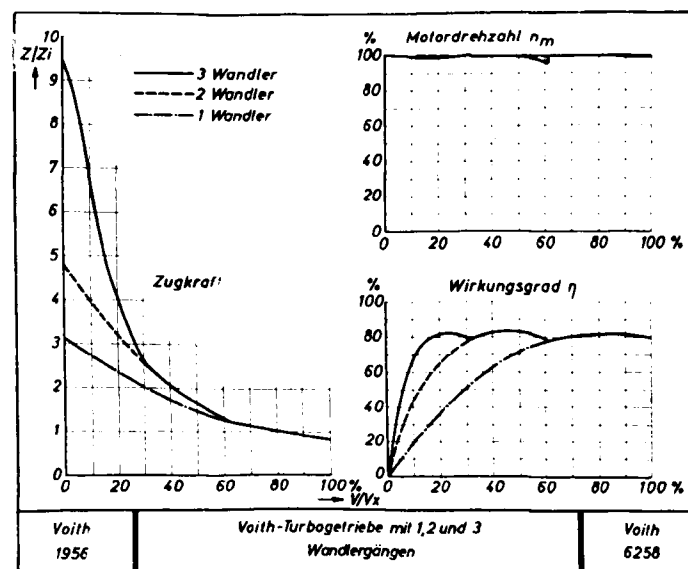
For the operation of rail vehicles such as locomotives and railcars usually high tractive efforts on starting and also a high maximum speed are required. Apart from some special cases such requirements cannot be met by one single torque converter, and, for this reason, the Voith transmission combines the torque converter with



Voith Turbo Transmission

with 1, 2 or 3 circuits
 Specific tractive effort Z/Z_1
 specific vehicle speed V/V_x
 engine speed n_m
 efficiency η

one or 2 hydraulic couplings or with one or two additional torque converters. Illustration 6257 shows to what extent, by the addition of one or 2 couplings, for the same maximum speed the tractive efforts and efficiencies can be improved in the low and medium speed ranges. In this context it should be noted that with such combinations the overall efficiency can reach up to 92% in the couplings.



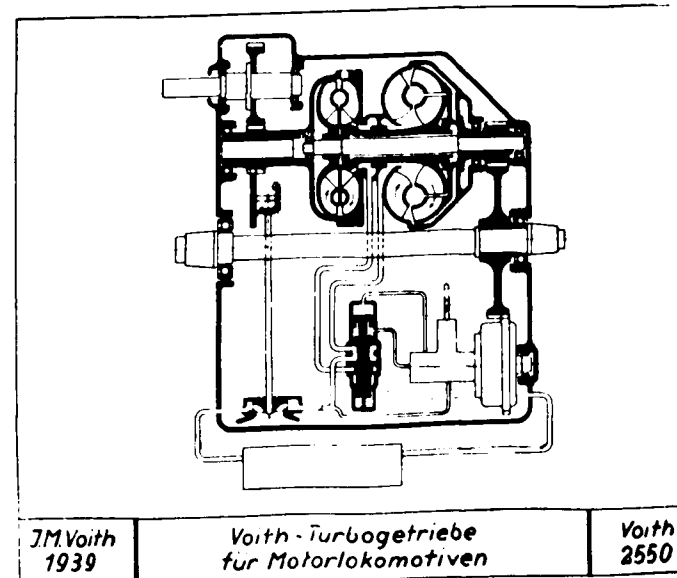
Voith Turbo Transmission

with 1, 2 or 3 torque converter speed ranges

Illustration 6258 shows the tractive efforts and efficiencies for a transmission incorporating one, two or three torque converters. In comparison with a combination made up by couplings, in the case of torque converters, the tractive effort curves as a function of the speed show a better continuity.

The efficiencies indicated in this illustration apply to the complete transmission from engine flange up to output shaft.

The following illustrations show the arrangement of Voith transmissions equipped with several working circuits. Each of these hydraulic circuits handles a predetermined speed range. These circuits, with the Voith transmission, are switched on and off by filling and emptying manoeuvres, a method that is without equal with respect to simplicity. This method, as already explained in connection with the former Foettinger torque converters, can be applied to handle even the highest inputs. If toothed wheels are used in such hydraulic transmissions, such gear is permanently meshing. Any parts subject to wear such as clutch couplings, friction couplings, overrunning clutches etc., have been eliminated altogether in the Voith transmission.



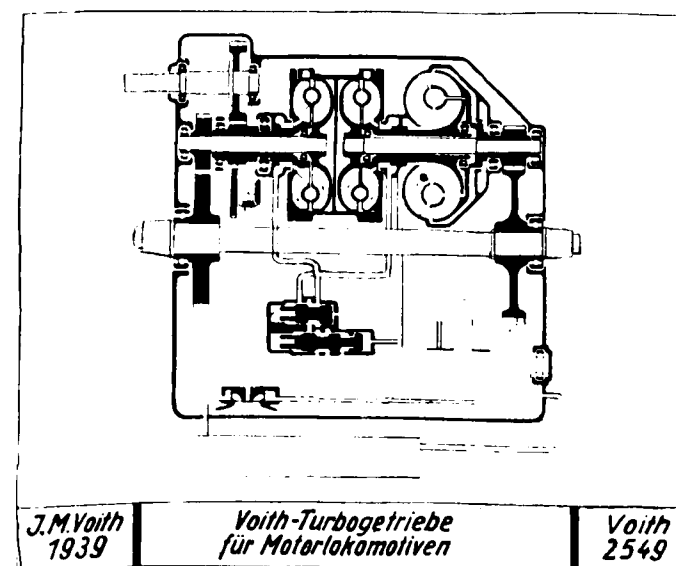
Voith Turbo Transmission

with 1 torque converter for starting and low speed and 1 fluid coupling for high speed.

Figure 2550 shows a Voith transmission comprising a torque converter and a coupling. At the input end a step-up gear is fitted in order to keep down to a minimum the overall dimensions by operating the pump at a high speed. This step-up gear also allows, by a proper selection of the step-up ratio to adapt a given

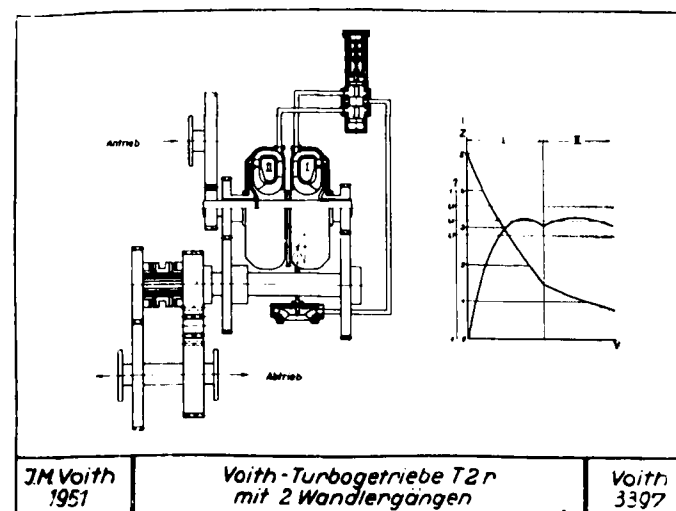
transmission size for the connection with various driving machines. The driving shaft drives a small filling pump, which via a control valve of the piston type furnishes the working circuits with oil. Depending on the position of this valve, the two working circuits are empty or the one or the other circuit is filled and switched on. From the driver's cab, the hydraulic transmission is switched on or off only as a whole as desired; however, the change-over from one working circuit to the next is automatically effected by means of a small governor controlled by the rail speed.

The spring load of this governor—if necessary—can be changed by connection with the fuel lever of the



Voith Turbo Transmission.

with 1 torque converter and 2 coupling speed ranges



Voith Turbo Transmission.

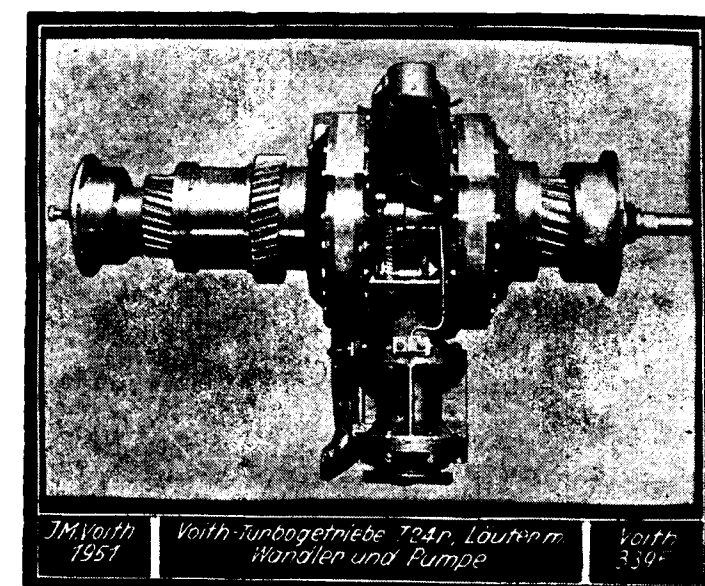
with 2 torque converters. Diagrammatic arrangement tractive-effort-speed diagram.

driving machine so that as the power of the latter decreases the change-over speed also decreases.

Fig. 2549 shows a similar transmission, which in this case is equipped with 2 couplings.

Fig. 3397 shows a hydraulic transmission incorporating 2 torque converters I and II, which are of identical design; however, between the 2 turbine runners and the output shaft different step-down gears are interposed, so that a sequence of converter stages results. In this case also a reverse gear is fitted.

Fig. 3395 shows the runner of the transmission illustrated in fig. 3397. The two torque converters together with the filling pump and the control constitute a compact unit, so that the short distances give short times for the filling and emptying manoeuvres.

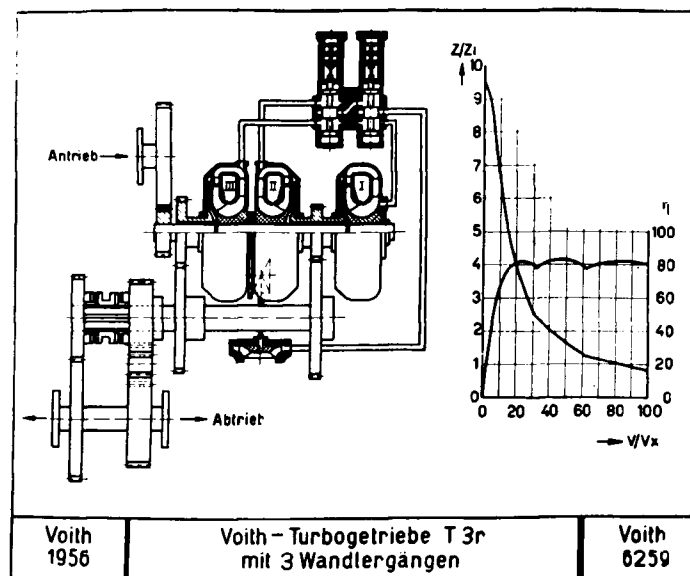


Voith Turbo Transmission.

with 3 torque converters. Diagrammatic arrangement tractive-effort-speed diagram.

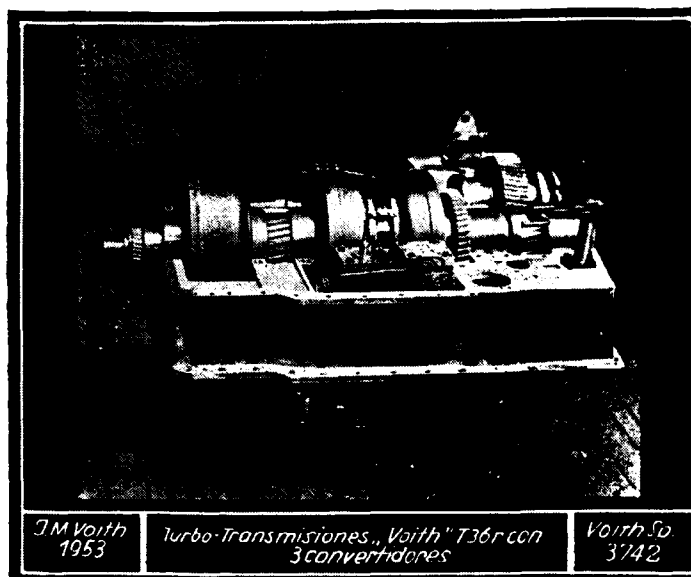
Fig. 6259 shows a transmission incorporating three torque converters and a built-in reverse gear. The addition of a further torque converter for a higher hydraulic transmission ratio than that of the other converters has allowed to further boost the tractive efforts in the starting and low-speed range.

Fig. 3742 shows the revolving parts fitted inside the housing. At the extreme left is the housing of the first torque converter and at the right that of the second and third converters with the output gearing. At the extreme right the step-up gear for the pump portion is visible.



Rotor of a 2 torque converter transmission.

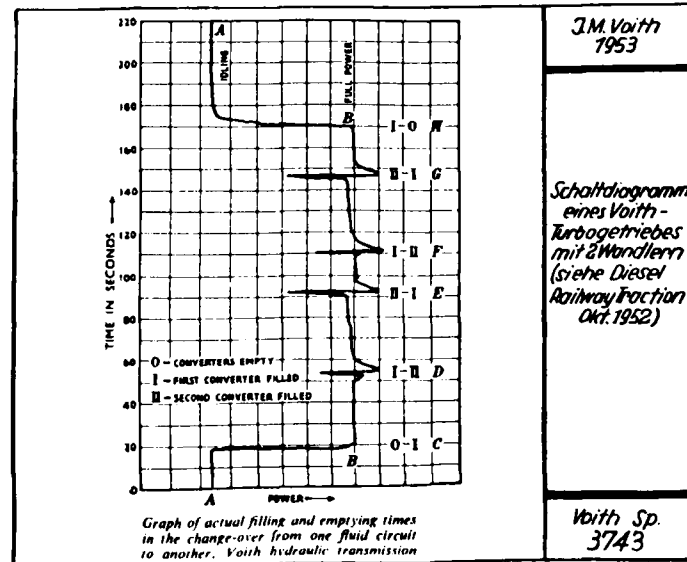
- (a) torque converter I
- (b) torque converter II
- (c) filling pump



Voith Turbo Transmission with 3 torque converters open.

- (a) torque converter I
- (b) torque converter II
- (c) torque converter III

The method based on the automatic switching on and off of hydraulic circuits by filling and emptying manoeuvres such as applied by Voith to their hydraulic transmissions has as no other design proved to meet all practical requirements. By improving the aeration of the working circuits by selecting a filling pump of proper size and a suitable control, extremely rapid starting and



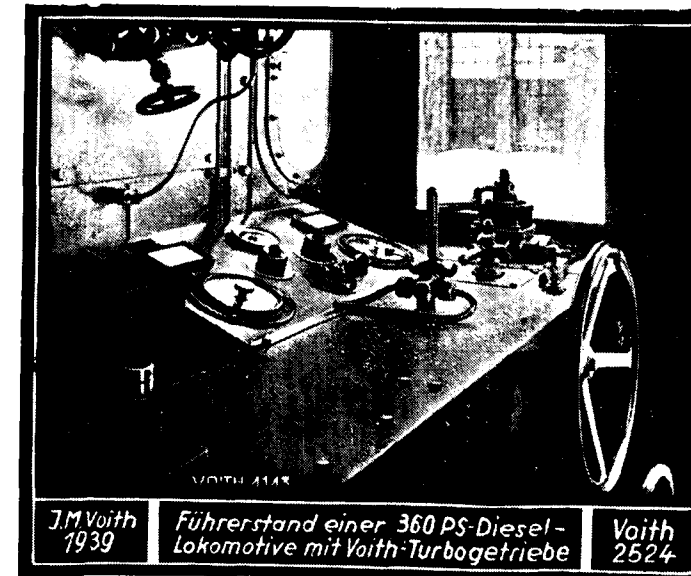
Wattmeter diagram showing the power absorbed in function of time in seconds during filling and emptying manoeuvres with a 2 torque converter Voith hydraulic transmission.

- (C) o — I starting with torque converter I
- (D) I — II Changing over from torque converter I to II
- (E) II — I Changing over from torque converter II to torque converter I etc.

a change-over without any noticeable power flow discontinuity can be accomplished. This has been achieved by an overlapping of the emptying of one working circuit by the filling of the next. Fig. 3743 is a graph showing the power consumption during the actual filling and emptying in the change-over from one fluid circuit to another. The values have been determined on the test bench with a transmission comprising two torque converters. It will be seen that after starting within one second the full power is absorbed as evidenced by the graph at point B when changing over from "idling" to converter I. When changing over from converter I to II at point D and back again from converter II to I, at point E etc. only a small variation in power and hence in the tractive efforts occurs.

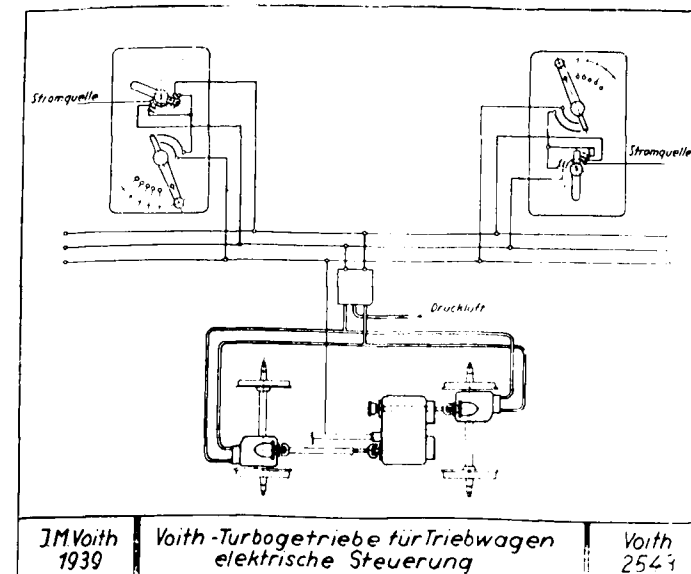
In contrast with this transmission any other transmission in which, e. g. a permanently filled torque converter is followed by a change-speed gear engaged by clutches a complete interruption of the power flow cannot be avoided.

As all change-over manoeuvres in the Voith transmission are fully automatic, the control to be effected by the engine driver is extremely simple. As may be gathered from fig. 2524 showing the driver's cab of a Diesel-hydraulic locomotive fitted with a Voith transmission, the



Control arrangement in the cab of a Diesel Hydraulic Locomotive.

control calls for the operation of a handwheel only. With the handwheel in position "O", the engine is "idling"; at such time the hydraulic transmission is completely empty and switched off. When the handwheel is rotated further away from the "O" position, the engine continues to idle, but the transmission is being filled. In the following positions of the handwheel the engine is gradually adjusted to its full loading, while the transmission stays filled. When the handwheel is brought back to the "O" position, coasting is possible with the transmission empty. As soon as the transmission is switched on again, while the vehicle is in motion,

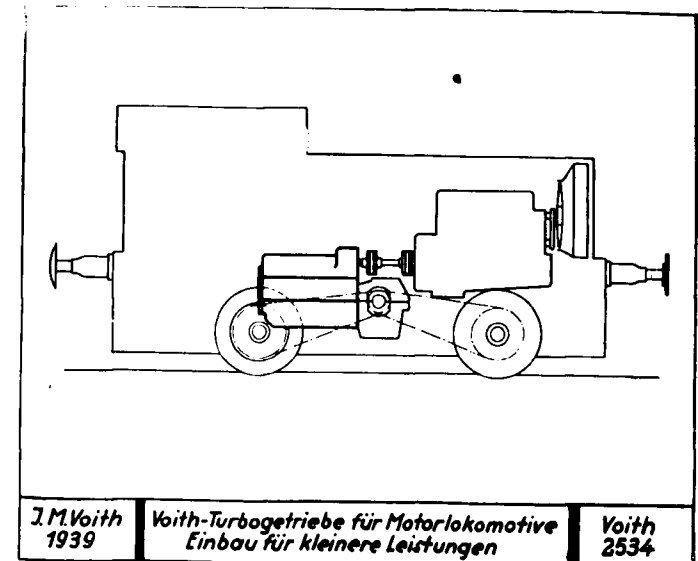


Multiple and remote electric control for Voith Transmission and 2 axle reversing gears for a railcar.

that working circuit is automatically filled which handles the prevailing momentary rail speed range.

This illustration (2543) shows the electrical remote control of several hydraulic transmissions, such as used for railcars. The control of the power transmission only requires one impulse for the starting and stopping of the transmission as a whole, one impulse for forward running and one impulse for reversing, thus a total of three impulses only. This extremely simple control also permits without any difficulty whatsoever the common operation of several Diesel-hydraulic vehicles from one cab.

When small power and low speeds are involved, the simple chain drive may be used. This simple drive has been fitted as standard equipment in more than 600 small shunting locomotives of the German Federal Railways equipped with hydraulic Voith transmission.

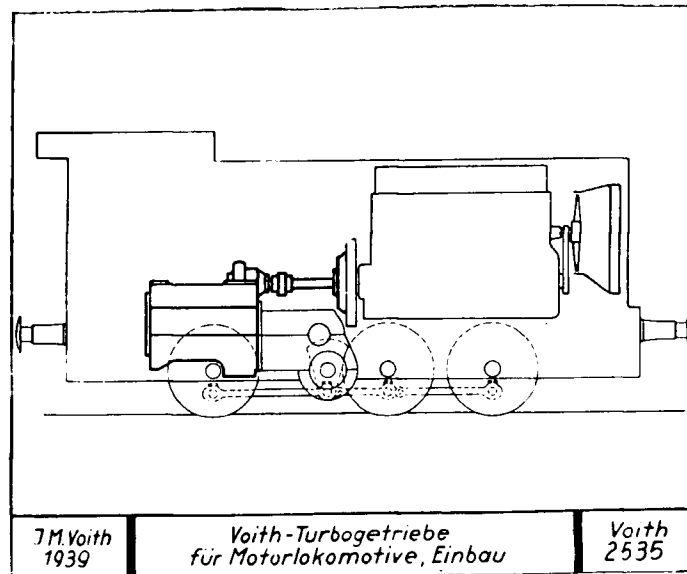


Diesel Hydraulic installation diagram for chain drive.

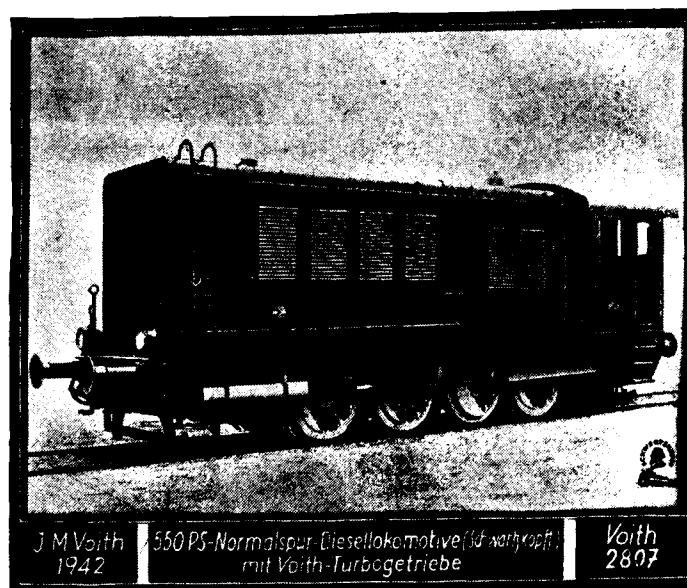
Fig. 2535 shows a rod drive which is very popular. In this case, the jackshaft drive is as a rule fitted with two speed ranges: a high-speed for line service and a lower speed range for shunting. Switching over from one speed range to the other is effected with the locomotive at rest. Several hundred locomotives of this type were used during the war for military purposes and have been found extremely satisfactory also when operated by unskilled personnel. So far locomotives fitted with rod drives have been built in units of 50—1,400 HP. each.

Fig. 2807 shows a 550-HP. locomotives of this type.

Fig. 2146 shows a 1,400-HP. locomotive with hydraulic Voith transmission, which is the biggest unit of a transmission designed and built so far.



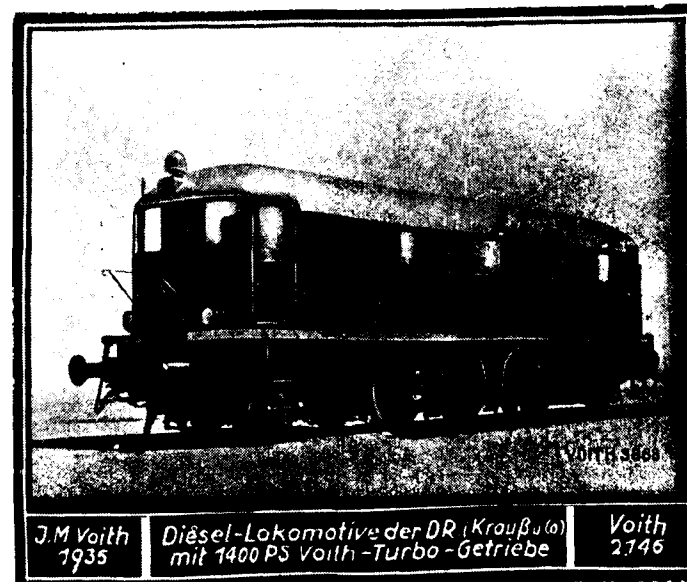
Diesel Hydraulic installation diagram for side rod drive.



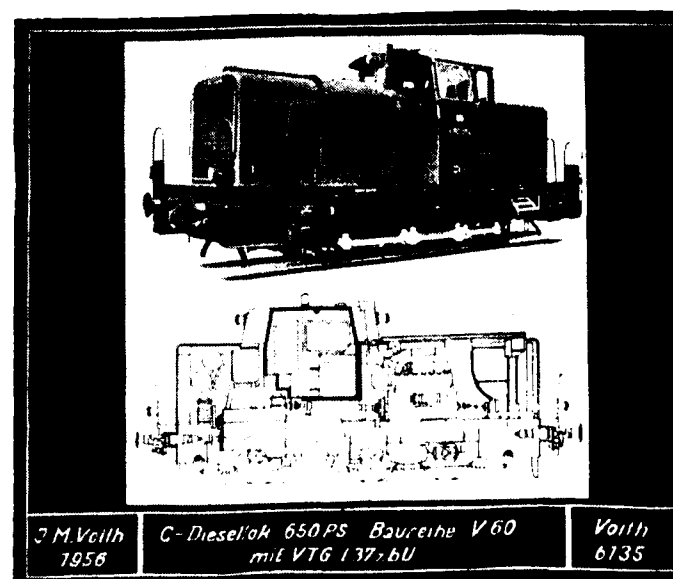
Diesel hydraulic D-locomotive with Voith Transmission.

A more recent 650-HP. Diesel locomotive is shown in fig. 6135. In this type V 60 of the German Federal Railways, all experience has been used that has been available to this day. Of this type 300 locomotive fitted with Voith turbo-transmissions are being manufactured for the German Federal Railways.

It has frequently been maintained that the hydraulic power transmission is suitable for a few hundred HP. and for steel-frame locomotive and for rod-driven steel-frame locomotives only. Apart from the fact that already for



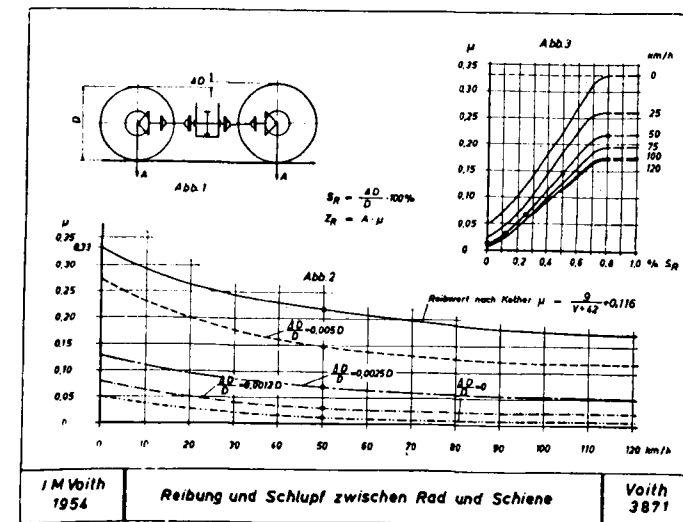
1400 HP. Diesel hydraulic I-C-1 locomotive with Voith Transmission (built in 1935)



Diesel hydraulic C-Locomotive V 60 of the German Federal Railway with Voith Transmission.

more than twenty years bogie drives have been used in railcars of 650 HP. per bogie, for some years already such drives by hydraulic power transmissions have been fitted in locomotives for 1,000 HP. and more per bogie, and with this arrangement also extremely good results have been obtained.

As soon as the bogies became an element of the drive incorporating hydraulic transmissions, the question was raised, whether the axles should be driven individually or could be coupled rigidly, i. e. whether each pair of



Rolling friction and slip between wheel and rail.

At the top left: Diagram showing 2 pairs of driving wheels coupled together of different diameters D and D + ΔD.

below: Variation of the value of co-efficient μ for different values of ΔD and of the running speed V.

At the top right: Variation of μ as a function of the rolling slip S_R for different constant running speeds.

A = axle load

$S_R = \frac{\Delta D}{D} \cdot 100$ in %; rolling slip resp. percentage of difference in wheel diameter.

$\mu = \frac{Z_R}{A}$ friction coefficient, resp. specific parasitic effort at the wheel periphery.

Z_R = parasitic effort at the wheel periphery.

wheels should be driven by a special hydraulic drive including reverse gear or if all the axles or groups of axles coupled together should be driven by one set of hydraulic drive. This latter drive is not only cheaper to build but its operation and the control of the transmission is simpler and clearer. It also has the advantage of reducing the slipping of the wheels.

In a large number of bogie drives fitted with hydraulic Voith transmissions an independent drive of the 2 axles had been adapted. For this purpose twin transmissions were used, each half driving one axle. Though it is generally known that in the case of steam locomotives several axles which are rigidly coupled can operate without giving any trouble, at the time an independent drive for each axle had been regarded as imperative. However, the actual phenomena in connection with the interaction between wheel and rail were not fully understood. The general opinion was that an effective slip between wheel and rail would occur whenever there is a difference—however small—in the diameters of the

driving wheels. Furthermore it was feared that such a slip could only occur by overcoming the usual high friction coefficient, as shown in illustration 3871, by the curve in full lines (Kother's friction coefficient) plotted against the rail speed.

In the meantime laboratory tests and practical tests in the field have given a better insight into this problem. It has been found that the usual friction coefficients occur only, if the difference in the diameters of the driving wheels is at least 0.7%, whereas smaller differences in the diameters are more or less absorbed by the elastic deformation of the material concerned of which rail and wheel consist at the point of contact and that accordingly a much lower "pseudo friction coefficient" must be taken into account.

In the illustration the "pseudo friction coefficients", which have been determined by torque measurements on the cardan shafts of a bogie, have been plotted against the rail speed for various diameter differences ΔD:D=0; 1.2; 2.5—5%. In the upper corner at the right the graphs show the effect of the differences in the diameters at constant speed. It will be noted that in case of differences in the diameters of 1—2%, only a fraction of the anticipated friction coefficients have to be taken into account. In this context it should be mentioned that also with a diameter difference=0, friction coefficients which should better be called "parasitic power factors" occur of the same magnitude.

Statistics compiled in railroad repair shops have revealed that with steam locomotives which had run 100,000—150,000 km. the difference in the wheel diameters were on the average as small as abt. 1% to 2%, which means that the wheels actually show even wear and tear, so that no major "parasitic power" can occur. In view of the above, no objection can be raised against a group drive of the axles, and it is therefore feasible to arrange for a simple drive in the bogie through cardan shaft and axle drive, and this the more since there is no difficulty whatsoever to handle by one transmission, e. g., according to the Voith design, the higher power required to drive a group of several axles.

In this way the basis was available for a correct calculation of the forces and the HP which have to be transmitted by the cardan shafts and axle drives. However, in order to eliminate such stresses in addition to the effective torques required for traction as can be set up in the cardan shafts, as a result of differences in the angular velocity and hence by additional forces due to

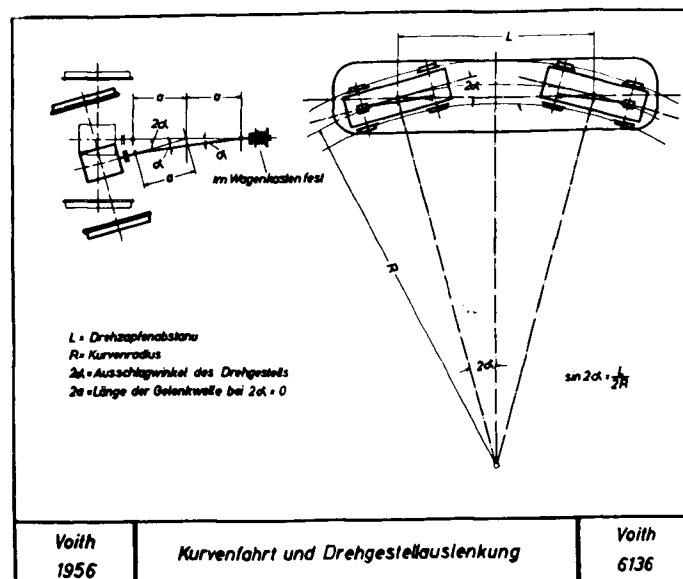
the rotating masses involved, the laws governing a kinematically correct arrangement should be followed to largest extent possible. A uniform angular velocity at the input and output shafts interconnected through a cardan shaft is obtained under the following conditions:

The driving and the driven shafts must be situated in one common plane, and the angles which the shafts form with the connecting cardan shaft must always be the same. This can be accomplished, if either the one or the other of the following two conditions with respect to the relative location of the driving and the driven shafts are met.

First case: The driving and the driven shafts are and remain parallel to each other, even if there is any shifting.

Second case: The driving and the driven shafts form an angle. If with a change of the angle between the driving and the driven shafts, the angles formed with the connecting cardan shafts are to remain constant, it is imperative that the distances of the pivots from the joints of the cardan shaft remain the same.

It should be stressed once more that in the plan view the basis may not be another arrangement of the shafts



Angle between truck and frame when driving through a curve.

L = Distance between bogie pivots
R = Curve radius
2 = angle between truck and frame
2a = length of cardan shaft between joints

than in the elevation. Hence the prerequisite that a plane must pass through the shafts to be connected.

As an example, with the help of fig. 6136 the driving connection between a shaft is the bogie and a shaft rigidly supported in the frame and their behaviour on negotiating a curve will be discussed. In order to obtain good kinematic conditions, the arrangement is such that the distance of the pivot from the cardan shaft joint located in the bogie is the same as the distance of the pivot from the joint located in the frame (case 2).

The maximum angle α between frame and bogie is found from the smallest curve radius R and the pivot distance L.

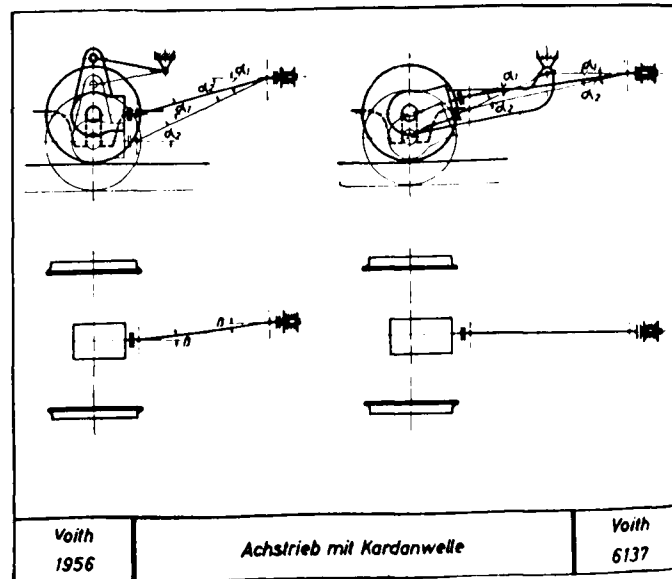
$$\sin 2\alpha = \frac{L}{2R}$$

For a practical example, where the pivot distance L = 9.00 m and the curve radius R = 100 m,

$$\sin 2\alpha = 9 : 200,$$

or, in other words, the maximum angle at the cardan shaft

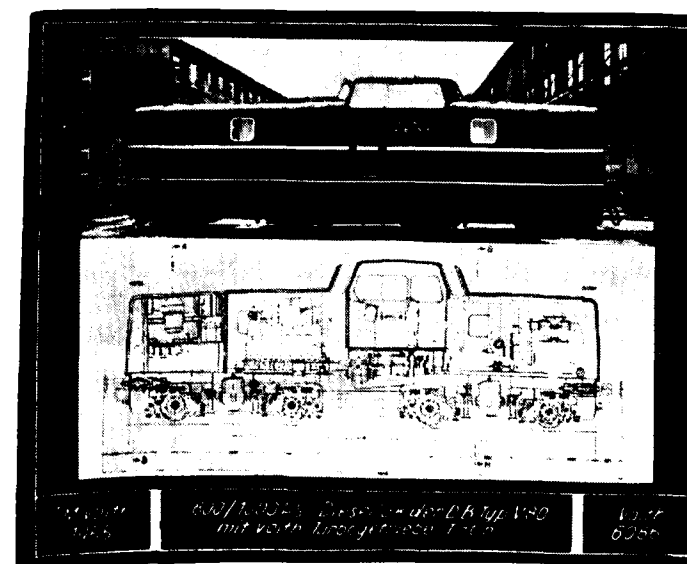
$$\alpha = 1^\circ 17'$$



Cardan shaft arrangement for axle drives.

In fig. 6137 further examples are shown: axle drive driven by a cardan shaft with alternating resilience, at the left for case 1 and at the right for case 2. In this context, the different methods of supporting the axle drives should be noted.

In most cases it is not possible to meet this prerequisite with absolute mathematic accuracy. However, the irregularities which occur are with respect to their effect mitigated due to the resilience inherent in any driving system. It may in many cases be advisable to arrange for an additional resilience by using a flexible coupling or a flexible suspension of the torque reaction levers.



1000 HP. Bo-Bo-Diesel hydraulic locomotive type V80 of the German Federal Railway.

Prompted by the extensive experience in the past, the German Federal Railways have decided to develop as first stage machinery of 800 1000 HP. which can be used both in bogie-Diesel locomotives of 1000 HP. and in 2000-HP. locomotives in the form of two such installations, and which are also suitable for use in railcars. The first of these locomotives is Lok V 80 shown in fig. 6086, of which for the first stage of the program 10 locomotives have been built for the German Federal Railways, so that extensive experience can be gained before further vehicles will be built on a larger scale.

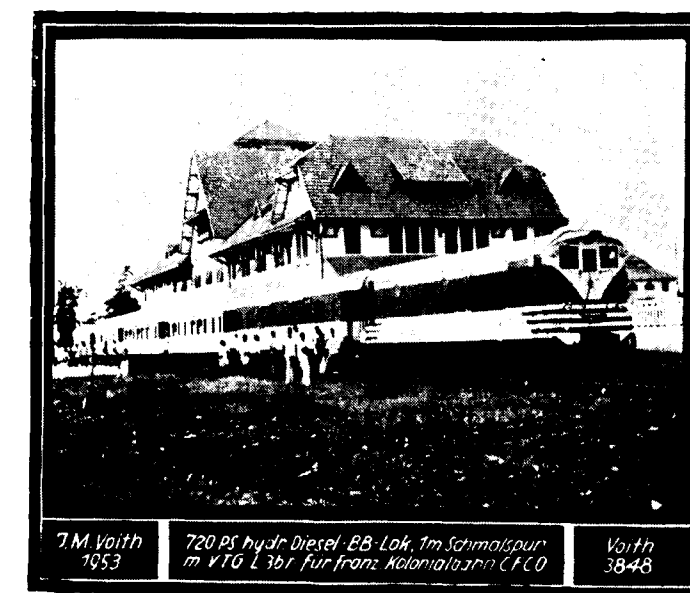
This design is characterized by the fact that all axles of the two bogies are rigidly connected through bevel gear axle drives and cardan shafts and that further these axles are driven from one single power transmission located in the frame in the center of the locomotive. Though when negotiating a curve the above mentioned conditions for cardan shafts are not fully met, excellent results have been achieved due to the use of the inherent resilience.

Fig. 3848 shows another BB-Diesel hydraulic locomotive with two bogies in which also all 4 axles are rigidly

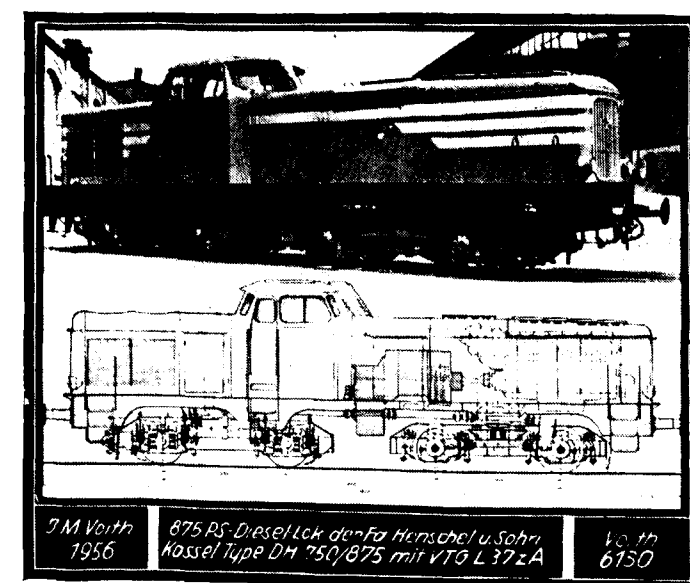
connected through cardan shafts. For this application the axles are driven through worm wheels.

In this context, also the BB-locomotive according to fig. 6130 should be mentioned which has been built by Messrs. Henschel & Sohn of Kassel. In this locomotive the four axles are coupled through cardan shafts and bevel gear axle drives.

Subsequent to the development of the V 80, the German Federal Railways have developed a 2000-HP.



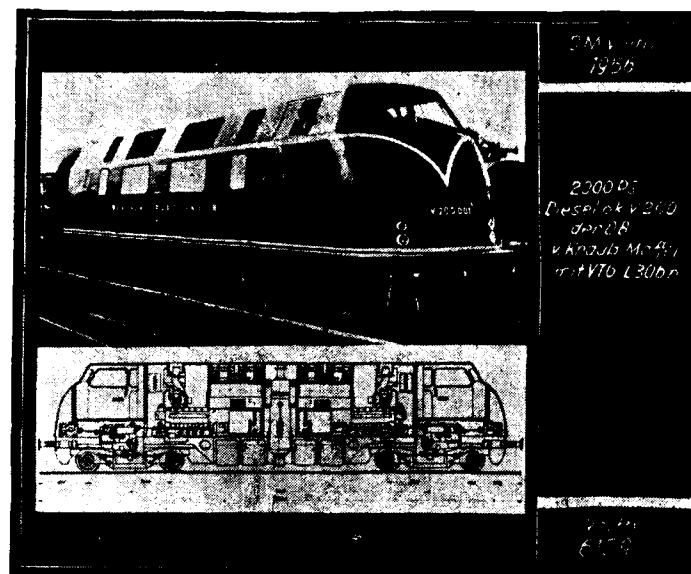
720 HP. Bo-Bo-Diesel locomotive with 3 torque converter Voith hydraulic transmissions for French colonial railway (CFCO).



875 HP. Bo-Bo-Diesel locomotive (Henschel & Sohn, Kassel) with Voith hydraulic Transmission.

locomotive of which in fig. 6129 an external view and a longitudinal section are shown. In this case, for each of the two bogies an engine and drive installation has been fitted. Therefore the two bogies are independent from each other, and only the two axles of the same bogie are interconnected rigidly.

Of this type for the first stage only a few trial locomotives had been built. After these locomotives had been found satisfactory during several years, the building program has been extended so that in the near future a total of 60 such 2000-HP. Diesel-hydraulic locomotives will be operated by the German Federal Railways.



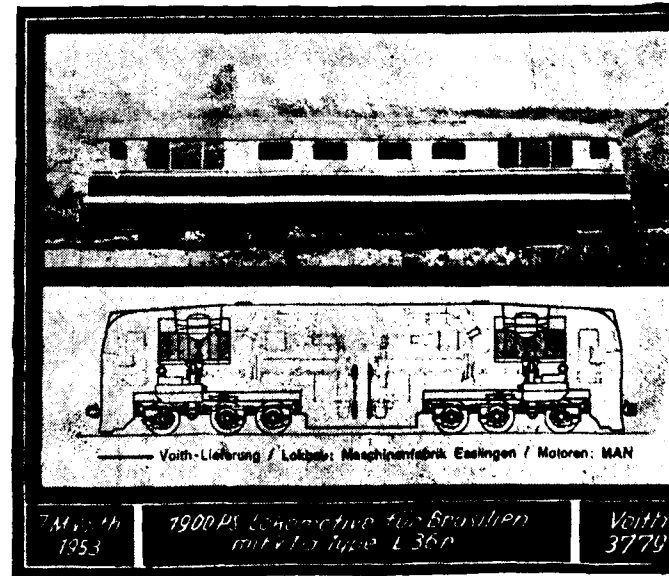
2000 HP. Bo-Bo Diesel locomotive (Krauss-Maffei, Munich) with 3 torque converter Voith hydraulic transmissions for the German Federal Railways (Diesel engine speed 1500 r.p.m.)

At the same time the 1900-HP. locomotive shown in fig. 3779 has been developed. This locomotive is of particular interest since it was built for 1000 mm. narrow-gauge and an axial pressure of 13 tons only. It was fitted with 2 three-axle bogies, all being driving axles (manufacturer Maschinenfabrik Esslingen). In this case, too, for each of the bogies a separate machine installation has been used.

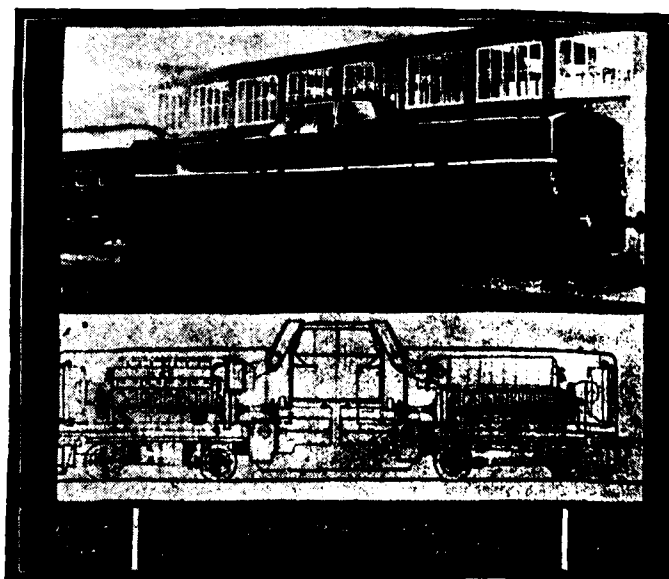
Another 2000-HP. Diesel-hydraulic locomotive built by Messrs. MAK of Kiel is shown on fig. 6096.

As the last locomotive of this type, the 2000-HP. locomotive built by Messrs. Klockner-Humboldt-Deutz should be mentioned. It is shown in fig. 6131.

With respect to the use of the hydraulic power transmissions as drive of railcars, there will be little



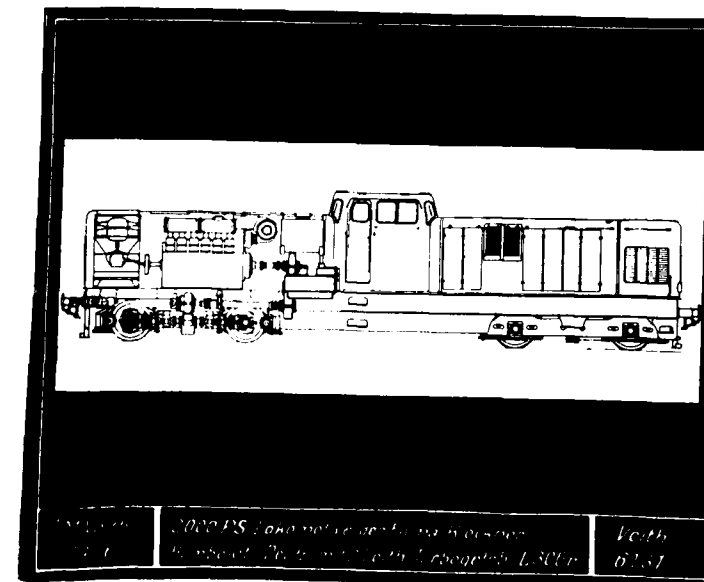
1900 HP. C'C Diesel locomotive (Maschinenfabrik Esslingen) with 3 torque converter Voith hydraulic transmissions (Diesel engine speed $n = 900$ r.p.m.)



2000 Bo-Bo Diesel locomotive (MAK in Kiel) with Voith hydraulic transmissions (Diesel engine speed $n = 750$ r.p.m.)

disagreement among the experts as to the advantages presented by this power transmission. For this application ample practical experience extending over many years is already available.

The rail vehicle which was the first to be equipped with a Voith transmission in 1933 was a rail bus for the Austrian Federal Railways according to fig. 2085.



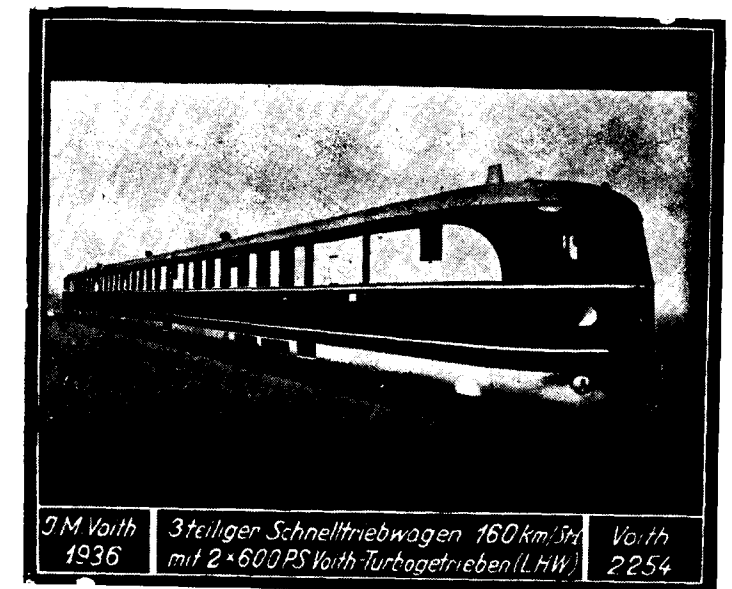
2000 Bo-Bo Diesel locomotive (Klockner-Humboldt-Deutz in Cologne) with Voith hydraulic transmissions (2 stroke Diesel, $n = 750$ r.p.m.)



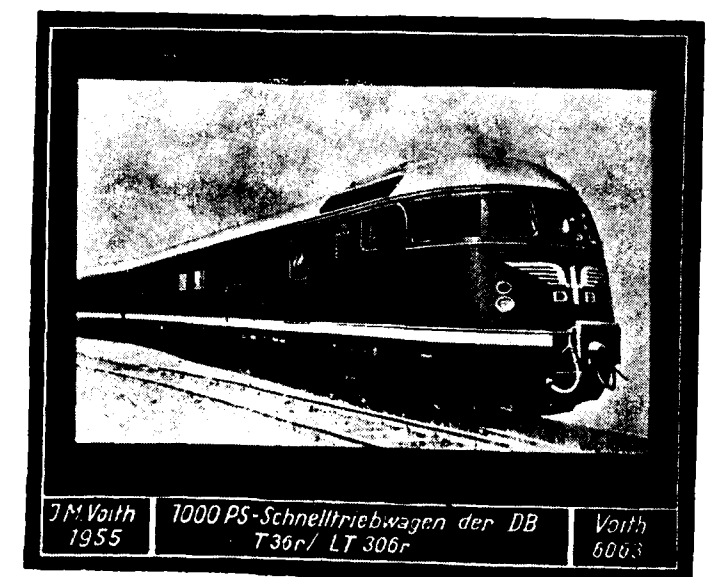
4 axle railbus with 2 Voith transmissions (built in 1934)

Illustration 2254 shows triple-articulated express railcars of the German Bundesbahn which were the first to be equipped in 1934 with 2 engines of 600 HP. each. The complete machine equipment: engine, hydraulic transmission and axle drives have all been accommodated on the bogie.

As already mentioned above, the 800/1000 HP. machinery developed primarily for the V 80 locomotive



1200 HP. triple articulated express Diesel train (2 Diesel engines, 2 Voith Transmissions) for the German Federal Railways (built in 1935)



1000 HP. articulated express Diesel train with 3 torque converter Voith Transmissions for the German Federal Railways.

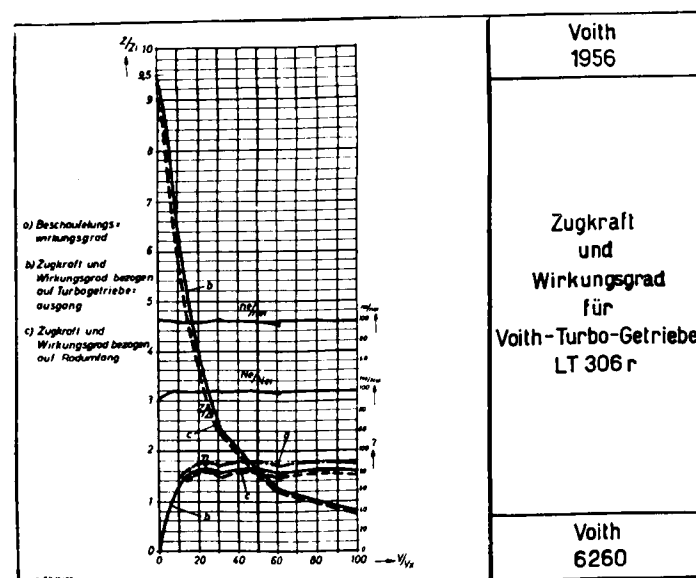
has also been fitted in the express railcars of the German Federal Railways. Such an express railcar is shown in fig. 6063. In this case, too, the entire machine equipment is fitted in the bogie and the 2 axles of the bogie are rigidly coupled as is the case with the railcar according to fig. 2254.

Another example of a hydraulic drive is shown in fig. 4385. This example shows one of the triple-articulated



1100 HP. triple articulated Diesel train for the Turkish State Railway (2 engines, 2 Voith Transmissions)

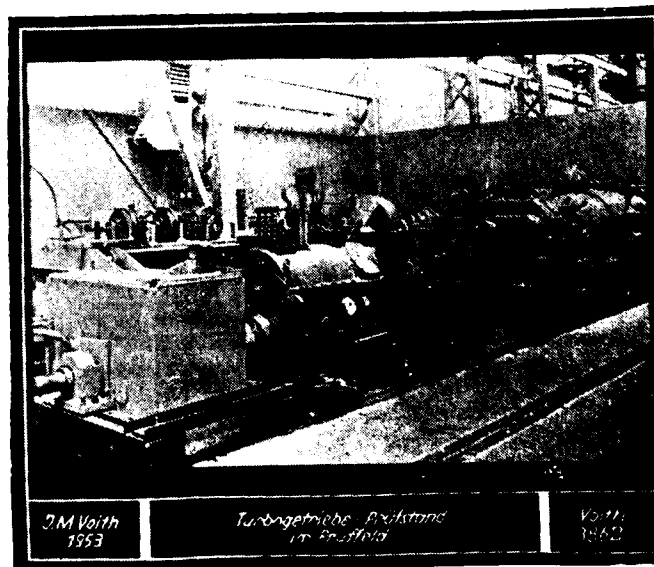
Diesel trains for the Turkish State Railways. The interior of the driving car, the Diesel engine, the hydraulic transmission, the axle drives and the cooling equipment are shown in fig. 3887.



Efficiency and specific tractive efforts for a 3 torque converter Voith hydraulic transmission.

- efficiency and specific tractive efforts based on the losses in the torque converters
- efficiency and specific tractive efforts applying from input flange to output flange of the transmission
- efficiency and specific tractive efforts as under b but deducted by the losses in the cardan shafts and axle drives i.e. applying from input flange to axle.

The efficiency η and the relative tractive efforts Z/Z_1 for a turbo-transmission of a 3-stage converter



Voith Transmission on the test bed.

(see fig. 3742) plotted against the relative rail speed V/V_1 are shown in fig. 6260. These apply from input flange up to output flange and include all losses due to the filling pumps, ventilation, toothed wheels, etc.

Illustration 3862 shows the test bench, on which prior to being despatched the transmissions are subjected to a trial run, and efficiency and output measurements are carried out. As drive an electric motor and an intermediate gear are used by means of which the input speed of the transmission is adapted to the Diesel engine speed which will be used. On the output shaft a Prony brake is fitted by means of which the torque at the output shaft is determined.

In a variant of this design instead of a converter a fluid coupling is used as third stage. In this case, not only in the maximum speed range and at full load a substantially higher efficiency (91%) is obtained, but also at part loads and at high rail speed.

In a comparison with the electric power transmission a point in favour of the hydraulic power transmission is the fact that the temperatures in the hydraulic transmission are always under perfect control. For heat considerations with either power transmission system there is a lowest locomotive speed allowing continuous operation with full power. In the case of the electric power transmission the heat losses must be dissipated from the insulated coils of the generators and traction motors. To this effect a blower blows air against the surfaces of the coils, and it can readily be seen that such cooling method has, of necessity, its limitations and cannot be increased beyond a certain point. The cooling surface

can only be enlarged by additional weight. An improvement by an increased cooling air supply is feasible only within certain narrow limits, and furthermore in this case an additional power loss cannot be avoided. But in spite of all these efforts the risk of overheating cannot be eliminated. When with low rail speed a large electric current flows in the coils, the power can be maintained only for a very short time, or in other words, in comparison with the maximum speed, the continuous running speed, at which the full power can be utilized, is relatively high.

The hydraulic power transmission, on the other hand, uses a working liquid, as a rule oil, for the transmission of the power. This liquid ideally lends itself to dissipate the heat losses. To get rid of this heat part of the transmission oil is passed through a cooler and after being cooled returned to the oil reservoir in the transmission gear casing. As cooler a heat exchanger is employed, through which the cooling water of the engine is circulated. This water is only heated up a few degrees and is subsequently cooled in an air-cooled radiator. The control of the oil temperature is exclusively a question of the dimensioning of the oil cooler. Therefore no physical limits are set as in the case of the electric power transmission.

Relatively to the direct cooling of the transmission oil by an air cooled radiator, this system has the advantage that owing to the much smaller difference of temperature between the oil and the engine cooling water the fluctuations of temperature are relatively small even when the amount of heat produced varies widely. Furthermore, as the engine cooling water is automatically kept to as nearly a constant temperature as possible, excessive cooling of the transmission oil is avoided. The lowest operating speed, that is to say the speed at which the full power of the engine can be transmitted during a long period without any anxiety as to excessive heating of the transmission oil, is therefore definitely lower than that allowable with electric traction with which such definite cooling conditions cannot be realized. This feature has great importance when starting and hauling heavy loads up long steep grades.

For the starting of heavy trains, when heavy "tearing-off" resistances may occur, it is essential that not only the heat is effectively dissipated by a suitable cooling equipment, but it is also essential that sufficient masses of metal and fluid are available in order to store temporarily the heat shock, or in other words the "time constant" must be favourable.

With the hydraulic power transmission, in particular with power transmissions based on the Voith principle,

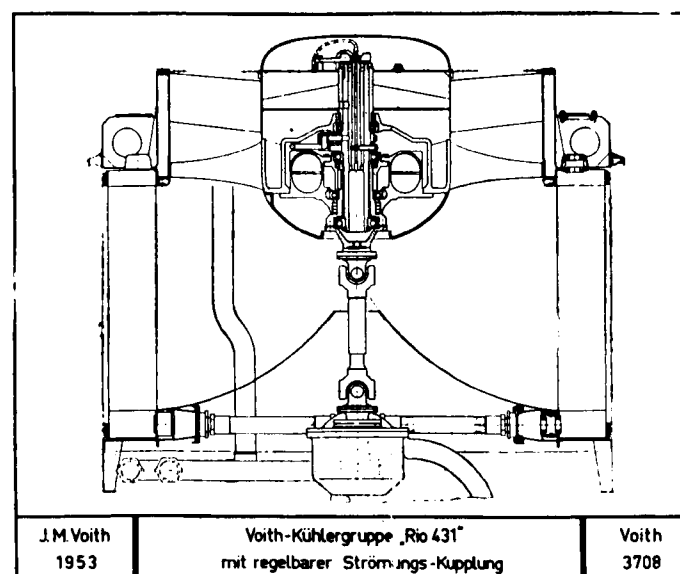
where the working fluid provides the required circulation, an even distribution of the heat is ensured. As already described above, the working fluid communicates with the engine cooling water circuit via a heat exchanger. In this way, for the heat storage not only the mass of the metal and the fluid filling of the power transmission are available, but also the cooling water as well as all metal parts of the engine coming in contact with the cooling water.

With the electric power transmission for the heat storage primarily the copper coils and conductors are used. However, since these parts must be insulated the iron parts in which the coils and conductors are embedded can be used for the heat storage only to a very limited extent.

In this context due consideration must be given to the fact that as compared with metals the specific heat (cal./kg. centigrade) of fluids is 5 to 10 times higher. For the metals the following values are applicable:

Water	1.0	Iron	0.1
Oil	0.55	Copper	0.093.

Also with respect to the capacity of heat storage the hydraulic power transmission is therefore superior.



Cooling Unit with automatic speed regulation fluid coupling within the hub of the ventilator.

Illustration 3708 shows as an example a section of the cooling equipment. A small hydraulic coupling is fitted in the blower hub in order to arrange for automatic adjustment of the cooling to the individual requirements and in order to maintain a practically constant cooling

water temperature. The filling of the coupling is controlled by a small thermostat, thus adjusting the speed of the blower.

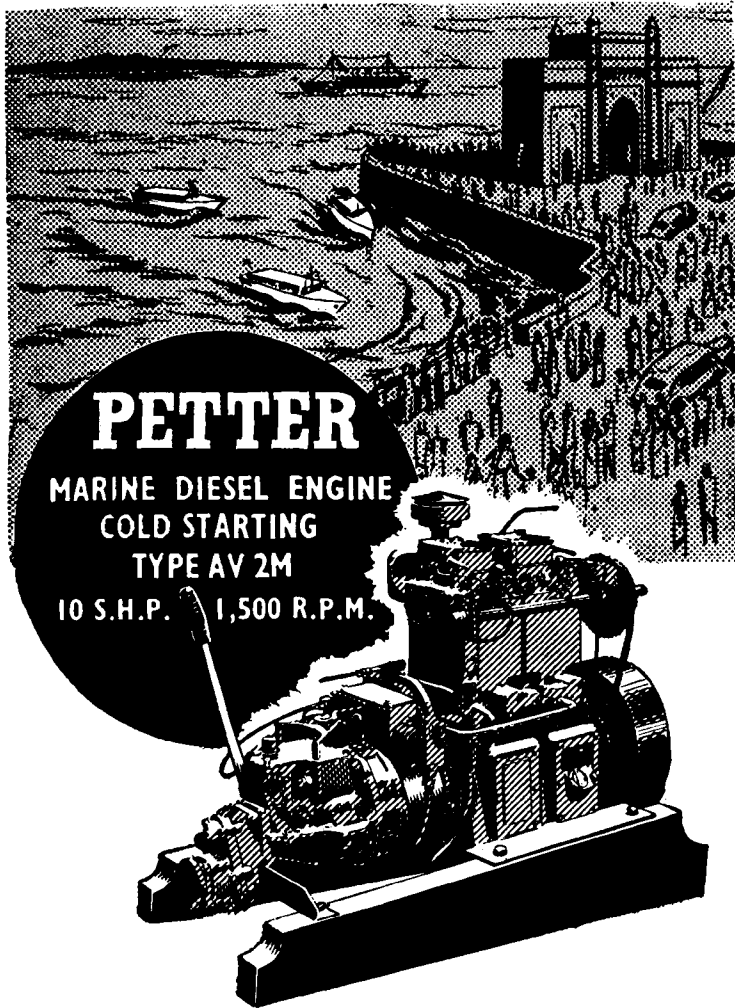
The cooling units are self-contained and can readily be removed as a whole.

The promoters of the Diesel-electric transmission claim that the hydraulic transmission can be used to handle inputs up to abt. 300—400 HP. and that for higher inputs the hydraulic transmission is unsuitable. This claim is refuted by the large deliveries by Voith of hydraulic transmissions totalling about 5400 transmissions (supplied until 31.12.1956) with an aggregate power of 1854 000 HP. These transmissions have been designed, manufactured and delivered for the following outputs of locomotives :

less than	100 HP.	313 locomotives
	100— 199 HP.	1774 „
	200— 399 HP.	1415 „
	400— 599 HP.	384 „
	600— 999 HP.	757 „
	1000—1500 HP.	35 „
about	1500 HP.	65 „

From this survey it may be noted that there is a fair number of locomotives in the output range of 1,500—2,000 HP., of which the preceding pictures have illustrated various designs. In this context special mention must be made of the lower weight and the smaller space requirements of the hydraulic power transmission, a point of considerable importance when small-gauge locomotives with low admissible axle pressures are involved.

The promoters of the Diesel-electric power transmission admit that whenever a given job can be handled by one torque converter range, as for instance in the case of shunting locomotives, the hydraulic system is not inferior to the electric system, but they claim that whenever several stages are required to handle a larger speed range, this presents a problem which is non-existent in the case of the Diesel-electric power transmission. However, in this respect it must be stressed that the method used by Voith for the switching-on and off of several working circuits by means of filling and emptying manoeuvres even with highest outputs presents no problem whatsoever contrary to any other method using purely mechanical means for such change-over manoeuvres while the vehicle is in motion. In addition to that any interruption of the tractive efforts during the changing-over is with this method avoided.



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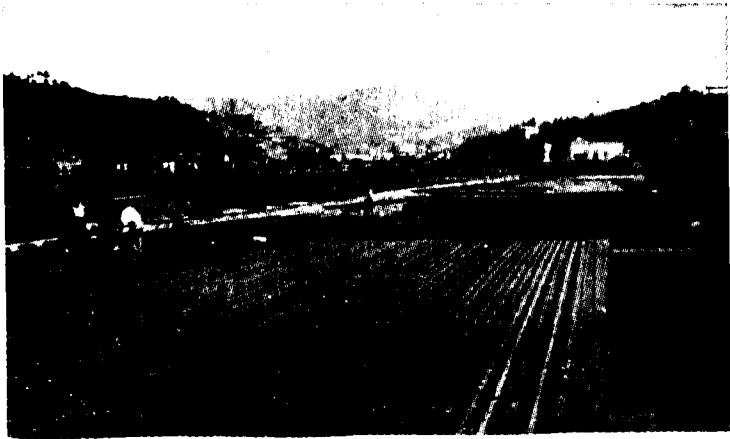
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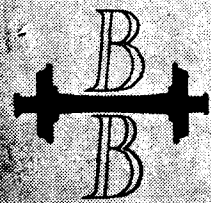
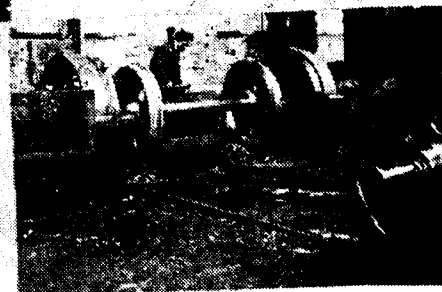
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Advantages of Diesel-Electric Locomotives

FUEL ECONOMY

THERE is usually a saving of 75% on the fuel cost of steam locomotives on shunting duties when replacing them by diesel-electric locomotives. This is due to the overall improvement in thermal efficiency and the elimination of lighting up and standby losses.

NO SMOKE OR DIRT

The exhaust of a diesel locomotive is clean and free from smoke, soot or ash. Elimination of smoke and other causes of air pollution is becoming a necessity. Driving of a diesel locomotive is a clean job.

AVAILABILITY OF HORSEPOWER

The nearly constant efficiency of electric transmission at about 80% over a wide range of rail speed with the diesel engine running at optimum speed provides the best utilisation of power and the diesel engine cannot under any circumstances be overloaded.

CONTROLS

The driving of a diesel-electric locomotive is a very simple matter. For example, it can be learned by a man in less time than it would normally take to learn to operate an electric crane.

There are no gears to change or clutches to operate. The controls can be grouped most conveniently to suit two driving positions.

AVAILABILITY AND MAINTENANCE

Experience has shown that a fleet of steam locomotives can be reduced by 20 to 30% by substituting diesel locomotives. This is because the short and long term availability of diesel locomotives is better. The time saved in coaling, watering and fire cleaning improves short term availability, and reduced time under repairs improves long term availability.

With electric transmission the locomotives need only a few hours at intervals of 200/300 hours for change of oil etc., a few days at 2500/3000 hours for top overhaul and no more than this at between 15000/20000 hours for complete overhaul of an engine and turning of tyres etc., if a spare engine/generator set is available and facilities exist for attending to wheels near at hand.

The power units are resiliently mounted on the frame and there is no rigid connection of any sort between it and the wheels so that the engines are completely protected from shock. The traction motors are axlehung and free to float in any direction with a flexible nose suspension to absorb shock through the gears.

Electrical maintenance is very simple, particularly as the generators are motored for starting thus eliminating auxiliary electrical or compressed air starting equipment.

Yorkshire Engine Company and its sub-contractors responsible for the design and maintenance of the power equipment have a service organisation and carry spare parts.

GENERAL

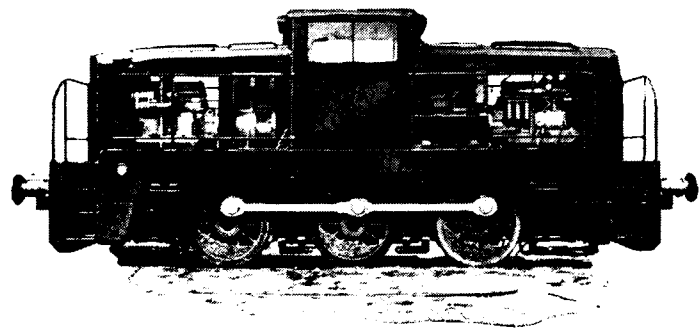
The general appearance of this type of locomotive is illustrated. The diagram and particulars are given on page 70.

The locomotive has two power equipments which are identical with those used singly on our 200 h. p. locomotives but are linked to one set of controls in the centrally placed cab for multiple working. Either can be used singly for light duty by simply stopping the other engine.

The locomotive is of the rigid frame type with axles coupled together. On each outer axle is slung inwardly a traction motor driving its axle through a gear box containing a right angle spiral bevel and single spur reduction totalling 22.85:1.

FRAMING

As the engine generator sets are compact and independent of the undergear, most of the weight is used to provide a rigid frame built up of rolled steel plates of B. S. 24, part 6, spec. 17, placed inside the wheels with fabricated stretchers and all bolted together. Buffer beams of heavy section are bolted at either end with good support and these are brought down to 6½" from rail level in order to cover the gear boxes in case of derailment. The whole structure is designed to withstand heavy traction and buffing and has the necessary weight to provide the adhesion required for the high starting tractive effort and brake power available.



The axlebox guides are steel castings of heavy proportions fitting closely into the frames and secured with driving fit bolts. Manganese liners are fitted to the guides.

GENERAL PARTICULARS

Locomotive weight	48 tons
Locomotive maximum tractive effort	30,000 lb.
Tractive effort at continuous rating	13,100 lb.
Speed at continuous rating	8 m. p. h.
Maximum permissible speed	23 m. p. h.
Oil Engines Supercharged	Rolls Royce C. 6. SFL
Total installed diesel engine rating	
at 1,800 r. p. m.	400 h. p.*
Horsepower available for traction	
at 1,800 r. p. m.	370 h. p.*
Generators	B. T. H. Type RTB. 6032
Traction motors	B. T. H. Type RTB. 5041
Gear ratio	22.85:1
Minimum rail clearance	6½"
Radiators	Rolls Royce
Battery	D. P. Lead acid 24 cells. 24/48 volts. 77 amp./hrs. at 5 hour rate of discharge.
Track gauge	4' 8½", 5' 3" or 5' 6"
Length over buffer beams	26' 0"
Length overall (1' 6" buffers)	29' 0"
Width overall, standard gauge	8' 5½"†
Width over cab, standard gauge	7' 10"†
Height over cab, standard gauge	11' 7"†
Number of driving positions	Four
Wheel arrangement	Six
Wheel base	11' 0"
Wheel Diameter	3' 8"
Can negotiate curves	120 ft. radius
Type of buffers	Optional
Type of couplers	Optional
Type of axlebox	Plain leaded phosphor bronze or roller bearings.
Brake Equipment	Westinghouse straight air brake. Rolls Royce compressors mounted on engines and belt driven. 30 cu. ft. per min. total swept volume.

Fuel tank capacity

400 galls.

The fabricated steel stretchers form a continuous deck between the frames on which the generator sets are mounted so as to avoid oil or water from the power unit dropping on to the traction motors and are provided with bearer plates on which the three point supports of the power units are carried. A transverse fabricated bridge straddles the frame carrying the air reservoirs and other brake equipment and forms the platform on which stands the cab. Between this transverse bridge and the buffer beams are fitted four fuel tanks which also form the platforms. Recessed steps and galleries are provided at either end.

The nose suspension of each motor is carried from the main stretchers and there is also a heavy pin linkage fitted below each motor which can be readily removed when dropping the wheel set and its motor.

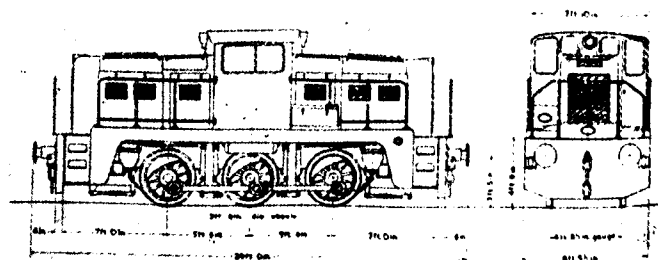
AXLEBOXES

Steel cast axleboxes to B. S. 24, part 4, spec. 10 are fitted as standard. These are provided with renewable leaded phosphor bronze bearings and collar liners. Manganese steel side liners are also provided.

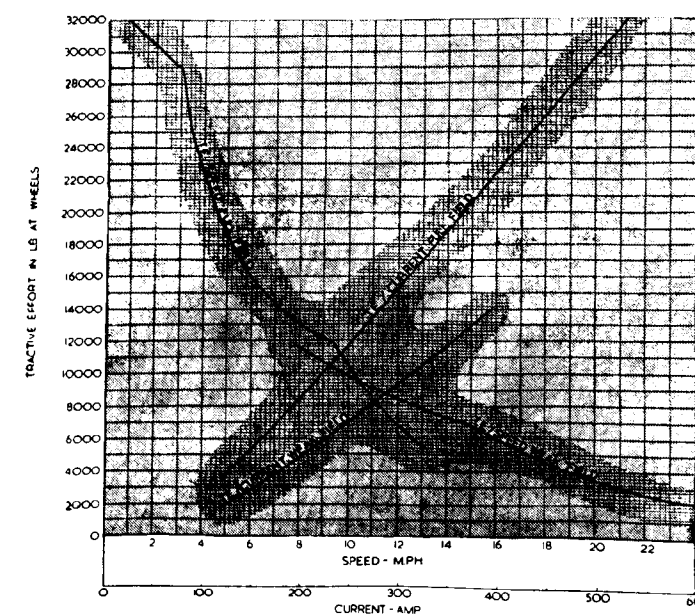
The axleboxes are fitted with cast iron keeps containing Armstrong oiler pads. The axlebox bearings are lubricated from a mechanical lubricator mounted on the platform and driven from the middle wheel axle. Alternatively roller bearing axleboxes with manganese side liners can be fitted. These are grease lubricated and therefore mechanical lubrication is not fitted.

NOTES:

- * Rating may be reduced for altitude and temperature.
- † Width and height of cab and fuel capacity can be reduced or increased to suit loading gauge.



PERFORMANCE OF 400 H.P. DIESEL-ELECTRIC LOCOMOTIVE



TRACTION EFFORT—SPEED CURVE

SPRING SUSPENSION

Laminated bearing springs with adjustable sword type hangers rest on the axleboxes and can be readily changed if necessary from underneath. The springs are manufactured from acid or basic water hardening spring steel in accordance with B. S. 24, part 3, spec. 6X.

WHEELS AND AXLES

Cast steel wheel centres to B. S. 24, part 4, spec. 10 are keyed and pressed on to solid forged axles to B. S. 24, part 1, spec. 2, and fitted with forged pins to B. S. 24, part 4, spec. 9, pressed into the wheel centres. The revolving masses are fully balanced in the design of the wheel centres.

TYRES

Tyres of steel to B. S. 24, part 2, spec. 4, for class 'D' are shrunk on to the wheel centres.

COUPLING RODS

The wheels are connected by coupling rods forged and machined from acid steel class 'C' and in accordance with B. S. 14, part 4, spec. 8, and are provided with solid leaded phosphor bronze bushes.

POWER BRAKES

The locomotive is fitted with Westinghouse straight air brake equipment. The brake pressure at the cylinders is 50 lb. per square inch. The compressors, as standard to the Rolls-Royce C6S oil engines have a total capacity of 30 cu. ft. swept volume of air per minute and are driven by Fenner vee belts from each engine. The air reservoirs have a capacity of 10 cu.ft. The feed valve, unloader, governor and safety valves are mounted on the bulkheads inside the bonnets.

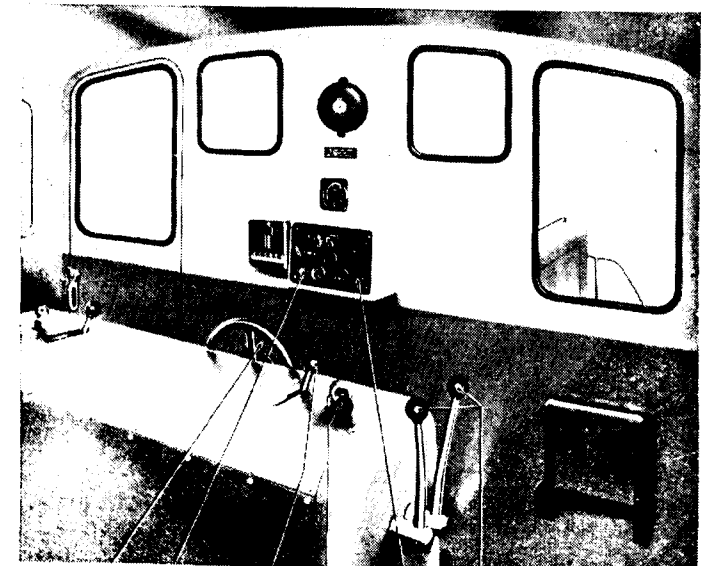
The drivers valve is mounted in the Control Cabinet and the Duplex gauge is mounted on the cab bulkhead. Clasp type brake rigging is fitted and provided with adjustment.

DRAWGEAR

Turflat forged side buffers and Gedges hooks and three link chains are fitted as standard. Any special buffer and drawgear can be fitted if required.

CAB

The drivers cab is constructed of steel plates welded together to form a totally enclosed structure and is provided with two doors diagonally opposite which open on to the platforms. The windows in the front and back panels and doors are fixed with rubber sealing strip. The side windows are metal framed and slide to open. The control cabinet is placed in the centre of the cab and contains the main controller, reversers and contactors. On this cabinet are mounted the throttle, reverser and brake handles in such a way as to provide for easy control from any position in the cab. The sanding pedals are placed in the floor adjacent to the cabinet on



either side. The throttle and reverser are mechanically interlocked to prevent the reverser being thrown when the throttle is opened or the throttle opened when the reverser is not in either position. An instrument panel is placed on each bulkhead containing the fuel pressure, engine R. P. M., oil pressure, water temperature gauges, battery charge ammeter and 'Start' and 'Stop' buttons for each engine. A speedometer is fitted on one panel and the air brake Duplex gauge is fitted on the other.

A separate panel is fitted to one bulkhead containing switches for head and tail lights, cab light, heater and a pilot switch. An earth leakage relay is mounted on the opposite bulkhead.

A battery change-over switch is provided and arranged so that in the 'Start' position the 24 cell battery is in series to give 48 volts to motor the generator and, in the 'Run' position in parallel to give 24 volts for lighting and the heater fan. The hand brake wheel is located on one bulkhead. A Service recorder is included as standard and mounted on one bulkhead. The floor is covered by wooden boards. The height and width of the cab can be modified to some extent to suit running dimensions or for customers special requirements. Seats and a tool box are provided in the cab. Wind screen wipers are fitted.

BATTERY

The 24 cell battery is contained in one battery box mounted on the platform.

POWER UNIT

The power units comprise Rolls-Royce C6-SFL supercharged oil engines direct coupled to their single bearing generators which are spigot mounted to the engine frames. The radiators are connected to the front of the engines and each unit is carried on three point resilient suspension mounted on the deck. The radiators, auxiliary generators and compressors are driven from the free end of each engine with Fenner vee belts. The complete power units and control equipments are supplied by The B. T. H. Co. Ltd., Rugby, and a detailed description of this equipment follows.

BONNET

The bonnets enclosing each power unit are built up of two sections which are easily detachable for maintenance purposes. The forward portion includes the front

moulding on which is mounted the radiator grill and encloses the diesel engine and its auxiliaries, while the rear portion encloses the generator. The engine air filters and exhaust silencer are mounted in the roof of the rear portion as it is only necessary to remove the front portion to attend of any major repair on the engine or its auxiliaries. As the weight of the locomotive required is provided mainly in the form of a strong frame, the bonnet sections have been fabricated mainly by welding from the lightest steel mouldings, and consistent with necessary strength. Doors and covers are arranged for access to the power units and these are provided with louvres with such air space as is necessary to provide for ventilation. The exhaust pipes and head lights are combined in neat mouldings on each bulkhead of the cab above the bonnet.

LIGHTING

The locomotive is provided with head lights and a cab roof light.

CAB HEATING AND VENTILATION

A Clayton Dewandre heater with ventilating fan of the latest type is provided in the cab.

MATERIALS

All materials, bolts, rivets and nuts are to British Standard Specification.

PAINTING

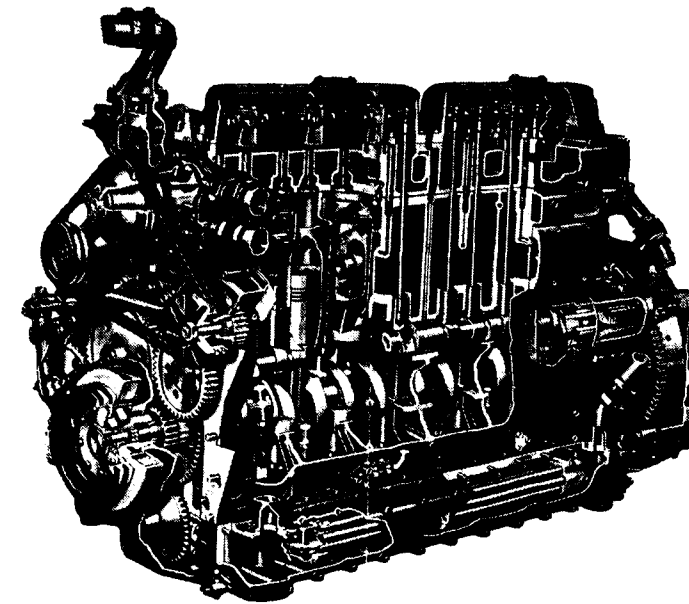
The locomotive will be painted to suit the customer's requirements.

TESTING AND TRIAL RUN

If required arrangements can be made for customers or their Consulting Engineers to examine the drawings or materials and visit the works to see the locomotives under construction. The power equipment is tested at the maker's works and the locomotive undergoes extensive trials before delivery. An acceptance test before the customer's representative can always be arranged.

TRAINING CUSTOMER'S STAFF

It can be arranged for customer's fitters and drivers to attend courses of instruction during the final stages of construction of their first locomotive.



Internal construction of the 6-cylinder dry sump engine.

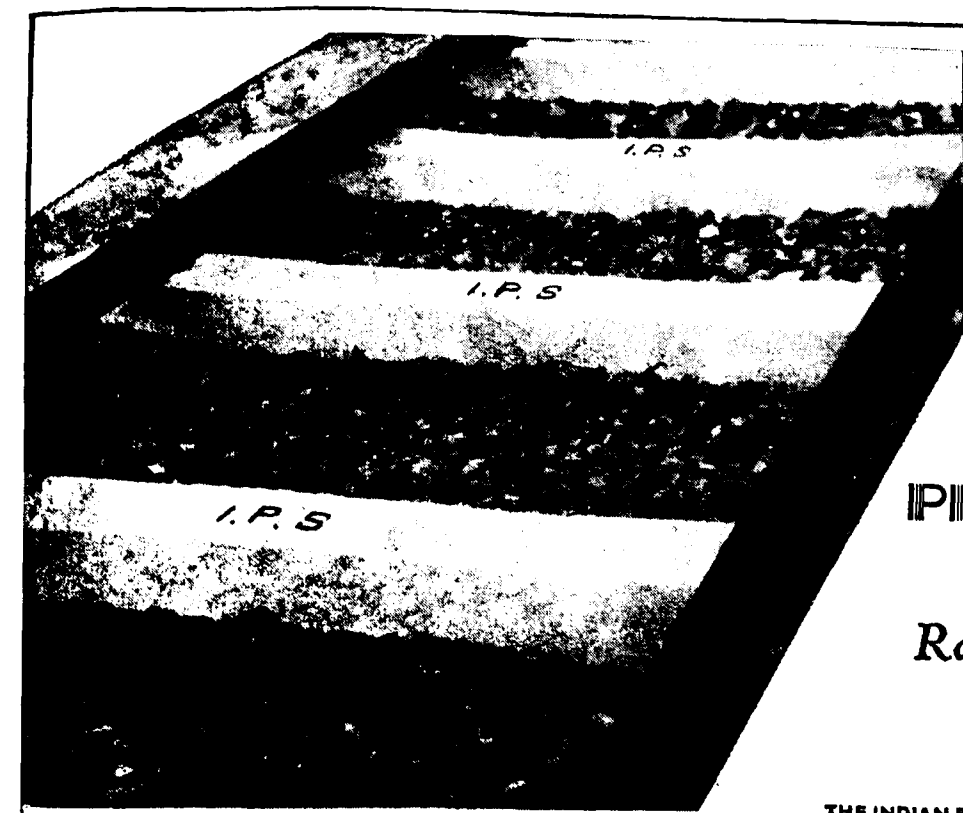
AFTER SALES SERVICE

A Service Engineer will accompany the locomotive to the customer's works and remain with it for five days.

The manufacturers of the mechanical parts, electrical machines and diesel engine will make periodic visits to the customer's plant during the maintenance period to ensure that the operation and maintenance is fully understood and to assist in any way to ensure satisfactory results.

SPECIFICATION

Type	4 stroke, direct injection, liquid cooled
Bore	5½" (130.175 mm.)
Stroke	6" (152.4 mm.)
Capacity (swept volume)	742.64 cu. in. (12.17 litres)
Compression ratio	14 : 1
B. H. P.	200 at 1,800 r. p. m.
Rotation	Anti-clockwise viewed on fly-wheel.
Fuel system	Direct injection governed at all speeds.
Lubrication system	Dry sump with heat exchanger. Full flow filters.



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B 1179

CONSTRUCTION

The cylinder block is integral with the crankcase. The crankshaft main bearing caps are supported by deep webs and the more heavily loaded centre and end bearings are additionally secured by transverse bolts. The main bearings are of pre-finished steel backed copper/lead type with Indium flash to ensure satisfactory life. Replaceable 'wet' type cylinder liners are fitted; the bottom seal being made effective by heat and oil resistance rubber sealing rings and the liners are nipped in position by the cylinder head.

CRANKSHAFT AND CONNECTING RODS

The crankshaft is nitride hardened and has at the front end an externally mounted viscous torsion damper, which effectively reduces the crankshaft oscillations over the full running range. The connecting rods are drilled longitudinally for pressure lubrication of the gudgeon pins, and for splash to the cylinder walls.

PISTONS AND VALVES

Each of the light alloy pistons is fitted with three compression rings and one oil scraper ring and is recessed in the crown to form a toroidal combustion chamber. The overhead valves are push rod operated and both inlet and exhaust valves have stellited seat faces and stem tips to minimize wear.

SUPERCHARGER

The supercharge is of the Roots positive displacement type, mounted on the crankcase and driven by a gear train and spring drive from the timing gears at approximately twice crankshaft speed; this gives about 8 lb. per sq. in. boost at an engine speed of 1,800 r. p. m. Pressure lubrication is provided from the main engines lubrication system.

AIR CLEANERS

Multiple air cleaner units have been developed for this engine by Rolls Royce Ltd. to ensure the highest practicable degree of air filtration. These comprise centrifuge primary and heavy duty oil bath secondary filters.

OIL HEAT EXCHANGER

To bring the engine oil rapidly to its most efficient working temperature and to maintain it at that temperature under all conditions, a heat exchanger is used.

Maintenance of correct engine temperature, apart from increasing the efficiency shortens the warming up period and so reduces wear.

On starting the engine the coolant radiator is bypassed, the warming coolant then re-circulating through the heat exchanger chamber and engine. When the coolant reaches 73°C. the automatic thermostat control opens and allows the coolant to circulate through the radiator.

LUBRICATION SYSTEM

A dry sump is fitted which reduces the overall height of the power unit and ensures efficient lubrication of the engine on any railway gradient. This sump incorporates an oil to water heat exchanger together with an oil reservoir. Two scavenge pumps return the oil to the reservoir and a pressure pump supplies the main feed to the engine.

Oil is pumped through the heat exchanger and full flow filters to the main feed gallery for distribution to the crankshaft main bearings, crankpins and gudgeon pins, and through drillings in the crankcase to the camshaft bearings and the bearings of the wheelcase gears. Smaller drillings feed oil to the valve rocker shaft bearings, the push rod ball ends and the end of the valve stems at a lower pressure. Twin oil relief valves are fitted; one valve maintains the main oil pressure at 40 to 60 lbs. per sq. in. and the other provides a by-pass in the event of the oil filters becoming choked.

COOLING SYSTEM

The coolant is circulated by a belt driven centrifugal pump through the oil heat exchanger, engine and radiator. Provision is made for fitting a cooling fan, and a thermostatically operated valve causes the coolant to by-pass the radiator until it reaches a predetermined temperature.

Whilst water can be used as a coolant, a correctly inhibited anti-freeze mixture is recommended for use all the year round, as this not only provides protection against frost but prevents corrosion within the cooling system.

FUEL SYSTEM

A fuel injection pump mounted on the side of the engine supplies fuel to the injection nozzles on the cylinder heads. The injection pump is driven from the engine wheelcase, and includes a lift pump for supplying fuel from the main tank to the injection pump

through paper element filters. The injectors are easily accessible for servicing. A mechanical compensated speed control governor forms part of the injection pump unit and ensures close governing at all speeds within the running range.

ELECTRICAL UNITS

A Simms dynamo of 960 watts output, is mounted on the crankcase and is belt driven in series with the coolant pump. The belt tension is adjusted by moving the dynamo. This dynamo provides the charging current for the twin lead-acid battery which is in two sections rated at 77 A. H. at the five hour rate of discharge.

The engine is not fitted with a normal type of axial starter as starting in this installation is through the generator and operates on a forty-eight volt circuit requiring a series parallel battery switch described later.

ENGINE SERVICE COUNTER

An engine service counter is fitted to provide an accurate means of determining the correct time for servicing.

MAIN DRIVE

The engine is designed for coupling direct to a single bearing generator. The engine-generator set is able to run indefinitely at any speed within the running range without incident of critical speed of torsional vibration. A viscous type vibration damper is attached to the free end of the crankshaft.

FUEL OIL RECOMMENDATIONS

It is recommended that Rolls Royce engines should be operated on fuel oils conforming to B. S. S. No. 209 (1947) Class A, but engines can also be operated on fuel conforming to B. S. S. 209 (1947) Class B. The makers will be pleased to give their recommendations for any fuel that does not meet the Class A specification and they should be consulted in every case.

CONTINUOUS RATING—(Self-Ventilated)

kW	Volts	Amps.	R. P. M.
124	500	248	1800
113	378	300	1660

Ratings in accordance with BS. 173/1941.

WEIGHT

Approximately 2,200 lb.

CONSTRUCTION

This machine is a single bearing, 6 pole, commutating pole traction generator specially designed for direct coupling to a diesel engine.

FRAME

The magnet frame is of the fabricated, barrel type with adequate opening for ventilation and access to the commutator and brush gear.

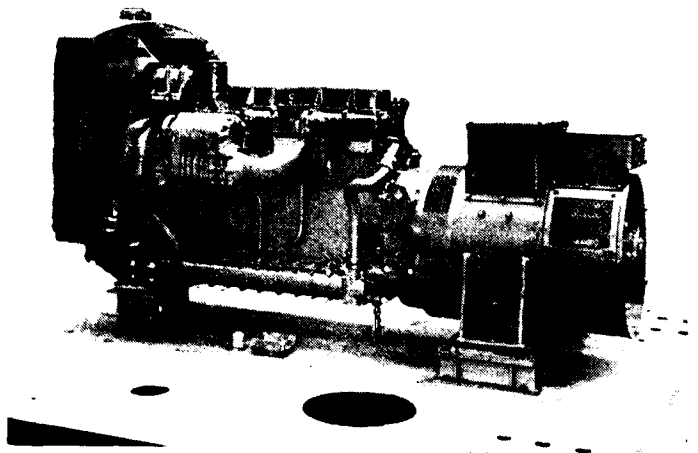
ARMATURE

The armature punchings are of thin electrical sheet steel and are secured on arms welded to a cylindrical spider by means of a heavy interference fit obtained by shrinking. A flexible coupling on the end of the spider is bolted direct to the engine flywheel. The armature windings are held in place by wedges of bonded material which retains its mechanical strength at high temperatures. Mica, glass and asbestos are used exclusively for coil insulation and all connections are brazed. The commutator is of the conventional Vee clamp ring design with hard drawn copper segments insulated with mica.

FIELD COILS

Self and separately excited field coils are provided. These are wound on the same former and are "Mummified." The compole coils consist of edge wound strip copper. A starting winding consisting of strip copper is also fitted on each main pole.

Mica, glass and asbestos are used exclusively for all coil insulation.



BRUSH HOLDERS

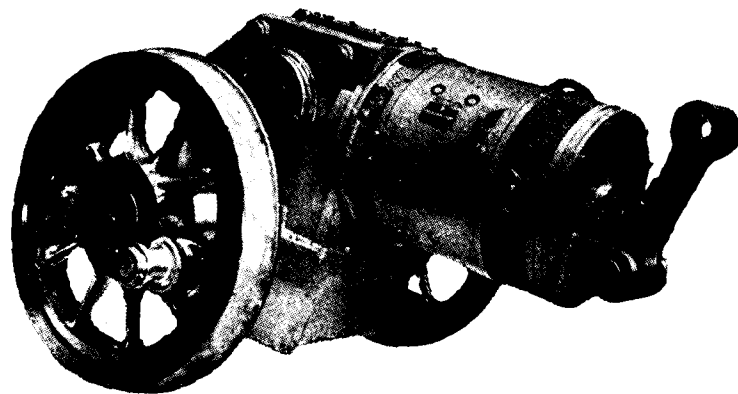
The brush holders are mounted on arms attached to a fabricated brush yoke and are adjustable radially. Split brushes are used with equalized pressure on each brush.

BEARINGS

The single bearing at the commutator end is a single row ball type arranged for grease lubrication.

VENTILATION

The fan is of fabricated steel construction and provides adequate ventilation of armature and field coils.



CONTINUOUS RATING ON FULL FIELD (Self Ventilated)

SHP	Volts	Amps.	R. P. M.
143	440	270	1330

Ratings in accordance with BS. 173/1941.

WEIGHT

Complete with gearbox, approx. 3,800 lb.

MAXIMUM SPEED

4000 r. p. m.

GEAR RATIO

22.85 : 1.

CONSTRUCTION

This machine is a 4-pole commutating pole traction motor which is spigot mounted on an axlehung gearbox.

FRAME

The magnet frame is of the fabricated barrel type with adequate openings for ventilation and access to the commutator and brushgear.

ARMATURE

The armature punchings are mounted directly on a very substantial shaft and are hot stacked under pressure. The windings, consisting of rectangular copper conductors, are insulated entirely with glass and mica and all connections are brazed. The armature windings are held in place by wedges of bonded material which retains its mechanical strength at high temperatures. The commutator is of the "Pollock" type in which the segments are retained against centrifugal force along their entire length. The spiral bevel pinion has a taper shank which is a very heavy press fit in a corresponding taper bore in the armature shaft.

FIELD COILS

These consist of edgewise wound strip copper insulated with asbestos and mica.

BRUSH HOLDERS

The brush holders are mounted on arms attached to a fabricated brush yoke and are adjustable radially. The brushes are split and are fitted with stranded copper shunts.

BEARINGS

The armature is carried on anti-friction bearings. A plain roller bearing is used as the commutator end. A pair of bearings is used to take the thrust and journal loads at the pinion end.

VENTILATION

A cast aluminium radial type fan provides adequate ventilation of armature and field coils.

GEARBOX

The gearbox is of fabricated steel construction and is split on the axis of the road axle. The lay shaft, which carries a spiral bevel wheel and spur pinion, is mounted on anti-friction bearings, cartridge mounted. The gears can be thrown out of mesh by external adjustment of the cartridges so as to allow the locomotive to be towed safely at speeds above the normal maximum.

The gearbox is carried on the road axle in split type oil-lubricated sleeve bearings.

GENERAL DESCRIPTION

The control equipment consists of a power controller, two reversers, contactor panels and battery series-parallel switch.

POWER CONTROLLER

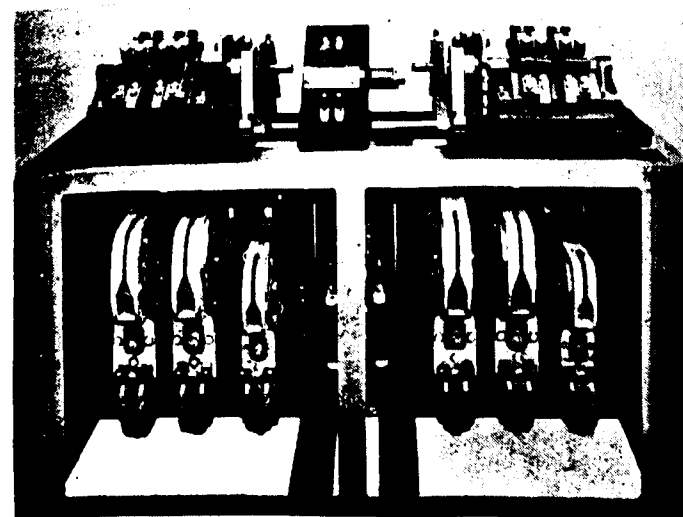
This is a cam operated unit with two silver tipped contacts through which the two contactors supplying power to the motors are energised. The lever of this power controller is mechanically linked to the governor and is used to control the engine speed.

Mechanical inter-locking is provided to ensure that this controller can be operated only when the reverse lever is fully in either the forward or reverse position.



REVERSER

Two standard single motor reversers are operated mechanically by the reverser lever. They have four pairs of copper contact fingers which engage with segments on the drum. Electrical interlocks ensure that the motor contactors can close when the reversers are fully in either the forward or reverse position.



Contactor Panel

CONTACTORS

One contactor is in each main motor circuit and one inserts a divert resistance in each motor circuit to give field shunt above a pre-determined generator voltage. A third contactor is in each generator circuit for engine starting purposes. These contactors are electrically interlocked to prevent the motor contactors and the starting contactor being closed at the same time. They are single pole, magnetically operated and are of simple and robust design. The construction includes a straight armature with rocker bearings. Blow out coils and arc shutes are provided to assist in rupturing the arc.

FIELD SHUNTING RELAY

Field shunting equipment consists of a field shunting contactor and a relay. The relay is connected across the generator and operates to introduce the field shunting of the traction motors automatically when conditions are suitable.

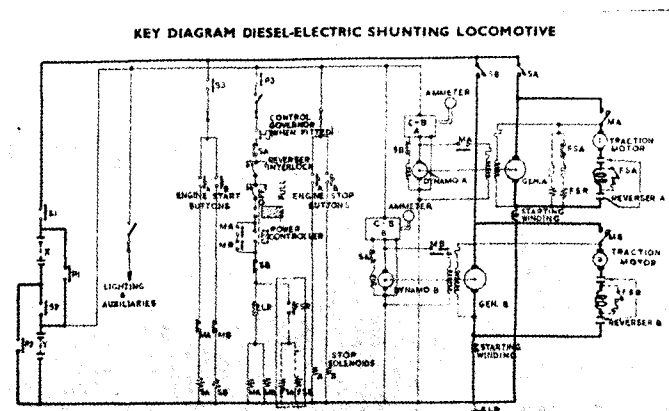
SYSTEM OF CONTROL

The fundamental traction circuit consists of two reversers and two contactors to connect the traction motors to the generators. The contactors are operated from a 24 volt battery and the reversers are mechanically operated by a link from the drivers reverse lever.

The traction contactors are closed by the throttle switch which is linked, together with the governor speed levers, to the drivers power controller. The locomotive power is varied by variation of engine speed so that, once the traction contactors have closed, no further change takes place, and the movement of the controller lever serves to increase the speed of the diesel engine by altering the setting of the governors. Traction motor field shunting takes place at a pre-determined generator voltage under control of the field shunting relay.

The control system is based upon a self-excited shunt wound generator coupled to the diesel engine. When using a diesel engine for traction duty, it is essential to introduce some means of employing full engine horse power over a wide range if the tractive effort of the locomotive is to be prevented from falling off rapidly at speed higher than normal operating speeds. The scheme adopted by B. T. H. on this locomotive is designed to give the widest possible use of engine horse power with the simplest of equipment.

The key control diagram appears on page 78 and the system of operation, briefly, is as follows:—



M = Motor Contactor P1-P3 = Parallel
S = Starting Contactor Contacts } Battery
FS = Field Shunt Contactor S1-S3 = Series Switch
FSR = Field Shunt Relay X-Z = Battery Sections
C-B = Dynamo Control Board ELR = Earth leakage relay

The series wound motors are connected by contactors through reversers to the main generators which are designed with steeply drooping characteristics. A light separate shunt field is provided to give a fixed short

circuit current. This short circuit current is chosen to correspond to a suitable 'stall' tractive effort of the motor and thus is self-protecting. The generators also have a series winding which is provided in order that the engine may be started by motoring the main generator from the supply available from the battery. The characteristics of the generators are also very sensitive with speed and advantage is taken of this to prevent the overloading of the diesel engines in the manner now described.

The maximum output of the diesel engines is determined by fixed stops on the fuel injection pump control racks. As the generator increases its loading upon the engines, fuel is increased by the governors until this maximum is reached after which further loading on the engines will cause a reduction in engine speed. This reduction in speed, however, rapidly reduces generator voltage and hence their loading upon the engines until a balance is reached. The reduction in speed is never sufficient to cause serious loss of available engine power.

This system of control provides continuous and entirely smooth variations of locomotive speed and tractive effort between stand-still and full horse power simply by varying the engine speed.

DOUBLING OF RAILWAY TRACK ON DELHI-MATHURA SECTION

Two stretches of railway line totalling about 45 miles on the Delhi-Mathura section of the Central Railway are to be doubled and the Railway Board has sanctioned Rs. 1.99 crores for the doubling project. The rail line will be doubled between Ballabhgarh and Hodal (31.75 miles) and between Chata and Chatikra (13 miles). With the construction of these two portions, marking the third and final phase in the doubling of the Delhi-Mathura section, a through uninterrupted double line would have been established between Delhi and Mathura. The Delhi-Mathura doubling has been undertaken in order to cope with greatly increased traffic which has developed over this section after partition, and also to cater to the increased traffic expected to materialise during the Second Five-Year Plan.

* * * * *

CANADIAN LOCOMOTIVES FOR INDIA UNDER COLOMBO PLAN

The arrival in India of the 120th Canadian W. P. locomotive under the Colombo Plan was marked by a ceremony arranged by the Railway Board at the New Delhi Station last month.

The Hon'ble Mr. Paul Martin, Canadian Minister of National Health and Welfare, made the presentation on behalf of his Government to Shri Jagjiwan Ram, Union Railway Minister, in token of the 120 locomotives given to India.

Canada had undertaken to supply to India, 120 locomotives, 56 boilers and 10 tender frames under the Colombo Plan. All these have now been received.

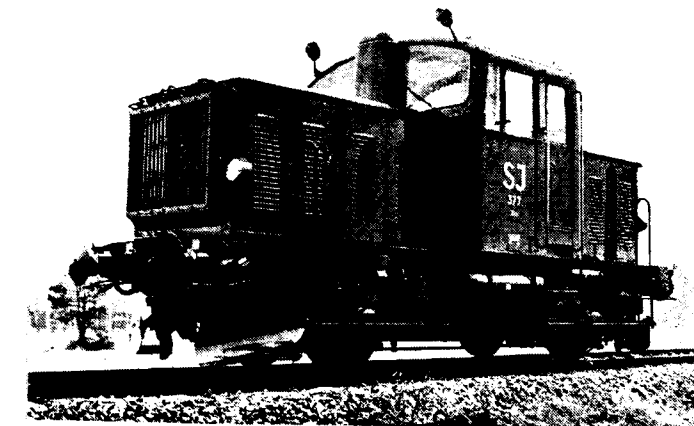
New Diesel shunting Locomotives for Swedish State Railways

IN December, 1956, Nydqvist & Holm Aktiebolag (NOHAB), Trollhattan, Sweden, delivered the first of a series of diesel shunting locomotives. They are the most powerful shunting locomotives of their kind in service on the Swedish State Railways. The locomotives have got the denomination "Z63".



The "Z63" is a cowl-locomotive the driver's cab being placed at the centre of the locomotive.

There are two axles. The driving wheel diameter is 980 mm. The locomotives are provided with two speed-ranges: in shunting service, 0-30 km. p. h. and in train service, 0-60 km. p. h. The maximum tractive effort amounts to ca 10,000 kg. The tractive effort at a speed of 10 km. p. h. is ca 5,900 kg.



The weight of the Z63 in working order is 28,000 kg. but the axle load can be increased by ballasting to attain 15,000 kg.

The fuel capacity can amount to 650 liters.

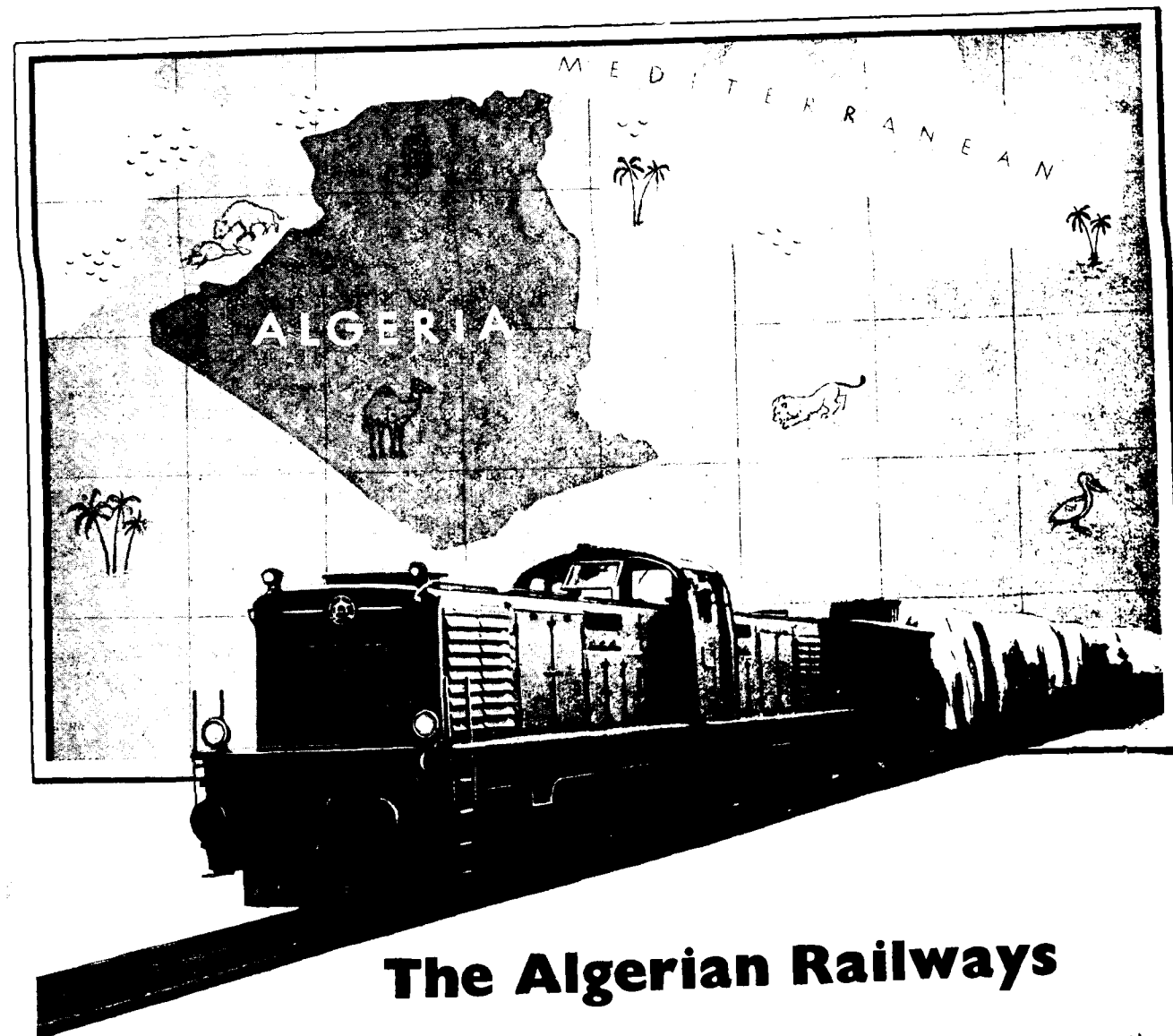
The driving machinery, installed in the larger cowl, consists of a 12-cylinder diesel unit of General Motors' make. The cylinder diameter is 4 1/4" and stroke 5". The output is 295 h.p. The driving power is transmitted to conical gears on the driving axles via a hydraulic gear, a reversing gear and cardan shafts.

Space is reserved, in the smaller cowl for connecting a 12 kW heat flow generator if, in future, it should prove desirable to provide the locomotive with train heating device.

The locomotive can be operated from either of the two control boards on each side of the driver's cab. From where the load of the diesel engine, the hydraulic gear and the reversing gear are controlled.

The Z63 is equipped with air brake and hand brake, which both act on all wheels. The air brake consists of an automatic brake with regulating valve and auxiliary air tank, and of a direct brake with pneumatic driving and brake valve, type Knorr.

When substituting steam traction for diesel traction on non-electrified Swedish lines, the shunting service was the first to be dieselized. The locomotives, now supplied, are, however, intended to be used also in local freight trains.

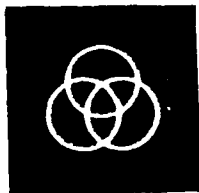


The Algerian Railways

were supplied by us with a six-axle Bo' Bo' Bo' diesel-hydraulic locomotive in addition to a number of smaller units. The centrally-supported underframes each carry a semi-boosted four-stroke six-cylinder in-line engine developing 610/550 h.p. at 1,000/900 r.p.m.

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Each of these two engines is arranged to drive three independent but parallel-coupled power trains each incorporating a Krupp type L. 1.0 torque converter with variable-pitch blades. Diesel engines and the six Krupp converters are lever-controlled from both driver's positions, each of the converters acting direct on a single axle. The six axles, anti-friction bearing mounted in three identical bogies, are true individual drive types, driving power being transmitted through universal-joint shafts. Uneven wear of the wheelsets will thus not adversely affect the performance of the locomotive.

The driver's cab is located in the centre of the locomotive to give a good all-round field of vision.

Weighing a total of 75 tons, this locomotive is designed to attain a top speed slightly in excess of 50 m.p.h.

Single Column Vertical Turret Lathes for high table speeds and heavy cuts

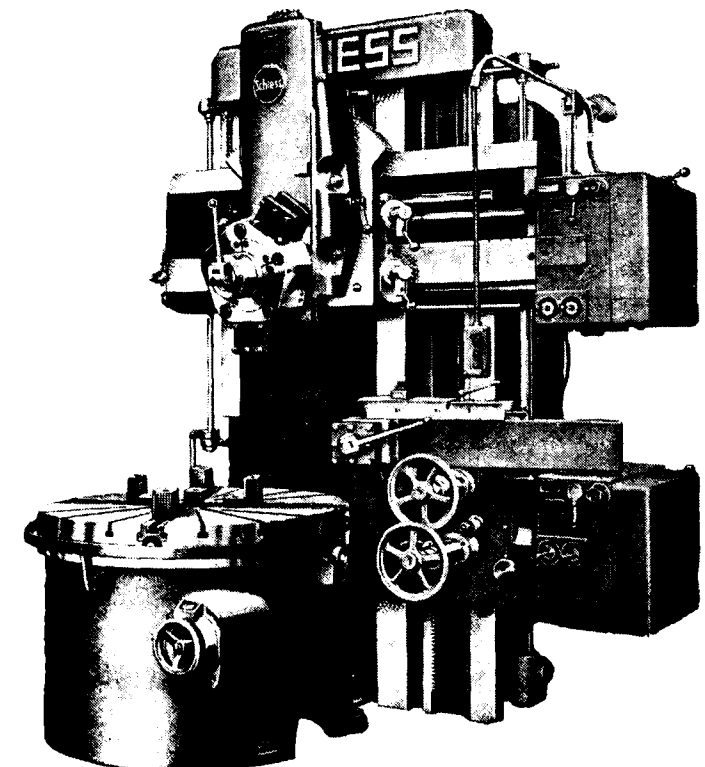
THESE machines are high speed types with maximum turning diameters of 39", 49" and 63" and are designed essentially to work with tungsten carbide tools. The table runs on precision tapered roller bearings which prevent lifting of the table and, at the same time, ensure an excellent surface finish. The large diameter table rim gear of high quality steel has external helical teeth.

The drive is exclusively by spur gears from a motor mounted vertically at the left-hand side of the column. The power is transmitted from the motor to the drive box through a flat belt. The gears in the main drive are of alloy steel, case-hardened, and ground. They are mounted on vertical shafts running in ball or roller bearings and, the case of sliding gears, these shafts are splined. The sliding gear clusters are held in shift forks, which are fitted with anti-friction bearings, and the entire assembly is counterbalanced.

Starting and stopping of the machine with automatic braking is effected from the pendant push-button panel. In addition to the "Start" and "Stop" buttons there is a tumbler switch which allows for inching. When this switch is set to "Inching", the machine will run only as long as the "Start" button is kept depressed.

The change of the sixteen table speeds with a ratio of 1:50 is effected by means of the pre-selector hand wheel at the right-hand side of the front of the table base. By turning the hand wheel with the machine either running or standing still, the speed can be set to an illuminated dial. When the machine is running, the "Stop" button is pressed, thus switching off the main motor and braking the machine, whereupon the pre-selected speed is automatically engaged by pressing the "Speed Change" button. At the start of the gear change, the lamp over the selector dial is extinguished and lights up again as soon as the shift is completed.

The cross-rail is raised and lowered by means of a flange-mounting reversing motor on top of the column which is interlocked with the rail clamping mechanism. The locking is effected by a hand lever on the left-hand side of the column. When this lever is in its central position, the rail is locked rigidly, and when it is in either of its end position, the rail is unclamped and the

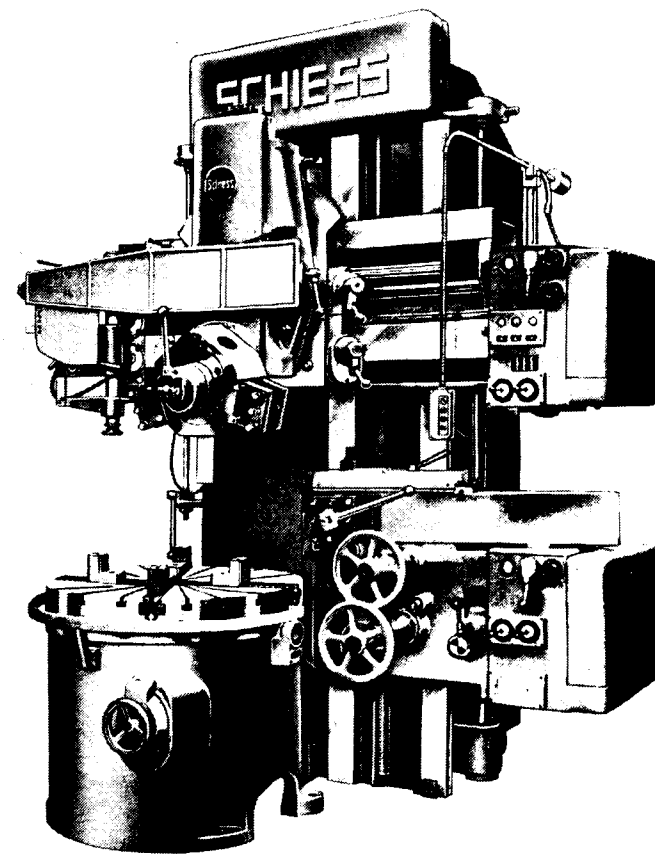


Model KE 125 Single Column Vertical Turret Lathe
with 49" max. turning diam.

elevating motor will run in the desired direction. This design is entirely fool-proof and limit switches are provided to prevent the rail from overrunning its extreme positions.

The cross-rail head runs on the narrow bottom way and can be swivelled through 45° to either side. Power feed in horizontal, vertical, and angular direction is provided, and hand adjustment of the head is effected through crank handles on the rail slide thus facilitating the observation of the tools by the operator when setting. The cast-steel turret slide is counterbalanced and runs on long rectangular ways with taper gibs for wear control.

The steel five-tool turret has a proven indexing and locking device which permits indexing with no danger to the operator even when the various stations carry unequal tool loads. The tools are held in concentric split bushings which are below the turret surface so that



KE 100

70128/1

Model KE 100 Single Column Vertical Turret Lathe
(3" max. turning diam.) with Electrically Operated
Profiling Attachment.

large tools or tool holders can be flange-mounted on the outside surface of the turret. One single lever is provided for indexing and locking. The latter is done with an eccentric which ensures absolute rigidity, and one full rotation of the lever in either direction indexes to the next turret position. Constant accuracy of the turret position is guaranteed through a very sensitive adjusting device. A hinged stop on the cross-rail assures concentricity for boring operations and can be opened to allow the rail head to be moved beyond the centre position.

The side head runs on long narrow ways on the column and is balanced by a counterweight inside the column. Power quick traverse is provided and the feeds can be set independently of those for the cross-rail head. The turret slide is of extremely heavy construction due to the comparatively large overhang sometimes required and is provided with very carefully designed adjustable guides. The square turret can be accurately

adjusted by means of a gib and is securely locked in each position by means of eccentric clamping.

The gear boxes for both the rail head and side head are identical and contain the gearing to give the different feed rates and to change the direction of feed and rapid traverse. The feed is derived from a vertical shaft which rotates in a definite ratio with the table speed, while the rapid traverse is by a separate motor flange-mounted on the feed box and running only when the rapid traverse is engaged. The feed change with an overall range of 1:100 is by pre-selection and monolever control. The engaged feed can be read directly from a dial.

All feed selections are accomplished from one feed to another without going through the intermediate positions which are not required. Case-hardened alloy steel gears are used in the feed works. Engagement and disengagement as well as change of direction of the feeds are by electromagnetic disc clutches actuated by a lever which is moved in the sense of direction of the feed. The use of electromagnetic clutches enables the machine to be equipped, at any time, with an electrically operated tracer control in conjunction with the necessary template. Separate shear pin safety clutches are provided for the vertical and horizontal feeds.

Graduated scales are fitted to the rail head and side head for vertical and horizontal movements, and given dimensions can be marked by means of pointers.

The electric controls which are easily accessible are accommodated in a completely dust-tight panel which is mounted inside the upper part of the column at the rear of the machine.

Lubrication is almost completely centralised. Main drive, table bearings, and driving gears (splash lubrication) are fed with oil from a pump with gap-type filter which also supplies the pressure oil for the hydraulic speed change. Automatic oil circulation is also available for the two feed boxes. Those points requiring only occasional lubrication are grouped together in a few locations which are easily accessible to the operator for simple hand lubrication.

SPECIFICATIONS

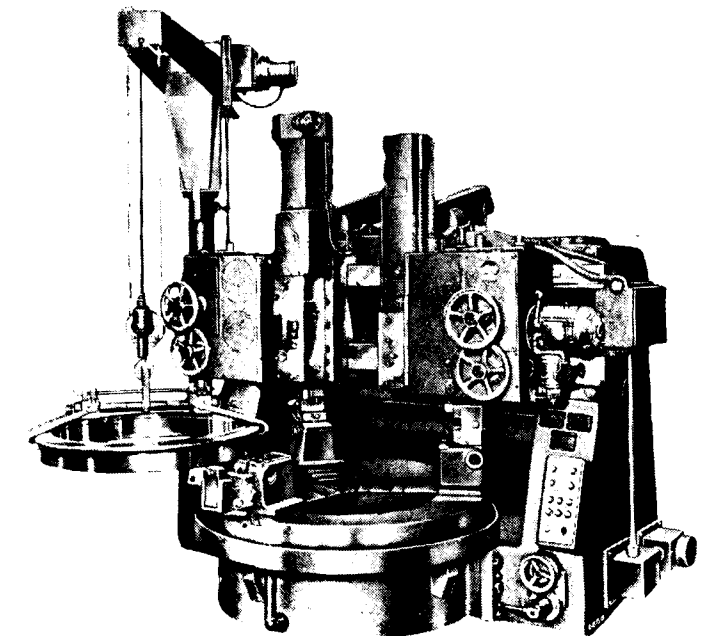
Model	KE 100	KE 125
Max. turning diam. table diam. .. ins.	39	49
Max. turning diam. with side head down .. ins.	45	55

Model	KE 100	KE 125
Max. turning height over table .. ins.	43	43
Max. vertical tool travel for rail head .. ins.	27½	27½
Max. distance table to cross-rail turret .. ins.	52	52
Max. horizontal tool travel for side head .. ins.	21½	25½
Max. distance table to bottom of side head turret .. ins.	29½	29½
Vertical travel of cross-rail .. ins.	29½	29½
Max. load on table .. tons.	3	4
No. of table speeds ..	16	16
R. p. m. of table ..	6.2—310	4.7—237
No. of horizontal, vertical, and angular feeds, each ..	12	12
Feeds per table revolution .. ins. .0023—.262	.0023—.262	.0023—.262
Rapid traverse of heads per minute .. ins.	89	89
Travel of cross-rail per minute .. ins.	15½	15½
Horse power of main motor ..	40	40
R. p. m. of motors at 50 cycles ..	1500	1500

VERTICAL TYRE BORING MILLS

The machine consists of the base, which carries the table, the two columns, the cross-rail with the two heads, and a swivelling jib crane with electric hoist. Base, columns and cross-rail are rigidly bolted together. The tyre is clamped and released by a power-operated chuck. If desired, the table can be designed as a pneumatically operated special chuck. The chips drop through large openings in the table and base into a chip tray in the foundation.

The main motor with the drive box is mounted on a base plate at the rear of the base. Three speed ranges are available, each having four speed rates. The first group with the four low speeds is intended for roughing with high speed steel, the second group is utilized for



Model 22 RRK 150 Vertical Tyre Boring Mill
with Automatic Sequence Control.

roughing with tungsten carbide tools, and the third group with the four top speeds is intended for finishing with carbide tools. Change from the first or second group to the high speed group is either by push-button or, if an automatic sequence control is used, automatic.

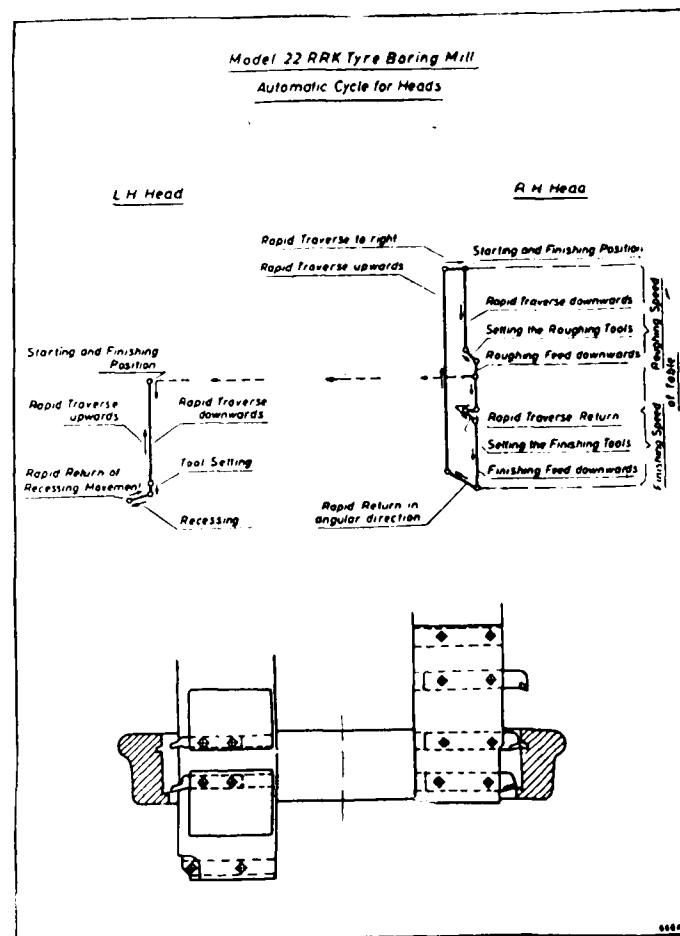
The table speeds are controlled by a lever and a hand wheel on the right-hand column.

The right-hand head is used for roughing the large bore and the lip bore with two tools in one operation and for the subsequent finishing of the large bore with one finishing tool. While the right-hand saddle is roughing the bores, the left-hand head recesses the lip and the retaining ring groove. The retaining ring groove is produced by two tools lying one behind the other and undercutting one another. The two recessing tools and the lower tool for machining the lip can very easily be set by means of a square tang to suit the individual distances between lip and retaining ring groove.

Although the retaining ring groove and the lip are machined simultaneously, the two plunge-cuts need not have the same direction, and it is thus possible to perform these operations independently of each other in horizontal and angular direction up to 20°. The cut with the left-hand head is completed by the time the right-hand saddle starts the finishing cut on the bore.

All the cutting tools which are necessary for the various operations are mounted on the heads and consequently no tool changing is necessary during the machining. The only change necessary is whenever a tool becomes dull or when a different type tyre is to be machined. Tool changing is facilitated through the use of setting gauges. Both heads are equipped with rapid power traverse in horizontal and vertical direction by means of separate motors. The right-hand head has three vertical roughing and three vertical finishing feeds, while the left-hand head has three horizontal feeds outwards, three vertical down feeds and three plunge-cut feeds. Change-over from roughing to finishing feed on the right-hand head is by means of push-buttons or automatic in the case of the automatic sequence control being used. All the movements on both heads may also be performed manually by using hand wheels.

When using the automatic sequence control, the operator need only load and unload the machine, once it has been set up for a specific type of tyre. The diagram on this page shows the automatic cycle of operations. At the beginning of this cycle, the right-hand head feeds down in rapid traverse into working position. After a short angular tool setting movement, the lower tool machines the smaller bore, while the centre tool rough turns the large bore. As soon as both roughing tools have reached the positions where the lip and the retaining ring groove are to be recessed, the left-hand head feeds down in rapid traverse into its working position, recesses the lip and the groove, withdraws the tools, and returns in rapid traverse to its starting position. At the same time, the right-hand head has continued the roughing operation, and on completion of this it moves horizontally inwards at rapid traverse until the finishing tool located above the two roughing tools is in its working position. At this very moment, the high finishing table speeds are engaged and the feed is cut down to the lower finishing feeds. After a momentary approach of the finishing tool in angular direction to the exact diameter, the bore is finished right down to the lowest corner of the lip. On completion of the finishing operation, the finishing tool moves rapidly up in angular direction for a short distance and the table is stopped. The head feeds up in rapid traverse and then to the right into its original position ready to start another cycle after the component has been changed.



SPECIFICATIONS

Model	Table Dia.	I. D. of Tyres	Horse Power of Driving Motor	R.p.m. of main motor at 50 cycles
22 RRK 150	59"	27½"-37½"	68	1500
22 RRK 165	65"	27½"-43"		
22 RRK 180	71"	27½"-49"		
23 RRK 190	75"	27½"-53"		
23 RRK 215	85"	27½"-63"		
23 RRK 230	91"	27½"-69"		
24 RRK 240	94"	33½"-73"		
24 RRK 255	100"	33½"-79"		
25 RRK 280	110"	33½"-89"		

The models 22 RRK 150—22 RRK 180 can also be used for machining tyres with an I. D. down to 24", but not with both heads simultaneously.

RAILWAY BOARD CHAIRMAN RETIRES

Shri G. Pande, Chairman, Railway Board, relinquished charge of his post on attaining the age of superannuation on December 31, 1956. He has been succeeded by Shri P. C. Mukerjee, Member (Engineering) of the Railway Board. Shri Pande has over 31 years of distinguished service to his credit. He joined the ex-East Indian Railway in 1925 and worked on several constructions. He joined the Railway Board in 1947 as Joint Director, Civil Engineering, and was promoted as Director, Civil Engineering, later in the same year. In July 1948, he was appointed Engineer-in-Chief, Ganga Bridge Project, Mokameh even though the old official view was that only a British expert could execute this project. In October 1950 he was posted as General Manager of the ex-O.T. Railway. Immediately before he became Chairman, Railway Board, Shri Pande was General Manager of the Rs. 16-crore Ganga Bridge Project. For this post he was specially selected.

Emperor Haile Selassie of Ethiopia visits Integral Coach Factory, Perambur

THE visit of the Emperor of Ethiopia to the Integral Coach Factory was memorable in that the factory was one of the very few places visited by the Emperor in Madras and that the programme was gone through as originally drawn up in spite of very unfavourable weather.

His Imperial Majesty accompanied by the Royal Party consisting of about 20 members visited the Factory on the 29th October. The Chief Administrative Officer, Shri K. Sadagopan, received the Royal Party on arrival, garlanded the Emperor and presented bouquets to the other members of the Royal family.

After introducing the principal officers of the Factory the Chief Administrative Officer gave a brief description of the factory with the aid of the layout model. The Royal Party was then taken round the Technical

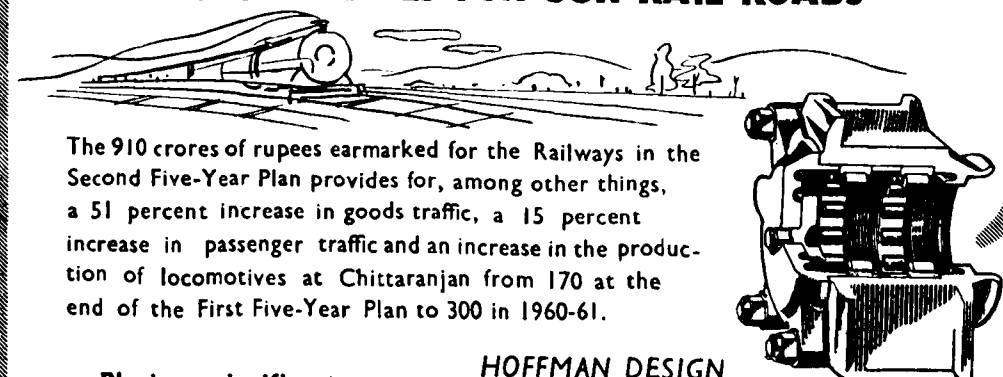
Training School, the Staff Colony and the Factory. At the conclusion of the visit the party was entertained to light refreshments.

Shri K. Sadagopan in a short speech thanked His Imperial Majesty for having found time to visit the factory and for the keen interest evinced by him in the progress made by the Factory. As a token of affection His Imperial Majesty was presented with a small silver model of an Integral Coach.

The Emperor in a short speech thanked the Administration for the excellent arrangements made for his visit and wished India all success in the industrial field.

As a memento of his visit to the Factory, His Imperial Majesty presented the Chief Administrative Officer with a gold coin.

MORE LOCOMOTIVES FOR OUR RAIL ROADS



The 910 crores of rupees earmarked for the Railways in the Second Five-Year Plan provides for, among other things, a 51 percent increase in goods traffic, a 15 percent increase in passenger traffic and an increase in the production of locomotives at Chittaranjan from 170 at the end of the First Five-Year Plan to 300 in 1960-61.

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His Imperial Majesty Emperor Haile Selassie of Ethiopia motoring in the workshops of the Integral Coach Factory, Perambur, Madras. With His Majesty in the car are seen Shri K. Sadagopan, Chief Administrative Officer and Shri K. Kamaraj, Chief Minister of Madras.

The Royal Party departed after the Ethiopian and the Indian National Anthems were played by the Southern Railway Protection Force Band.

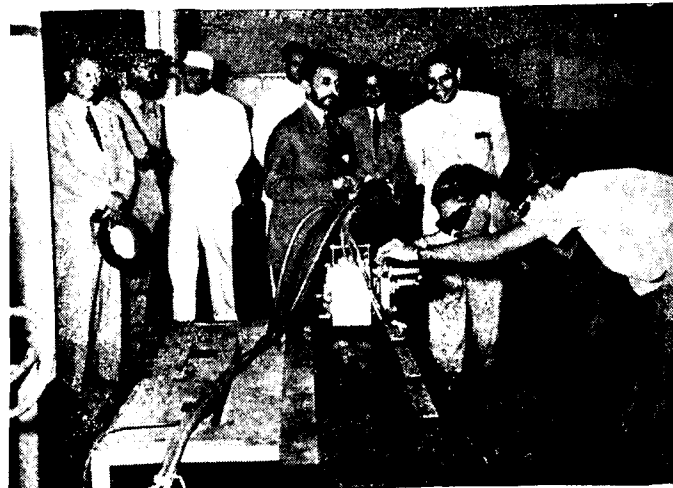
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RAILWAY MINISTER INAUGURATES THIRD ASSEMBLY LINE IN INTEGRAL COACH FACTORY, PERAMBUR

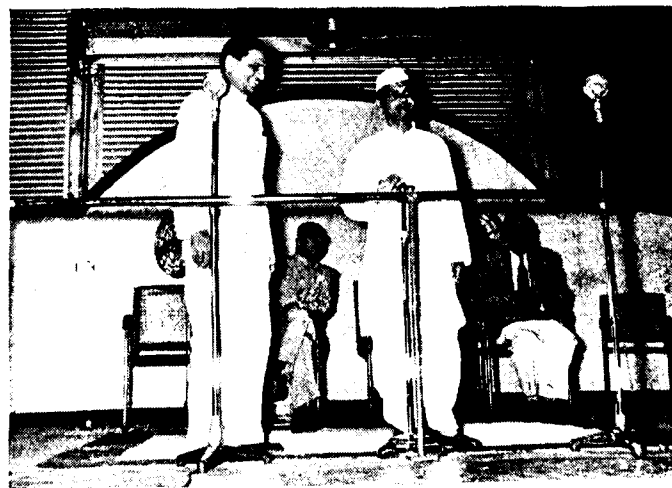
Shri Lal Bahadur Shastri, Minister for Transport and Railways, inaugurated the Third Assembly Line at the Integral Coach Factory, Perambur on 23-10-56 at a function held in the Main Assembly Shop of the factory. The function was attended by the Principal Officers of the Southern Railway and by all Officers, Swiss Personnel and staff of the factory.

The Main Assembly Shop has 6 assembly lines and the inauguration of the third assembly line marks another step towards the increase of production in the Coach Factory. The output during the second year of production will be 120 as against 43 during the first year.

Shri K. Sadagopan, the Chief Administrative Officer, welcomed the Railway Minister and reviewing the work done during the first year of production, stated that the original target of 20 coaches a year was increased to 40 and that the actual number completed was even greater than that, being 43. He assured the Railway Minister that the full production target of 350 coaches



His Imperial Majesty Emperor Haile Selassie of Ethiopia at the Technical Training School attached to the Integral Coach Factory, Perambur, Madras.



Shri Lal Bahadur Shastri pressing a button for the first coach assembled on the 3rd Assembly line to move out. Seated behind are Shri Bhattacharya, Financial Commissioner of Railways and Shri T. A. Joseph, General Manager, Southern Railway.

a year would be reached within 4 years instead of 5 years as originally planned.

Whilst reviewing the progress made towards manufacture of components from indigenous material, he said:

"You may be pleased to hear that we have made considerable progress in the indigenous manufacture of details and sub-assemblies of the coaches to be produced in the Factory. Five batch orders have already



The Union Railway Minister Shri Lal Bahadur Shastri addressed the workers of the Integral Coach Factory, Perambur, Madras at a meeting in the Main Assembly Shop of the Factory for the inauguration of the 3rd Assembly line in the factory.

been issued on the Works, the first for 10 coaches, the second, third and fourth for 2 coaches and the fifth for 30 coaches. We have been able to successfully manufacture all the details and sub-assemblies in the Factory, and the first "all-Integral Coach Factory", manufactured coach shell was moved out of the assembly line on the 14th of August this year, much ahead of schedule, on the occasion when our revered Rashtrapati, Shri Rajendra Prasad honoured us with a visit".

He also stated that all that had been achieved so far had been only due to the enthusiasm, efficiency and patriotic devotion to duty of the workers of the factory and also due to the co-operation given by the Swiss engineers and experts.

With regard to raw material procurement he said:

"We are actively pursuing a policy to develop capacity for the manufacture of all the materials required by us in the country. We have approached the Iron and Steel Ministry for planning the production of steel required by us in the new Steel Plants that are coming into existence. In regard to the other imported items, we have been able to cut down our imported items from 133 in the first lot to only 33 in the fourth lot. This reduction has been possible by maintaining a constant drive to develop indigenous manufacturing capacity, and the following action has been and is being continued to be taken in this connection.

(1) Educational orders (trial orders) are being placed on the Manufacturers in the country to ascertain their capacity for the manufacture of imported items.

(2) Samples of imported items have been displayed in the Railway Equipment Show Room.

(3) Advertisements have been inserted in all the leading Newspapers in the country inviting firms and industries to quote for the manufacture of the imported items.

(4) Imported samples of materials are being sent to Manufacturers who are interested in the production of such items.

We have been successful in locating indigenous capacity for aluminium extrusions, light alloy castings, rubber profiles, small springs and other miscellaneous items. Wheels and axles, steel castings, helical and laminated springs, roller bearings for the axles and other miscellaneous items are continued to be imported"



The Railway Minister Shri Lal Bahadur Shastri in the workshops of the Integral Coach Factory, Perambur, Madras

With regard to ordering of machinery Shri Sadagopan observed :

"As a measure of financial prudence, our procurement of plant and machinery was for a production capacity of 250 coaches in a year. It was the intention then that, with a view to obviate the possibility of excessive investment on plant and machinery, we should order machinery sufficient for 250 coaches only in the first instance, pending actual experience and determination of the plant and machinery required for the attainment of the full production target of 350 coaches a year on a single shift. We have now gained sufficient experience of the work loads and the capacity of the machines already installed and we have already taken action for the procurement of a second lot of plant and machinery totalling about Rs. 60 lakhs. These machine tools are expected to be delivered in the course of this year and the next year".

In connection with the furnishing of coaches Shri Sadagopan said :

"The Railway Ministry have accepted in principle that the Integral Coach Factory should make necessary arrangements for the furnishing of coaches turned out by the Integral Coach Factory by establishing a Furnishing Annexe in close proximity to the Integral Coach Factory instead of depending on the Railway Systems to furnish the coaches in their Workshops. A Special Officer has been investigating the possibility of the establishment of such a Furnishing Factory, and a Project Report has now been submitted to the Railway Board in this connection. The plan is to have a separate Factory close to the Integral Coach Factory and, in order to cover the gap between now and the establishment of a permanent Factory, it is proposed to organise interim furnishing arrangements with temporary structures. It has also been decided that the Integral Coach Factory should immediately take up the furnishing of a limited number of coaches in the free space available in the existing shops. The work of furnishing the first coach has already been taken in hand. The commencement of the furnishing work immediately in the Integral Coach Factory on a temporary basis will enable the building up of the technical personnel required in stages so that, by the time when the permanent Furnishing Factory takes shape, it may be possible to switch over the entire technical personnel to the permanent Factory and take in hand the furnishing of the entire output of 350 coaches by the Integral Coach Factory without any time-lag".

In conclusion he stated :

"I beg to acknowledge the assistance and co-operation we have always received from the Southern Railway. It

(Continued on page 89)

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BLAST CLEANING PLANTS

By W. M. Oddie

IN so complex an Industry as Railway Engineering it is inevitable that problems are much more diverse than in Trades where the end product is standardised. Versatility is, therefore the key to success and these remarks refer not only to personnel responsible for organisation and control of Railway projects but equally to the plant and machinery which must be employed in the Workshops.

To quote one example of the latter it will be appreciated that many parts eventually built up into Locomotives or even items which are in themselves complete such as Rail Chairs, must be cleaned before they can be further processed. In the case of the Rail Chair the object is to remove sand after casting, and before fettling whilst in the case of a bearing housing the surface must be prepared for the "running" of the anti friction lining. Even the tools used in the machines themselves

must pass through a cleaning or descaling process after they have been hardened whilst removal of scale from a forging will save wear on lathe tools, milling cutters, etc.

It will therefore be apparent that a means of cleaning, descaling and surface preparation embodying the overriding principle of versatility is likely to be of the greatest possible advantage in any Railway Foundry or Workshop and such a means exists in the form of Blast Cleaning Plant. As its name implies "Blast Cleaning" performs its function by "blasting" or projecting a granular substance against the article or work to be cleaned. The 'blast' may be produced by the entrainment of the abrasive material in a moving stream of air under high compression which is forced through a jet or nozzle in a high velocity stream of the more modern Centrifugal means employing a high speed impeller and generally known as "Airless".

(Continued from page 88)

is heartening to us to note that the Southern Railway have been able to take in hand the furnishing of the shells we have sent to them, and you have just inspected the first coach completed by the Southern Railway, if I may say so, within a record time. This, if I may respectfully say so, is a creditable achievement, as, although we have been supplying shells to Railways since October last, the credit for putting the Integral Coach Factory Coach on the line, in as short a time as possible, goes to the Southern Railway".

Shri Lal Bahadur Shastri in his speech said that he was pleased with the progress made during the past one year and that he was keenly looking forward to the day when the factory will be reaching the full production capacity of 350 coaches a year, making the country self-sufficient so far as broad-gauge coaching stock is concerned.

Shri Shastri said that third class travel should be made as attractive as possible and that continuous efforts should be taken to improve the amenities provided.

He added that the sleeping berths provided for third class passengers, as a trial measure, had proved to be very successful and that arrangements had been made to provide 60 upper berths in third class carriages with a seating capacity for 80, so that sleeping accommodation would be available for 60 out of the 80 passengers. He

stated that a nominal fee of Rs. 3 per night would be levied and that sleeping accommodation would be available only for 60, as some of the passengers might not wish to avail of the amenity and some might be only short distance travellers.

Shri Shastri then referred to the ambitious plan of the railways launched during the Second Five-Year Plan and drew the attention of the railway workers to their responsibility in seeing that the plans were fulfilled. He also remarked that by the end of the second plan period the country would be self-sufficient so far as coaching stock went.

The Railway Minister expressed his appreciation of the interest taken and the co-operation extended by the Swiss Personnel of the Factory.

In conclusion Shri Shastri said that the cleanliness of the workshop and the way in which the colony had been developed made a deep impression on him and that this Factory had become one of the show pieces of the Indian Railways.

He then pressed the button and formally inaugurated the Third Assembly Line, when a completed coach shell rolled out of that line amidst Nadaswaram music and a shower of rose petals from an overhead crane.

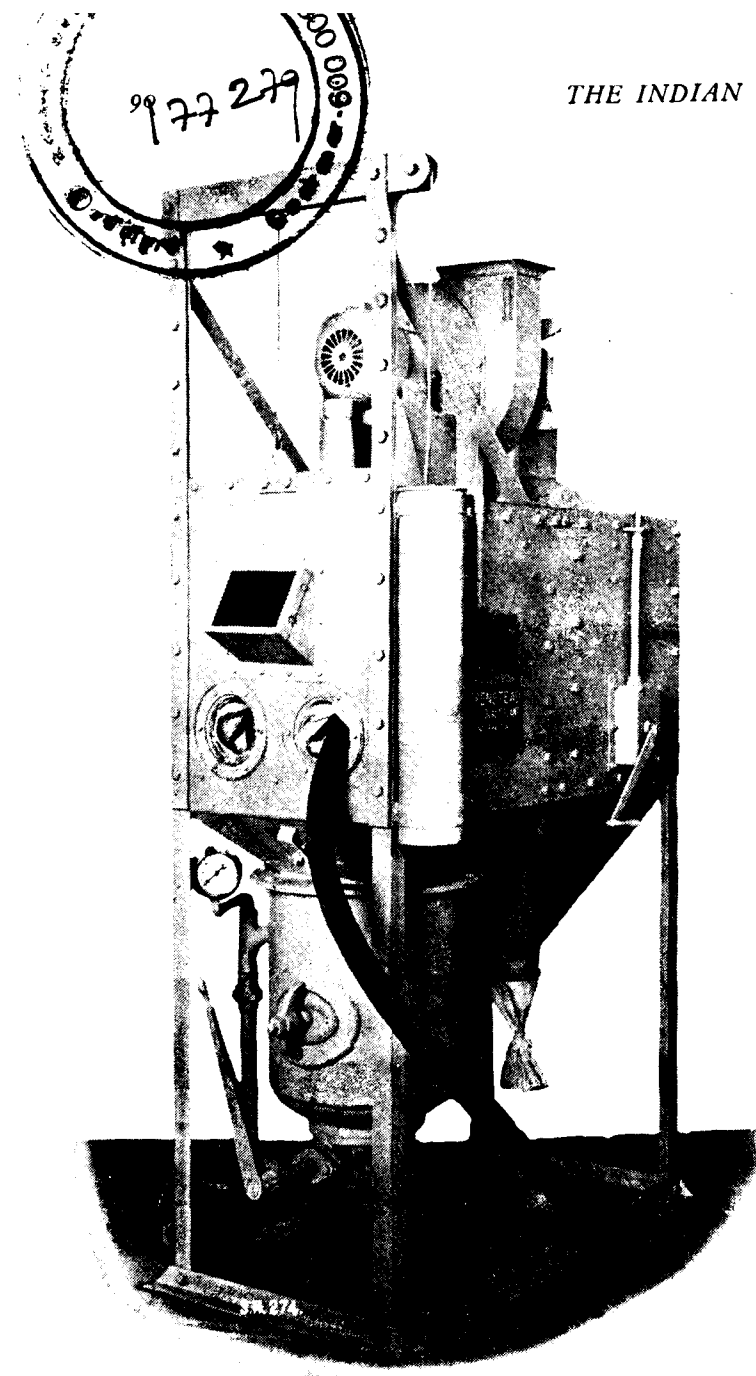


Fig. 1.

The compressed air system is the more versatile in that the nozzle is manually operated and a trained operator can judge the amount of blasting required to fulfil the object in view but it is considerably slower than the Airless method which however is invariably used in conjunction with some form of mechanisation designed to expose the surfaces of the object to the "blast stream" in such a way and for such a period of time as will ensure the same effect as that produced by the judgment of the human operator.

One of the simplest and most versatile forms of Blast Cleaning Plant is the Hand Cabinet (Fig. 1) consisting of

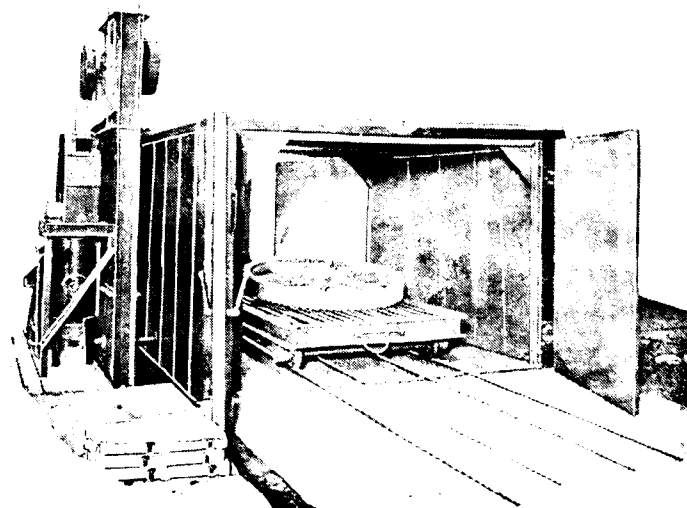


Fig. 2.

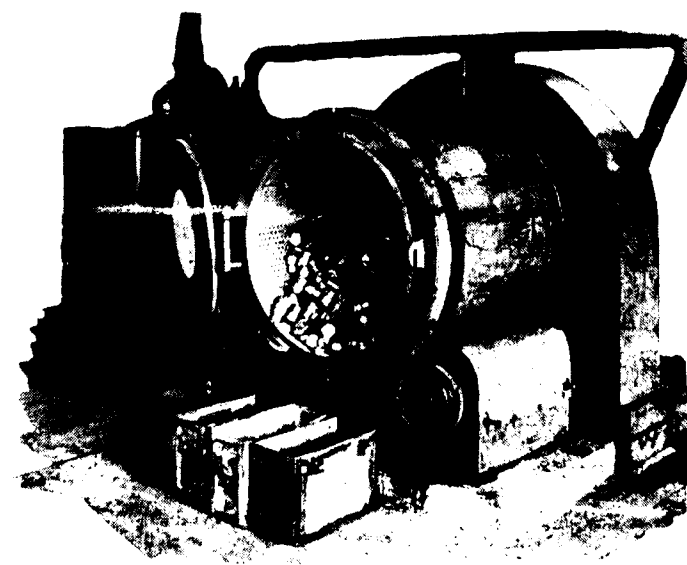


Fig. 3.

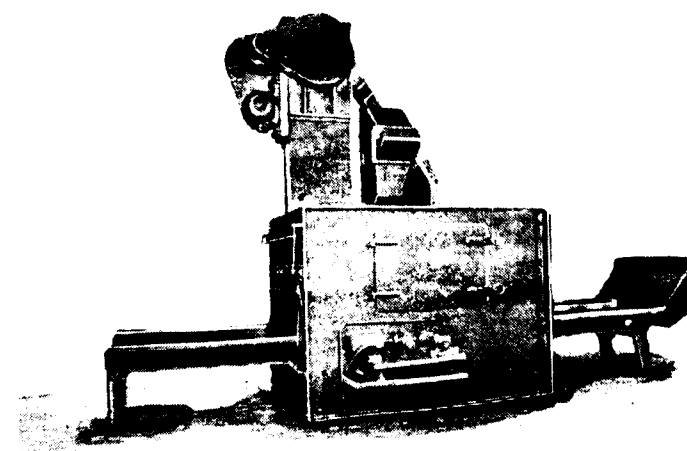


Fig. 4.

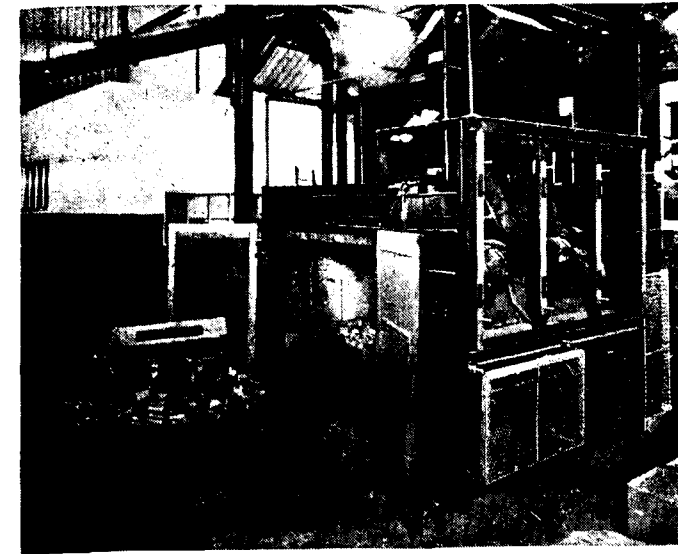


Fig. 5.

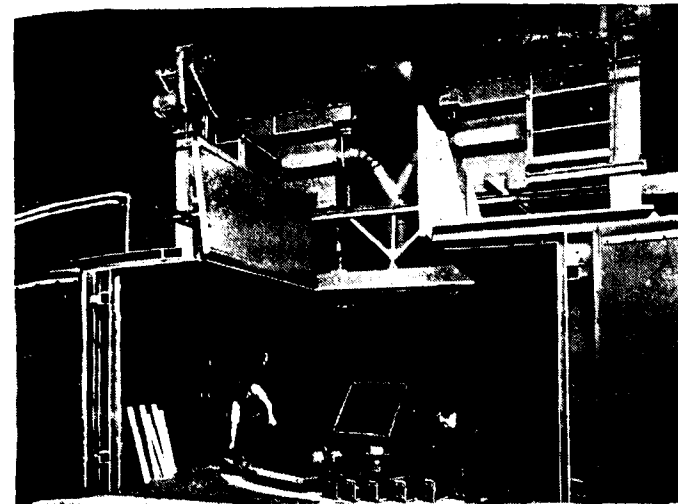


Fig. 6.

a work chamber with rise and fall, or swing door, fitted with sight screen and armholes. The pressure apparatus containing the abrasive, under static pressure of from 10 to 100 lbs. per square inch is suspended from a small hopper below the perforated floor of the work chamber. At the base of the pressure vessel is a control valve regulating the flow of abrasive to mixing pipe or Venturi where compressed air, creates a flow in which the abrasive is entrained and which is carried through heavily protected flexible hose to the nozzle held in the hand of the operator.

Where the size or weight of the article to be blasted is too great for this simple Cabinet (Fig. 2) type of Plant the same principles are embodied Blast Rooms but in such cases the operator must enter the Room, wearing

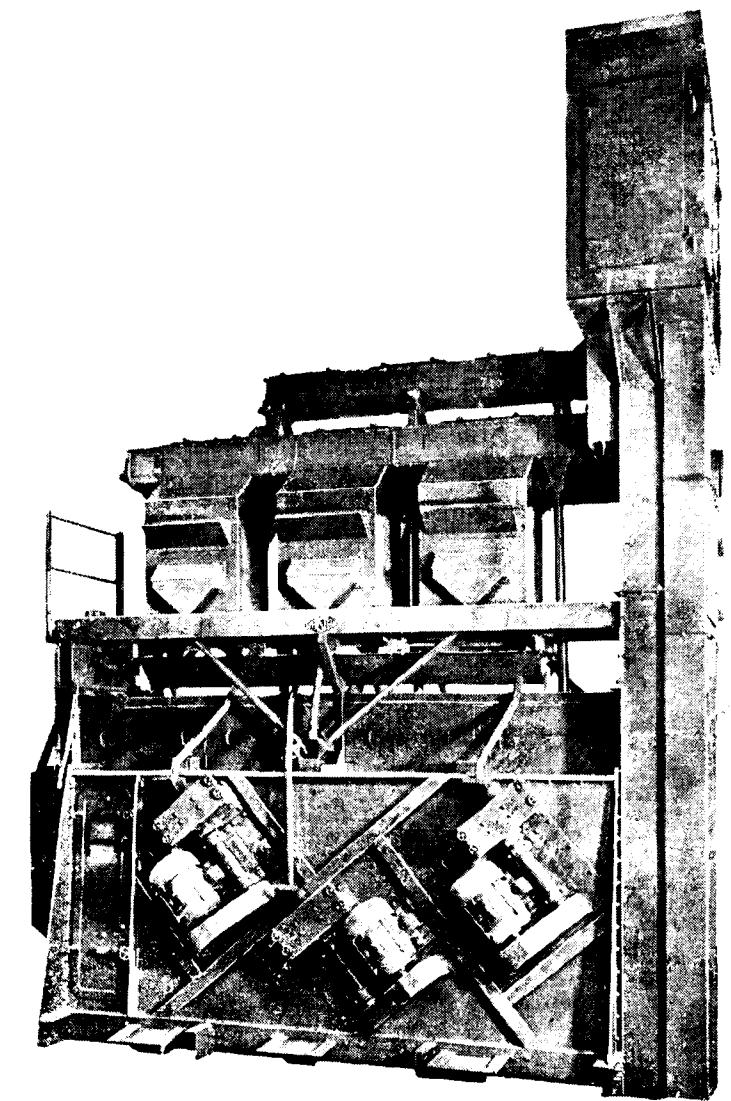


Fig. 7.

protective clothing and an air supplied helmet. Rooms of this type may vary in size from $6' \times 6' \times 8'$ high up to $50' \times 25' \times 12'$ high or in fact any size to accommodate the work involved. In the smaller sizes the used abrasive (as in the Cabinet type Plant) is returned to the pressure vessel by gravity via a pressure operated filling valve whilst larger installations embody mechanised abrasive circulating systems normally provided with means for classifying the mixture of abrasive, sand, pulverised scale and dust into re-useable and waste products.

From the smallest Hand Cabinet with work chamber measuring $2' \times 2' \times 2'$ high to the largest Room Plant the variety of work which may be cleaned is enormous and includes the descaling after heat treatment of tools, gears, pinions, drills, splined shafts, preparation of bearing housings for white metalling, cleaning of castings, cleaning of welds, removal of rust and scale from forgings and



fabrications, preparation of surfaces for welding and soldering, etc., up to the cleaning of complete Railway Coaches, Wagons and Locomotives.

In the Airless range of plant there is a wide variety of machines covering general purposes and special applications. Again on the note of versatility the small 36" dia. $\times$ 42" long Rotary Barrel (Fig. 3) is an excellent example. This machine will clean up to 1 ton per hour

of castings, forgings, or fabrications, of an individual weight up to 30 to 40 lbs. The work is tumbled in the slowly rotating barrel whilst the abrasive is projected onto and into the surfaces and cavities by the high speed impeller. Abrasive, sand and scale are separated and reusable abrasive recirculated through the impeller until it is of no further value.

When the work is too delicate to withstand even the gentle tumbling action of a Barrel the small Twin Table Cabinet (Fig. 4) may be used. In this machine the work to be cleaned is loaded onto one of the two turntables which then enters the blast chamber where it rotates, so turning all exposed surfaces towards the blast stream. Meanwhile a second turntable is loaded and in its turn replaces the first table which by this time bears a load of clean work. A feature of this machine is its continuity since tables may be changed over without stopping the impeller.

Larger work of a general character whether castings, fabrications or forgings may be handled in one or other of the range of Airless Room Plants. In the smaller sizes the work enters the Blast Chamber on a bogie fitted with power rotated turntable top (Fig. 5) whilst in larger installations the floor of the Blast Chamber rotates, work entering on a bogie of suitable design or through doors in the roof of the chamber where an overhead crane is available. (Fig. 6).

Work of a repetitive nature such as Rail Chairs, Brake Blocks, Cylinder Blocks and many similar castings of interest to Railway Engineers may be cleaned in the Monorail Conveyor type of Plant indicated by (Fig. 7) which may form a link in the castings Cooling Conveyor of a Mechanised Foundry.

Whether the product is "special" or "standardised" Blast Cleaning Equipment is available, backed by a wealth of experience and in every application it can be truthfully asserted that no more efficient or economical means exists for the production of the desired result.

FOREIGN LOAN FOR DEVELOPMENT OF INDIAN RAILWAYS

The World Bank have expressed their willingness to consider an initial loan in support of the Indian railway investment programme, said Shri T. T. Krishnamachari, Minister for Finance, in a written reply to a question by Moulana M. Faruqi in the Rajya Sabha last month.

Asked whether Government had recently sent a delegation to the United States of America for discussions with the world Bank for obtaining loan for the Indian railways for their development programme, the Minister replied in the affirmative, adding that the delegation concluded the discussions.