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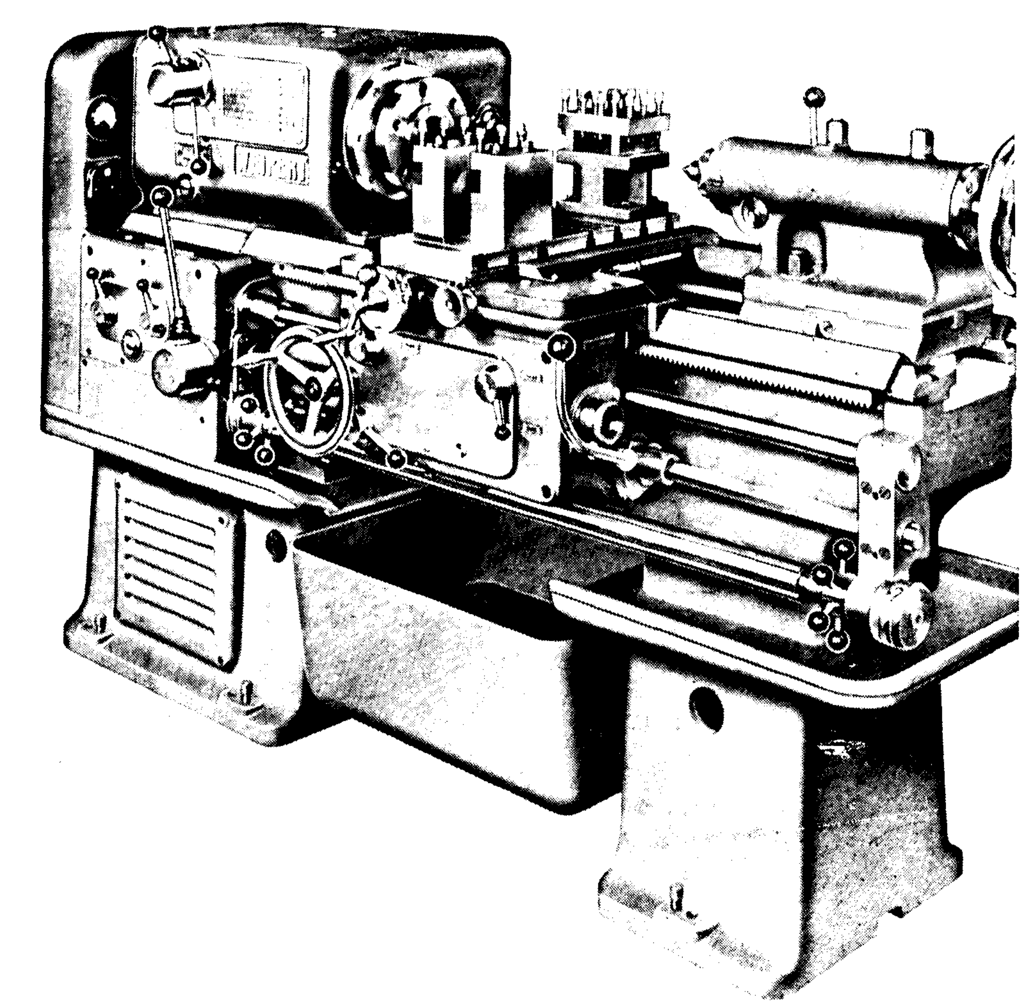

THE INDIAN RAILWAY ENGINEER

(A Quarterly Journal devoted to Railway Matters of technical interest)

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MACHINE AGE

WE belong to an era of "Machines" and "Mechanisation" yet we are vascillating. Should we rationalise or not? An uproar has been raised over rationalised production in Textile Industry, in the Press and Parliament, disillusioning the public. Shri T. T. K. is a nationalist to the core. Chintamani Deshmukh is an illustrious economist. Pandit Nehru is an illustrious 'Jawahar'. To convince him is no easy task. The decision of the Central Cabinet to 'rationalise' textile industries cannot be easily unpatriotic. What has been the secret of advancement of United Kingdom in the early half of this century. Alfred Herbert, Churchill and other illustrious machine tool manufacturers alone brought wealth pouring into the country. They flourished on exports. With home market alone, England would not have gained leadership in Europe.

Recall the great upheaval in our own land. Recently we have outwitted Japan in our export programme of textiles. Products of B. & C. Mills of Madras, Binny's of Bangalore are sought for, from Delhi to far off Indonesia. Handloom fabrics may suffice for home needs. But if we are to be sustained only export is the answer. Can we compete if production costs are not kept low and quality of a superior standard. The assurance that modern techniques would not oust out a worker is easily understandable? The output will increase to cater for enlarged markets which can be caught only on "Price" and "Quality" basis in the teeth of cut-throat competition.

We are on the threshold of "making" or "marring" ourselves. Let us not kill the goose that lays the golden egg. Let us produce more and more machines, machinery, plant and equipment. Let us not depend on imports for these essential production implements. Of what use is a worker without his tool. Let us concentrate to make ourselves self-sufficient to equip our factories with machines and tools. Proper planning is essential. The dispersal of our talent broods no good, if not evil. To have a Machine Tool Company in Bangalore, next door to Harihar where the Kirloskars developed long ago a modern factory is not in general interests. Let not the Military develop in its own way, blind to other developments, their own machine tool factory in Bombay.

Manufacture of Machine tools is an industry by itself. This must be as Steel Works the responsibility of the Production wing. Only then can rationalisation be on a planned basis. The Planning Commission has a great duty to perform. It should set its thoughts to re-organisation of a "rationalised" secretariat. The production department of the Government of India should be under the control of intelligent economists, industrialists and not seasoned diplomats only. Except manufacture of oil engines, in other spheres we have yet to produce giant firms of the type of Alfred Herberts, Associated British Machine Tool Makers, Churchill

(Continued on page 82)

The Most Suitable Type of Signalling and Interlocking for Main Line Sections

By L. C. Mohindra, *M. I. R. S. E. (Eng.), F. P. W. Inst. (Eng.), A. M. I. E. E. (London).*

Assistant Chief Controller of Standardization, Central Standards Office for Railways, New Delhi.

(Continued from January issue)

(B) CONVENIENCE OF SHUNTING

The provision of a cabin at each end of a yard is very convenient especially where considerable shunting has to be performed over the facing points. In multiple aspect signalling, the practice followed in India so far has been to operate all points and signals from a central cabin situated near the station master's office. This system has been found generally satisfactory at road-side stations where shunting is not frequent. Where, however, considerable shunting is to be performed, difficulties in the prompt working of points are bound to arise, as the cabin is far away from the facing points. These difficulties have not been felt quite acutely on the Indian Railways so far, as double wire signalling has mostly been installed on metre gauge sections, where the length of train loads has not been great.

* On the broad gauge sections and even on metre gauge sections when the train loads are made longer in accordance with Board's recent directive, the working of points from a central frame is likely to cause difficulties and even if supplemented by the provision of telephones between the facing points and the central cabin, the working may not be equally satisfactory. At stations provided with two cabins, one at each end of the yard, shunting can be performed with considerable ease, promptness and efficiency, and this system has given entire satisfaction on railways, irrespective of the length of loops.

(C) ECONOMY IN OPERATING STAFF

In the signalling installations of two cabins, one leverman has to be posted at each cabin. Thus there are six levermen required for each station assuming eight hours shifts. In signalling installation of a central cabin, however, only one leverman is required in each shift, and due to his being close to the station he can be utilized for other odd jobs also, e. g. obtaining and delivering of tokens. Thus one man in each shift of duty, i. e. three levermen will be saved, equivalent to nearly † Rs. 3,500 annually in the operating recurring expenditure. This would justify a capital expenditure

† SCALE OF PAY OF LEVERMAN

Rs. 35-1-50 P. M.

Pay	..	$\frac{35+50}{2}$	= Rs. 42 8 0		
DA	..		= ,, 45 0 0	Saving in recurring operating expenditure by reducing 3 levermen.	
Leave Salary	..	$\frac{\text{Pay}+\text{DA}}{20}$			
		$= \frac{42\frac{1}{2}+45}{20}$	= ,, 4 6 0	= Rs. 1,168-8-0×3	
				= Rs. 3,505-8-0	
Gratuity	..	$\frac{\text{Pay}+\text{L.S.}}{24}$	= ,, 1 15 0		
P.I. Fund	..	Pay/12	= ,, 3 9 0		
Total cost per month			= ,, 97 6 0		
Total cost per year			= ,, 1,168 8 0		

* *Railway Board's letter No. 7477-W, dated 13th October 1952 lays down that on the broad gauge the length of goods loops should be 2,450 feet suitable for 80 wagons, and on the metre gauge it should be 2,250 feet suitable for 80 wagons.*

of over Rs. 35,000, reckoning a yield of over 5 per cent after allowing the maintenance expenditure and depreciation costs. The advantage of economy in the operating staff is, therefore, rightly claimed by Signal Engineers in favour of double wire signalling, which is of great importance particularly with the rising wages of the staff.

Where, however, there are level crossing gates near the facing points, two cabin signalling is better, as it may then be possible, in most cases, to have those gates operated, by the provision of lifting barriers by cabinmen themselves, thus saving gate-keepers. Therefore, the economy in operating expenditure, sometimes claimed with the provision of central cabin, does not really accrue for stations where there are level crossing gates at the end of a yard.

5. REVIEW AND UTILITY OF VARIOUS SYSTEMS

While reviewing the merits and demerits of single and double wire, two aspect and multiple aspect two cabin and central cabin, mechanical and power operated signalling schemes, it may be stated that all the systems have their good points and limitations and these are briefly as under—

(i) *Single wire system:—*

Quite suitable where points and signals are not situated at long distances.

(ii) *Double wire system:—*

Provides an efficient method of operating signals at distances and points as well to certain limits, specially central cabin.

(iii) *Two Aspect Signalling:—*

Quite suitable where speeds of trains are not very high.

(iv) *Multiple Aspect Signalling:—*

Suitable for high speed traffic.

(v) *Central Cabin:—*

Provides economies in operating staff, provided there are no level crossing gates near the points.

(vi) *Two cabin:—*

Very suitable where considerable shunting is to be performed at the facing points and for ensuring complete arrival of train.

(vii) *Power Signalling:—*

Most efficient and modern method of signalling, but is very expensive.

In conclusion, the following comments are offered for the common possible combinations of the systems of signalling with the mode of their operation:—

(a) *Power signalling:*—Power signalling when combined with continuous track circuiting between stations is most suitable, but is highly expensive.

(b) *Two aspect, two babin schemes:*—Quite suitable except on sections where speeds are high.

(c) *Double wire with Central Cabin Operation:*—Quite suitable for M. G. Sections. It is possible to effect economy in operating expenditure by its installation. For B. G. Sections with long loads and on B. G. and M. G. Sections where shunting over points is frequent or there are level crossing gates near the facing points it would not result in similar economies it the operating staff.

* (d) *Multiple aspect signalling with two cabin scheme:*—It is the most suitable system of signalling for high as well as low speed sections. It is also convenient for shunting and ensuring complete arrival of trains on busy sections.

6. PRESENT SYSTEMS OF SIGNALLING AND THEIR COMPARATIVE ESTIMATES

The systems of signalling and interlocking as now generally existing on main line sections in India are as under:—

1. Two aspect, Two cabin, Standard III Signalling; and;
2. Multiple aspect, Central cabin, Standard III Signalling.

* *Such a system of signalling does not exist at present at any station on Indian Railways. In fact, on sections where multiple aspect signalling has been provided, large stations have been left alone and continued to be worked under two aspect signalling with a cabin at each end of the yard. This is not a good practice, as complete sections should have uniform system of signalling.*

Estimates for the above have been prepared and the costs are shown below:—

	Two aspect single wire, two cabin station	Multi-aspect Double Wire, Central Cabin
1. Two line station Standard III Signalling (Single line).	** Rs. 90,600	*@Rs. 84,600
2. Three line station Standard III Signalling (Single line.	** Rs. 1,15,000	@Rs. 1,08,300

From the above, it would be observed that for Standard III signalling installations, the installation costs of the following two systems of Signalling are nearly the same:—

(a) two aspect, single wire two cabin working, and

(b) multiple aspect, double wire, central cabin.

7. DETAILS OF MULTIPLE ASPECT, TWO CABIN SIGNALLING SCHEME

The question of selecting a system of signalling most suitable for Indian conditions, has been under examination for some time; and my study of the subject has revealed that neither of the systems as it is described in the last paragraph, can be said to be entirely fulfilling all the needs of the present-day requirements of higher speeds and longer loads. Therefore a system embodying good points of both has been evolved. The main features of this scheme are as under:—

(1) *Station Master's control:*—The Station Master is provided with a slide control frame to control the reception and last stop signals. The arrangements similar to those existing at two aspect, Standard III Signalling installations have been retained.

(2) (a) *Operation of Points and Signals:*—The points will be operated by rodding from cabins, as under two aspect signalling.

(b) *Signals:*— (i) *Warners and main Line Home Signals*—These signals will be three aspect, operated electrically by the provision of three position, upper quadrant signal machines. ‡ It has been so arranged that they will work automatically when the conditions for taking them "off" to 'Attention' or 'Clear' are complied with as under—

WARNER SIGNALS

Attention	.. 45°	Requires	Loop Home Signal 'off' (Caution).
† Clear	.. 90°	„	Main Home Signal 'off' (caution).

MAIN HOME SIGNALS

Caution	.. 45°	Requires	Points set and locked for main line.
Clear	.. 90°	„	Points set and locked for main line and Main line Starter 'off' (Clear).

In the above arrangement the driver would know from the position of the Warner Signal whether he is to be received on the main line or on the loop line.

The signals will work from local batteries of about 12 volts.

** *Includes the cost of two signal machines for Distant Signals as these signals at such distances are not considered to work satisfactorily by single wire.*

@ *Includes the cost of:—*

(1) *Telephones at each end of the yard with the station, and*

(2) *Provision of arm repeaters to repeat the Distant Signals in cabins.*

* *The system provides for bracketted Home Signals. Where single armed Home Signal is provided, estimated cost would be approximately Rs. 78,000.*

‡ *The signal has been arranged to work automatic for the sake of simplicity. If desired otherwise, it can be operated from the cabin lever.*

† *This is assuming that full braking distance exists between the home signal and the relevant starter.*

(ii) *Loop Home Signals and Loop Starters :—*

These signals need only display two aspects in the upper quadrant worked by single wire from the existing lever frame.

Loop Home Signals when off will show—Caution (45° in the upper quadrant).

Starter Signals when off will show—Clear (90° in the upper quadrant).

(iii) *Inter-slotting between cabins on reception signals :—*

This will be arranged electrically in the same way as for two aspect signalling at Standard III signalling installations.

(3) *Estimated cost :—*

(a) *New Installations :—*

The estimated cost for a new installation is approximately Rs. 91,200/- for a two line station and Rs. 1,16,400/- for a three line station. (Single line) ‡ A plan of a typical layout for a two line station for a new job is at Appendix 'A' and its estimate at Appendix 'B'.

(b) *Cost of alteration from two aspect to multi-aspect signalling :—*

The cost involved is approximately Rs. 25,700/- assuming that the station master's electric control over signals and electric inter-slotting between cabins already exist. It will be observed that the cost is surprisingly low. This is so because for the conversion involved, the points will continue to be operated by rodding from the existing cabins. The only major change is the provision of signal machines on warner and main Home signals to operate signal arms in the upper quadrant in three positions. The other work of converting the loop Home signals and starters from Lower Quadrant two aspect to Upper Quadrant two aspect is simple and would not cost much.

Where the station master's control is at present by key transmitters, the cost of converting a station to Upper Quadrant signalling including the provision of station master's electric control will be approximately Rs. 32,000/-.

A plan of a typical layout for a two line station along with an estimate showing conversion from two to multi-aspect are attached as Appendix 'D' and 'E'.

8. OTHER IDEAL REQUIREMENTS OF MULTIPLE ASPECT SIGNALLING

While evolving the system of signalling described in Paragraph 7 above, the following objectives have also been provided for :—

§ (i) To keep the *initial* cost as low as possible, comparable with the two aspect signalling.

* (ii) To keep the cost of conversion from two aspect signalling to multiple aspect signalling as low as possible.

† (iii) To provide a direct control of the station master over all the reception signals as well as the last stop signals, enabling him to put back signals himself in case of emergency.

(iv) To provide suitable inter-slotting between the two cabins.

(v) To keep the system of signalling as simple as possible for installation and maintenance.

(vi) To design the signalling on progressive lines, yet avoiding excessive use of batteries which are expensive. Power in the country is generally not available at road side stations.

(vii) To retain the existing cabins and lever frames where existing.

(viii) To utilise the existing signals.

*(ix) To hold the route under station master's control.

**(x) To retain the route signalling principles.

‡ A statement showing the average annual cost of service for this system of signalling as also for the other two types detailed in paragraph 6, for a two line station, is attached as appendix 'C'.

§ This is comparable with the cost of other type of signalling detailed in paragraph 6.

** For providing multiple aspect, upper quadrant, double wire signalling to replace two aspect, two cabin signalling, according to the existing system of signalling in force, the entire gear of two aspect signalling has to be replaced.*

† In the present multiple aspect, double wire, Central Cabin scheme, the Station Master has a control over the signals by means of interlocking keys but the Station Master cannot replace the signals to danger himself in case of emergency.

9. REAL NEED OF EARLY PROVISION OF MULTIPLE ASPECT, TWO CABIN SIGNALLING

As stated in the beginning, according to the draft of the General Rules, under two aspect signalling, on sections where the speeds are in excess of 30 m. p. h. the existing Warner Signals are to be removed and Distant Signals have to be provided instead, in rear of the first stop signals, located not less than a quarter of a mile. For stations, where outer warner combination now exists, the Distant Signals will thus have to be shifted out. The working of the Distant Signals so far away by means of single wire is not likely to be entirely satisfactory and provision of electric signal machines on these signals will be a necessity at most of these stations. The cost involved for these modifications will be approximately Rs. 19,400/- per station.

The above rule has to be applied to all stations where speeds are to be in excess of 30 m. p. h., but for sections where the speeds are already in excess of 60 m. p. h. the work has to be given a high priority, particularly for reducing the 'start to stop' timings on the major trunk routes, as per Railway Board's directive.

To comply with the requirements of Draft General Rules, which no doubt aim at improved working, the question is whether to :—

1. Provide the Distant Signals in rear of the first Stop Signals and still to retain two aspect signalling with its inherent unsuitability for high speed traffic; or

2. Convert the existing two aspect signalling to multiple aspect, two cabin scheme, thus providing a system suitable for high speed traffic, in line with the trends of progressive countries.

10. CONCLUSION

Taking into consideration the superiority of multiple aspect signalling for high speed traffic and suitability of two cabin working for ensuring complete arrival of a train, shunting and possibility of operating level crossing gates from the cabins, MULTIPLE ASPECT, TWO CABIN SIGNALLING SCHEME is considered more suitable than :—

(i) Two aspect, two cabin signalling, or

(ii) Multiple aspect, central cabin signalling.

for busy sections where maximum permissible speeds are high, train loads are long and shunting at the points frequent.

11. RECOMMENDATIONS

It is recommended that :—

(1) Multiple aspects, two cabin signalling may be provided at road side stations on the main trunk routes in the future signalling installations; and

(2) On the main trunk routes where the existing signalling arrangements have to be modified to permit higher maximum permissible speeds, in compliance with the draft General rules, Multiple Aspects, two cabin signalling be provided on a programmed basis,

in preference to the installations of distant signals, located in rear of the first stop signal, operated under two aspect signalling.

** Under two aspect signalling, at a majority of Standard III Signalling installations, route can be altered by the cabin man by throwing the signals to danger. This is considered to be a weakness of the system and has resulted in several accidents.*

*** In the Multiple aspect signalling of the type existing on Southern and North-Eastern Railways, the home signal does not indicate the route.*

Appendix 'B'

Abstract Estimate for providing Upper Quadrant,
2 cabin Standard III Signalling at a typical
2 line station with one siding off the loop.

Sl. No.	Description	Quantity	Rate @ Rs.	Rate per	Cost Cash Rs.	Cost Store Rs.	Cost Total Rs.
1	Cabin buildings to accommodate 22 lever frames ..	†2	5,400	Each	7,200	3,600	10,800
2	Interlocking lever frames 12 levers ..	2	275	Lever	..	6,600	6,600
3	Miscellaneous cabin fittings such as clock, cabin lamp, glazed frames, stools etc., ..	Lot	L. S.	..	..	640	640
4	Signals 2 armed bracketted	* 2	2,200	Each	..	4,400	4,400
5	Signals warner	* 2	1,100	„	..	2,200	2,200
6	Signals starter	4	1,000	„	..	4,000	4,000
7	Signal roundels	24	L. S.	..	..	288	288
8	Signal lamps	12	75	Each	..	900	900
9	Signal transmission including detectors ..	* 6	215	„	..	1,290	1,290
10	Facing point bolt locks & covers	4	95	„	..	380	380
11	Facing point bolt, Economical Lock and covers ..	1	225	Each	..	225	225
12	Lock bars and equipment	5 Sets	260	Set	..	1,300	1,300
13	Rodding	2,260 ft.	1-2-0	per ft.	..	2,540	2,540
14	Cranks and compensators	34	30 67	Crank Comp.	..	1,310	1,310
15	Rollers and foundations	Lot	L. S.	..	..	2,135	2,135
16	Joints, lugs and adjusting screws	Lot	„	..	..	1,032	1,032
17	Bolts and Nuts, split pins and rivets	„	„	..	..	350	350
18	Cement concrete	„	„	..	..	350	350
19	Consumable stores	„	„	..	..	200	200
20	Painting	„	„	..	..	200	200
21	Tools and plants	„	„	..	..	250	250
22	Labour for erection at site	„	„	..	4,500	4,500	4,500
	ELECTRICAL PORTION						
23	SM's slide control frame 12 slides	1	100	Slide	..	1,200	1,200
24	Reverser style 'A'	6	245	Each	..	1,470	1,470
25	Electric signal machines	4	2,400	„	..	9,600	9,600
26	Electric detectors	3	400	„	..	1,200	1,200
27	Electric slot indicators	10	110	„	..	1,100	1,100
28	Arm and light repeaters	4	180	„	..	720	720
29	Pyroscope	4	70	„	..	280	280
30	Electric key transmitter locks	2	200	„	..	400	400
31	Lever contact boxes	12	110	„	..	1,320	1,320
	Carried over	..	..	..	11,700	51,480	63,180

† *Complete with lever locks on two levers.*

* *Main Homes and Warner Signals will be provided with electric Signal machines.*

Appendix 'B' continued.

Sl. No.	Description	Quantity	Rate @ Rs.	Rate per	Cost Cash Rs.	Cost Store Rs.	Cost Total Rs.
	B. F.				11,700	51,480	63,180
32	Arm contact boxes	6	111	„	..	660	660
33	Relays ordinary	6	25	„	..	150	150
34	* Relays line 1,000 W	4	275	„	..	1,100	1,100
35	Bells ordinary	6	25	Each	..	150	150
36	Magneto telephone	3	190	„	..	570	570
37	Extension bells and 2 way switches	3 sets	60	„	..	180	180
38	Cells, caustic soda for electric signal machines and Arm repeater circuits	52 cells	36	„	..	1,872	1,872
39	Cells, dry	15	3	..	..	45	45
40	Battery cup board	5	200	..	..	1,000	1,000
41	Overhead lines using iron wire for all circuits up to home signals and copper wire between home and warner signals	Lot	L. S.	..	..	5,218	5,218
42	Junction Boxes and earths	„	„	..	..	375	375
43	Wiring materials	„	„	..	..	1,847	1,847
44	Bolts, nuts, flats, &c., ...	„	„	..	..	100	100
45	Miscellaneous and consumables	„	„	..	..	100	100
46	Painting	„	„	..	..	50	50
47	Tools and Plant	„	„	..	..	150	150
48	Labour for erection at site	„	„	..	2,200	..	2,200
49	Freight charges on stores i. e. Rs. 65,047 ..	..	..	..	3,903	..	3,903
50	Carriage charges	..	L. S.	..	500	..	500
51	Supervision and Establishment charges ..	..	„	..	3,500	..	3,500
	For 2½ months { 1 Signal Inspector; 1 Block Inspector; 2 Clerks; 8 Trollymen }						
					21,803	65,047	86,850
52	Contingencies at 5 per cent on				1,090	3,252	4,342
	Cash 21,803 Stores 65,047 Total 86,850						
	Grand Total				22,893	68,299	91,192

* *For electric Signal machines.*

Appendix 'C'

* See detail at 'A'
** See detail at 'B'
@ See detail at 'C'

Economics of Signalling Layouts for a Two Line Station, Standard III Installations

Serial No.	Type of layout	Number of Signals	Cost of Installation	Annual cost of service of new installation: Operation	Maintenance and Repairs	Sinking Fund	Interest at $3\frac{1}{2}\%$	Total annual average cost of services
				Rs.	Rs.	Rs.	Rs.	Rs.
1	Two Aspect, Lower Quadrant, 2-Cabin. (Single wire Frame).	Distance —2, Outers —2, Homes 2, Doll —2, Starters —4 = 12	90,600	** 7,011 (6 levermen)	** 1,380	@ 2,519 (i) *+(ii)	3,171	14,081
2. (i)	Multi-aspect, Upper Quadrant, Central Cabin (Double Wire) No gate at either end of yard.	Warners —2, Homes, 2 Doll —2, Starters —4 = 10	84,600	* 3,506 (3 levermen)	** 1,140	@ 2,354 (i) +(iii)	2,961	9,961
2. (ii)	Multi-aspect, Upper Quadrant, Central Cabin (Double Wire) one level crossing gate at each end of the yard.	Ditto = 10	84,600	* 9,293 (3 levermen and 6 Gatemen)	** 1,140	@ 2,354	2,961	15,748
3	Multi-aspect, Upper Quadrant 2 Cabins (Single wire frame).	Ditto = 10	91,200	** 7,011 (6 levermen)	* 1,380	@ 2,535 (i) +(iv)	3,192	14,118

'A' Details of Operating Charges

	(i) Levermen	(ii) Gateman
	Rs. a. p.	Rs. a. p.
Scale	Rs. 35-1-50	Rs. 30-1-35
Average pay $\left(=\frac{\text{Max}+\text{Min.}}{2}\right)$	42 8 0	32 8 0
Dearness Allowance	45 0 0	40 0 0
Leave Salary $\left(=\frac{\text{Pay}+\text{DA}}{20}\right)$	4 6 0	3 10 0
Gratuity $\left(=\frac{\text{Pay}+\text{LS}}{24}\right)$	1 15 0	1 9 0
P.I. Fund	3 9 0	2 11 0
Total expenditure P. M. pay for 1 man.	97 6 0	80 6 0
Total expenditure P. A.	1,168 8 0	964 8 0
Total expenditure for 3 men P. A.	3,505 8 0	2,893 8 0
Total expenditure for 6 men P. A.	7,011 0 0	5,787 0 0

'B' Details of Maintenance and Repairing costs

Average maintenance cost per lever P. A. Rs. 60

(i) Total number of working levers at single wire installation. = 23 levers

Total maintenance cost = 23 × 60 = Rs. 1,380

(ii) Total No. of levers at M. A. U. Q. installation with central cabin. = 19 levers

Total maintenance cost = 19 × 60 = Rs. 1,140 %

(iii) Total number of levers at M. A. U. Q. 2 cabin installation with distant signals and Main Home Signals working by electrical signal machines. = 19+4 = 23

Total maintenance cost = 23 × 60 = Rs. 1,380

% Additional levers allowed for signals, operated without lever by Electric signal machine. This amply covers renewals of battery elements.

'C' Details of Sinking Funds

Life	Capital cost	Rate at 3% of the table	Amount
	Rs.		Rs.
(i) Telephone apparatus 13	1,000	.0640	64
(ii) Signal 25 and Interlocking	89,600	.0274	2,455
(iii) Signal 25 and Interlocking	83,600	.0274	2,290
(iv) Signal 25 and Interlocking	90,200	.0274	2,471

N. B.—1. From the above it will be observed that the annual average cost of service of the following two types of signalling is nearly equal—

(i) Two aspect, lower quadrant, two cabin signalling, and

(ii) Multiple aspect, upper quadrant, two cabin signalling.

Both these systems of signalling are capable of operating level crossing gate situated close to the cabin, thus eliminating the necessity of appointing separate gatemen. From the financial angle, therefore, both the systems should be equally acceptable.

2. The annual average cost of service for multiple aspect, upper quadrant, central cabin signalling is lower than the other two systems of signalling detailed under items 1 and 3 above. Where, however, there are level crossing gates at one or both ends of the yard, the annual cost of service is more than taken up by the appointment of gatemen. On busy sections, therefore, where there are level crossing gates at present existing near the facing points or are likely to be required in the near future to meet the growing requirements of public, either of the two systems of signalling, viz., detailed under item 1 or 3 above, is more economical.

Again, from the operating and traffic points of view, the system of signalling described against item 3 above is superior to that shown against item 1. The system, therefore, which may be considered the most suitable from the operating, the traffic and the financial points of view is the one described under item 3.

Appendix 'E'

Estimate for Signalling and Interlocking Layout Standard III

For conversion of Two Aspect Lower Quadrant to Multiaspect Upper Quadrant Signalling

Sl. No.	Description	Quantity	Rate @ Rs.	Rate per	Cost Cash Rs.	Cost Store Rs.	Cost Total Rs.
1	Electric signal machine	4	2,400	Each	..	9,600	9,600
2	Electric detectors	2	400	,,	..	800	800
3	Electric key transmitters	2	200	,,	..	400	400
4	Lever locks (Mechanical)	2	50	,,	..	100	100
5	Batteries, Soda, Caustic	36	36	,,	..	1,196	1,196
6	Housing for above	4	200	,,	..	800	800
7	Line Relay 1,000 w	4	275	,,	..	1,100	1,100
8	Signal fittings upper Quadrant	6	300	,,	..	1,800	1,800
9	Arm and Light repeaters and fittings	4	350	,,	..	1,400	1,400
10	Earth plate	6	16	,,	..	96	96
11	Cable VIR 1/.044	12 coils	14	,,	..	168	168
12	G.I. Wire No. 8 SWG	1 cwt.	45	per cwt.	..	45	45
13	G.I. Wire No. 12 SWG	8 cwt.	45	,,	..	360	360
14	Copper wire 200 lbs./Mile	5,000 Yds.	0-4-0	per Yd.	..	1,250	1,250
15	Solder Soft	L. S.	..	..	..	20	20
16	Rail Post 24′	8	1	Per ft.	..	192	192
17	Rail Post 30′	4	1	,,	..	120	120
18	Stay Rods	4	20	Each	..	80	80
19	Brackets 6 line	12	6-8-0	,,	..	78	78
20	Clamps for above	16	2-12-0	,,	..	44	44
21	Insulator porcelain	66	1-8-0	,,	..	99	99
22	Stalks for above	66	1	,,	..	66	66
23	Shackles porcelain	16	2-12-0	,,	..	44	44
24	G.I. pipe ¾″ bore	300 ft.	1-8-0	,,	..	300	300
25	Bends for above	10	0-8-0	,,	..	15	15
26	Sockets for above	10	..	,,	..	5	5
27	White lead	L. S.	..	..	..	5	5
28	Coal, Bengal	,,	..	..	..	5	5
29	Alteration to miniature frame	,,	..	..	..	100	100
30	Alteration to lever frame	,,	..	..	..	100	100
31	Petty stores	,,	..	..	..	100	100
32	Labour charges	,,	..	..	1,800	..	1,800
	Total	..	..	..	1,800	20,488	22,288
33	Freight charge 60 per cent on Rs. 20,488	Store	..	..	1,229	..	1,229
	Total	..	..	..	3,029	20,488	23,517
34	Supervision charges	..	..	..	1,000	..	1,000
	Total	..	..	..	4,029	20,488	24,517
35	Contingencies at 5 per cent on Cash—4,029, Store—20,488 Total—24,517	..	..	..	201	1,024	1,225
	Total	..	..	..	4,230	21,512	25,742

Commonwealth Conference on Electrical Cable Standards

By E. D. Johnson, Production Director, The Indian Cable Co. Ltd.

DURING recent years National Standards Organizations have been set up in almost all countries where engineering products are made and used, and there has tended to develop in these countries the formulating and publishing of national standards that differ, either largely or only in detail, from those of other countries. The tendency has been for the engineers and standards authorities of each country to adopt standards that are considered to be especially suitable for their own particular country and for the climatic conditions appertaining thereto.

Of the countries throughout the Commonwealth, with the exception of Canada where different voltages are employed, the national standard specifications for the different types of electrical cables were considered to be sufficiently closely related to make Commonwealth Standards possible. Such standards are very desirable because electrical cables now have such a wide range of uses and are connected to such a diversity of equipment that at least common dimensions for the different types of cables would avoid equipment going out of service because of the non-availability of cables of the correct dimensions in any particular country.

The United Kingdom, as the biggest producer of electrical cables, is particularly interested in common standards, but with the further industrial and social development expected in the coming years from the other countries of the Commonwealth, the demand for electrical equipment should steadily increase. Productivity should also increase and countries other than the United Kingdom should find themselves with production standards that exceed domestic demands. Under such circumstances, it is apparent that the avoiding of a multiplication of types and dimensions of cables for the same purpose is very desirable throughout the commonwealth.

THE CONFERENCE

Commonwealth Conference on Cable Standards was held recently in London, in the building of the British Standards Institution, to endeavour to secure a better understanding of the different points of view held in the Commonwealth countries on standards for rubber-insulated, paper-insulated and polyvinyl chloride (PVC)—insulated cables, and to endeavour to make recommendations, for subsequent consideration by the Standards Bodies of the Commonwealth, with the object of securing as much uniformity as possible in the future in the standards for cables.

The countries represented at the Conference were Australia, Ceylon, India, New Zealand, Pakistan, United Kingdom and the Union of South Africa. The Indian delegation consisted of Mr. W. Evans of the National Insulated Cable Co. of India Ltd.; Shri P. S. S. Mudaliar of the Radio and Electrical Manufacturing Co. Ltd.; Mr. C. T. Wright, Chief Electrical Engineer, India Stores Department, London; Shri L. N. Mathur, Senior Inspector of Railways and Dr. S. Krishna, Scientific Liaison Officer of the High commissioner's Office, London; Dr. Lal C. Verman, Director, ISI, and the writer.

To simplify the work of the Conference, working parties had been formed in most of the participating countries and recommendations regarding standards for each particular type of cable had been prepared by such working parties and circulated through the Standards Bodies of the countries concerned.

Before the Conference, and on perusal of the different recommendations, it did not appear that the better understanding which was the aim of the Conference was possible of achievement. The greatest diversity of opinion was in respect of dimensions, especially of rubber-insulated and P. V. C. insulated cables. Uniformity, or at least near-uniformity, of dimensions was the most important agreement sought from the inter-change of views.

In the United Kingdom, and in most of the Commonwealth countries, the thicknesses of insulation on rubber-insulated cables had remained practically unchanged for almost 50 years. Cables are an expensive item of equipment and the British Electrical Authority had approached the British Standards Institution with the suggestion that with the improved techniques of rubber manufacture and the improved standards of purity and fineness in many of the ingredients used in rubber dielectrics, the thicknesses might be reduced without reducing the standards of safety. The costs of such cables could thereby be reduced.

REDUCED CABLE THICKNESSES

After consultation with the manufacturers of the United Kingdom, the British Standards Institution had agreed to reduce thicknesses for rubber-insulated cables. It was also agreed similarly to reduce the thicknesses for PVC-insulated cables; the PVC dielectric had been developed during the war as a necessity, following the loss of plantation rubber, and used with thicknesses in close relation to those previously in use on rubber-insulated cables.

These proposals for reduced thicknesses were an important feature of the Conference, and at one time this appeared to be by far the most controversial issue. The Conference was reported in the daily press and the Manchester Guardian; it was announced that men had come thousands of miles from Commonwealth countries to spend a good part of the coming week sitting round a conference table in Westminster arguing about a few thousandths of an inch.

The issue, however, did not turn out to be so very controversial, and after the first expressions of opinion, it became apparent that a close agreement might be possible. Ultimately, the Conference did agree in principle not only to the desirability of cable standards in Commonwealth countries being as nearly as possible the same but also agreed on common dimensions in almost all cases. In some countries of the Commonwealth, Australia and the Union of South Africa in particular, the standards for cables and flexibles are statutorily enforceable and cables or flexibles which do not conform to national standards cannot be sold or used. This condition means that any new standards, or revisions of the old standards, in such countries cannot be made without full consideration of the statutory implications. If the delegates to the Conference can, on their return to their own countries, convince the Standards Bodies concerned regarding the need for revision of the existing standards, the necessary statutory agreement will be a simple matter.

Sitting around the Conference table one had two vivid impressions. The first was on the statutory enforcement of engineering standards for the maintenance of a high factor of safety for human life and property, and that it has been achieved only in what might be looked upon as

the newly developed countries. In spite of the problems attached to such statutory enforcement, the desirability is very apparent. The second impression was how much easier it appears to be to obtain agreement round a table from a group of international engineers than it is from a group of politicians, international or otherwise.

RUBBER-INSULATED CABLES

Rubber-insulated cables were considered for working voltages up to 11,000 and in ranges as follows:

(1) Not exceeding 400 volts to earth
(2) 660 volts to earth
(3) 3,300 volts between phases
(4) 6,600 volts between phases
(5) 11,000 volts between phases

There were differing views as to the desirability of specifying the composition of the rubber Insulation, and the majority opinion was in favour of relying entirely on physical and electrical test requirements to assess its quality. It was agreed that consideration should also be given to the desirability of specifying two separate grades of rubber insulation for use in temperate climates and in tropical climates, respectively. It is appreciated that tropical conditions cannot be accurately created in the testing laboratories of temperate countries, and that the actual tropical climate itself is the only accurate testing ground for any engineering equipment. The Conference derived considerable interest from the experiences of delegates from tropical and sub-tropical countries.

Testing standards and methods of measurement of thicknesses were recommended. Steps were taken to reach agreement on mathematical formulae for determining rubber and lead-alloy sheath thicknesses. Core identification standards and identification standards for the actual manufacture of the cables were agreed upon.

PAPER-INSULATED CABLES

Paper-insulated cables were considered for 3-phase working voltages up to 33,000 and in ranges as follows:

(1) 1.1 kv (4) 11 kv
(2) 3.3 kv (5) 22 kv
(3) 6.6 kv (6) 33 kv

Core and cable end identification were agreed upon and a special identification for 1.1 kv cable was recommended. Dimensions were agreed upon and, probably for the first time in such a standard, a recommendation was made in regard to an actual specification for the compound used for the impregnation of beddings and servings.

Testing methods and values were agreed upon.

PVC-INSULATED CABLES

PVC-insulated cables were considered for medium voltage only, i. e., not exceeding 400 volts to earth, but with classifications into two grades, general purpose and heavy duty.

There was a reasonably general agreement on both dimensions and composition of PVC. Testing methods and values were recommended as also was core identification.

This being a comparatively new form of cable dielectric, there was a long and interesting discussion and evidence of a greater diversity of both ideas, opinions and experiences than on other dielectrics.

GENERAL

The Conference met for a total of six days with a further meeting a few days later to approve the final report. The chairman throughout was Mr. P. V. Hunter, a cable engineer of both great experience and world renown.

There was a unanimous opinion that the Conference had achieved its objective and that, as a result, the standards for electrical cables in the Commonwealth countries would, in due course, be brought very much more closely in line with one another. It is expected that further conferences of a similar nature will take place in different countries of the Commonwealth from time to time with the object of securing a continuance of the closer agreement and that new cable standards in the Commonwealth countries shall be developed on similar lines to the maximum possible extent. (ISI Bulletin)

"Paramite" Cables in the Delhi Low Cost Housing Exhibition

THE keen attention which the Delhi Exhibition of Low Cost Housing has aroused, is an indication of the Indian public's vital interest in the burning topic of housing. The fact that one of the country's most urgent problems is to house adequately its large and growing population, requires no underlining. For many years enlightened employers have been active in meeting the needs of their workers for houses near the place of their employment, but this has merely touched the fringe of the country's acute need of new dwellings on a vast scale.

The problem is at last being approached at a national level, and it is extremely encouraging to note that, at Delhi, Indian architects have been prominent in devising a range of inexpensive houses of attractive appearance, which should provide a welcome answer to the question of making available cheap and easily constructed homes for the millions.

It is not enough nowadays to provide mere shelter, however, and most of these modern homes afford the essential amenities of tap water, internal sanitation, cooking facilities, fans and electric lights. The Indian public moreover, can note with satisfaction that not only the building materials themselves, but the more complex industrial products involved in providing water, sanitation and light are available from the country's own resources.

In the electric wiring of a house, for example, several hundred yards of cable may be required, and it can be recorded with pleasure that, with few exceptions, the houses on show at the Delhi Exhibition, were wired throughout with Indian-made cables produced by The Indian Cable Co., Ltd., at its Tatanagar factories. This fact is certainly sound testimony to public confidence in the products of a modern Indian industry, which has behind it over thirty years of experience in producing these very cables and wires in tropical

(Continued on page 19)

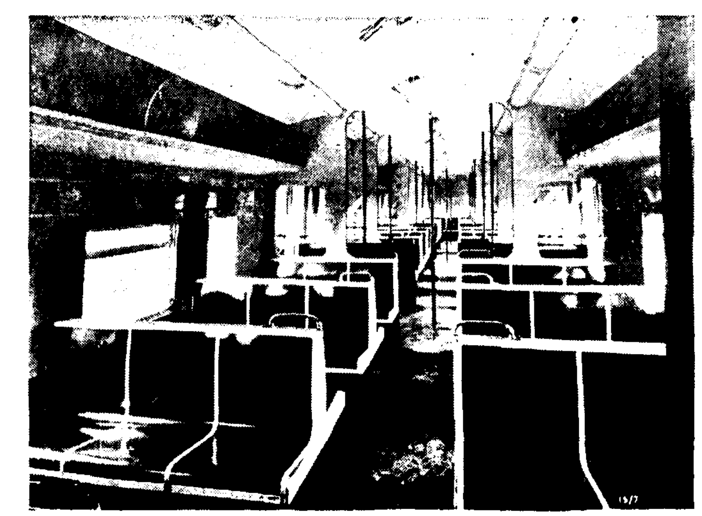
Lightweight Trailer cars for Electric Multiple Unit Stock

DURING 1951 and 1952 twenty eight 4-car rakes of multiple unit stock, built in the United Kingdom, were delivered to the Western and Central Railways and these have, no doubt, been inspected and used by many readers of this journal. It may be of interest, therefore, to your readers to have some technical information regarding their design and manufacture.

A general description of the coaches would appear unnecessary, as the accompanying photographs indicate the appearance of the exterior and interior and the leading dimensions are given below. Before dealing with the problems of design and manufacture which face the builder of lightweight stock, it may be useful to briefly review the origin of the mechanical design, and in this article only the trailer cars will be considered which were supplied by The Birmingham Railway Carriage and Wagon Company Ltd.

The new stock supplements and replaces that built some 24 years ago to inaugurate the electrified suburban services of the Great Indian Penisula Railway and the Bombay Baroda and Central India Railway (the latter then still a Company line). The original stock would today be considered unduly heavy, the motor cars weighing 70 tons and the trailers 53 tons, and, though it has given excellent service under arduous traffic conditions, the Railway Administration and its consultants desired, understandably, to take advantage of present day methods of construction to effect a considerable reduction in tare weight; the replacement stock has a specified weight of 52.½ tons for motor cars and 31.½ tons for trailers, giving a reduction in total weight of the rake from 229 tons to 168 tons, a saving of 26.6%—the existing stock being made up in rakes consisting of a trailer and a motor car between two driving trailers, and the new stock in rakes of two trailers between two motor cars.

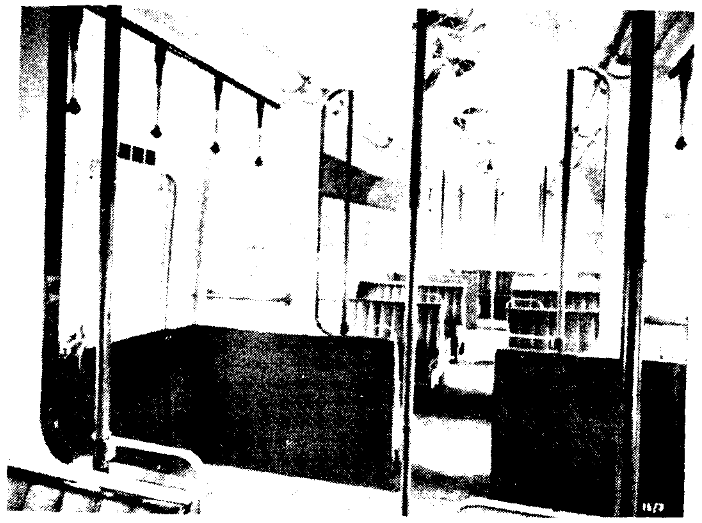
It is obvious that the Railways requirements—trailer stock capable of running at a speed of 65 m. p. h., carrying a dense crush loading of 22 tons with a maximum permitted tare weight of 31.½ tons, and able to resist a head on loading of 100 tons—calls for skill both in design and execution, as it is a pre-requisite that all stressed members be designed to carry their full share of the load and are built together in such a manner as to be capable of so doing. The problem facing the builders of the trailers was rendered slightly more difficult by the fact that the minimum weights to which it was found possible to build the Motor Coaches made it necessary to keep the weight of the Trailer Coaches much lower than the specified figure, so that the tare weight of a rake did not exceed 168 tons. The heavier of the two trailer cars, as shipped to India, weighed 28



Interior view—lower class.

(Continued from page 18)

conditions for service in the arduous climatic extremes of this great sub-continent. Both the prize-winning designs, won by V. J. Mistry for Hot and Humid Climate, and the other by S. P. Caprihan for Hot and Dry Climate were, of course, wired with The Indian Cable Company's well-known "Paramite" brand of rubber-insulated cables. In fact, as far as the provision of lighting for the entire Exhibition is concerned, The Indian Cable Co. Ltd. would appear to have stolen the show. In addition to furnishing the wiring for most of the houses on display, two power units supplying electricity for the Exhibition, all the stalls, the Art Theatre, the Amusement Park, and the Administrative block has "Paramite" cable installations throughout.—An impressive record far a leading Indian Industry specialising in house-wiring, but only a fore-taste of what can be done with India's own resources when once the lessons of this Exhibition are applied, and low-cost homes for the millions begin to spring up throughout the land.



Interior view—upper class.

tons, it being some 35% lighter than trailers of the existing stock.

REDUCTION OF WEIGHT

Generally speaking, rolling stock can be lightened in two ways, assuming that every advantage of integral construction has been taken; the material may be either a high tensile quality steel which permits reduction of the sections or a light alloy which, although its low modulus of elasticity invariably necessitates an increase in sections, is attractive on the score of its low specific gravity; both materials have concomitant disadvantages, the former in that laminations frequently occur in rolling, and the latter in that its cost renders it expensive (sometimes prohibitively so) as a means of reducing weight, in addition to the fact that heat treatment is required to develop its mechanical properties to the full, thus rendering subsequent repair work more difficult.

The solution adopted for these coaches was—as so often in engineering—a compromise; the use of high tensile steel of a weldable quality (B. S./S. T. A. 5/V6A) for the stressed portions of the underframes and shell, and aluminium alloy (B. S./S. T. A. 7/A. W. 5) for interior panelling, flooring and roof sheets, "Alpax" being extensively employed for doors, louvres, seat ends, etc.

STRAIN GAUGING

In view of the relatively high calculated stresses allowed it was thought advisable to check these by practical means. Aircraft manufacturers had, during the war, developed a method of electrically strain gauging structures and this system was adopted for assessing the loads obtaining in the car superstructures due, firstly; to the weight of the structure itself, secondly: to vertical loads, and thirdly: to end loadings combined with vertical loadings. It was a matter of extreme gratification to the builders that the accuracy of their theoretical calculations was confirmed by the strain gauge readings, the discrepancies usually being of a very low order indeed.

It may be of interest here to describe the method by which the cars were strain gauged as the system itself is comparatively new, although it had been used to some extent in the U. S. A. for checking stresses obtaining in locomotive frames and bogies.

The first essential for successful strain gauging is the provision of a suitable building, free from draughts and having an even temperature, as the strain gauges are remarkably sensitive to changes in temperature and unless these conditions are provided and the gauges themselves insulated by felt pads, inaccurate, and therefore valueless, readings result. Theoretical calculations had indicated the regions of maximum stress and a total of 250 strain gauges were applied to a trailer car superstructure at these points.

As a preliminary it is necessary to obtain the initial stress which occurs in the structure due to its own weight, and this was done by loading the superstructure with weights equivalent to half the weight of the structure distributed in the same manner as the weight of the superstructure itself. The figures thus obtained represent, when doubled, the "built-in" stresses occurring in the structure.

The various vertical loadings are simulated by placing the full load in the form of 56 lb. weights distributed over the flooring in the same manner as the pay-load.

Exterior view—trailer car 'C'

End loading is applied at the drawgear retainer castings by means of a hydraulic ram while the car is standing in a testing fixture consisting of crossbeams at each end coupled by tie bars at approximately solebar level, the cars themselves standing on shop trolleys; by this means any combination of vertical and end loadings may be obtained within the capacity of the ram and the resistance of the car structure to lead. The addition of the stresses induced by the loadings and the inherent stresses due to the weight of the structure give the actual stress occuring at any point. Physical deflections of the car structure are measured in relation to strained wires fixed to the shop floor, whilst these loadings are applied.

CONSTRUCTION

In order to effect the maximum saving of weight integral construction has been adopted, that is to say the car shell and underframe are designed and built together in such a way as to act as a single stress carrying member. The underframes, bodysides, bodyends and roofs are built in jigs as welded sub-assemblies and then riveted together on erection.

The underframe is of all-welded construction and almost entirely composed of high tensile steel in the form of rolled sections, pressings and fabricated plates. The floor sheets are of 16 swg aluminium alloy folded into a $2.\frac{1}{2}''$ pitch x $\frac{5}{8}''$ deep dovetail section secured by aluminium rivets to the floor bearing members of the underframe—it may be noted that aluminium flooring has a considerably greater deflection than steel flooring of a similar gauge and it is necessary, therefore, to provide additional floor bearers to what would be required with a steel floor.

The stress carrying members in the roof are of high tensile steel but the remainder of the light scantling steel work and also the body panelling is of 14 swg mild steel; pressings of channel or zed section are extensively used for the framing members but the bottom crib rails and the body cantrails are of rolled section. The body shell is tied transversely at all doorways by windscreens having 16 swg mild steel frames panelled with 16 swg aluminium alloy sheet.

PRECAUTIONS AGAINST CORROSION

Corrosion in stock built to withstand monsoon conditions and running on coastal routes is a matter of primary importance but provided adequate attention is given in the design to avoidance of horizontal surfaces which trap condensation and that the steel work is adequately protected, the effect of corrosion may be minimised to a large degree. The whole of the body steel work in these cars is subjected after erection to a shot-blast and zinc-spray treatment on all interior and exterior surfaces, the windscreen frames being treated separately prior to panelling. Treatment of this type effected on the complete structure has several advantages over individual treatment of members but it does necessitate the erection conversion of a shop expecially for the shot-blasting and spraying.

As a further deterrent to corrosive action on the steel work and aluminium alloy, zinc chromate iron oxide primers were used throughout subsequent, in the case of the light alloy, to the use of Deoxydine treatment to improve the bond between paint and metal.

USE OF ALUMINIUM ALLOY

Whilst on the subject of aluminium alloy, it many be interesting to note that the parcel racks are fabricated completely from this material, being built up of aluminium alloy pannels and extrusions on cast "Alpax" brackets. Aluminium extrusions are indeed widely used in the form of louvres, cappings, light frames and fittings and generally receive a self-colour anodic treatment which besides acting as a protection ends to lighten the painted interior finish.

The flooring system in the lower class cars was designed expressly to withstand the hard service conditions encountered in suburban stock of this type. The dove-tail section aluminium floor sheets are overlaid with shaped slabs of compressed cork and then topped with a 5/32″ thickness of "Ferobestos" sheeting stained to match the maroon colouring of the lower interior body sides. All three floor layers are riveted together by means of hollow rivets which provide drainage additional to that given by the floor drains at the bodysides. Great attention was paid in the design of this flooring system to sealing against the ingress of water to the structure during the floors to remove betal nut expectoration.

In order to obtain a lighter lower class seat than that given by the usual slatted construction, timber framed plasticised inserts are locked into a fabricated steel and aluminium frame, the seat risers being of aluminium sheet while the seat ends are formed of "Alpax" castings. The upper class seats are more orthodox in construction, the squabs being composed of spring units trimmed with leather cloth; "Alpax" seat end castings are again used.

LIGHTING

Interior lighting is provided by two continuous rows of fluorescent tubes giving at reading level an illumination of 20 candle power per square foot and in the event of this main lighting system emergency lights are automatically switched in.

BOGIE DESIGN

The bogie design is of conventional bolster type. The spring planks are suspended from the solebars by swing links with double-coil nexts of helical springs fitting between the spring and bolsters; half-elliptic laminated springs with helical auxiliaries are used for the side suspensions. The bogie frams consist of welded sub-assemblies rivetted together and are constructed entirely in high tensile quality steel. Stress relieving was carried out on the various sub-assemblies before fabrication into a complete unit.

BRAKES

The new stock is fitted with Westinghouse air brake arranged for gradual application with electro-pneumatic control as it is possible with this system to vary the brake force during an application without first passing to release.

The brake cylinder is mounted on the underframe and the bogie brake arrangement is an orthodox clasp-brake one. Successful trials in India with non-metallic brake blocks had led to their being specified for this stock but after the first units had been put into service it was found that the high temperatures induced flaking of the tyres, and it was decided to revert to the standard Indian cast iron block.

In is hoped that the foregoing has indicated to some extent the factors which influenced the Railways' consultants and the builders in designing this lightweight trailer stock and that the service performance of the stock will prove that it is possible to build safely and economically at such weights.

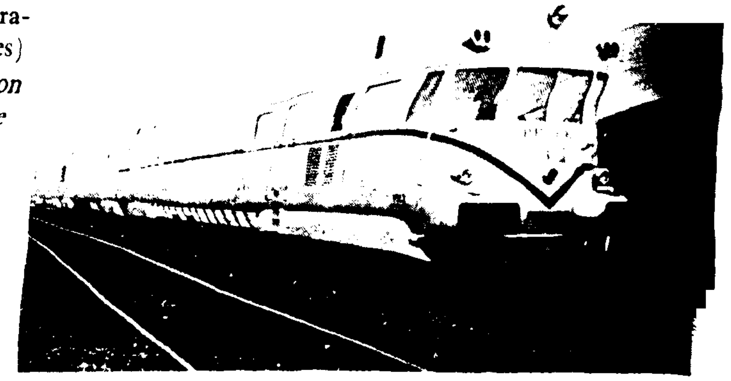
LEADING DIMENSIONS

Rail gauge	5 ft. 6 ins.
Length over body	68 ft.
Width over body	12 ft.
Height, rail to top of roof (tare condition)	12 ft. 6 ins.
Height, rail to top of floor (tare condition)	3 ft. 10.1/4 ins.
Distance between bogie centres	48 ft.
Bogie wheelbase	9 ft. 6 ins.
Wheel diameter	3 ft.

A NEW FIAT MOTOR TRAIN

A VERY MODERN PRODUCT

THE new Fiat motor train, which is being shown to authorities and journalists on a demonstration run from Turin to Asti *(56 km., 35 miles)* and back, *was built by Fiat's* Railway Materials *Section* for the Spanish National *system (RENFE) who have* ordered *20 trains of this type. Three* other similar *trains are being* supplied to the Portuguese Railway Company (C. P.). This batch of twenty-three motor trains, built in Turin, constitute an important export item of Italian engineering and workmanship. They are very modern trains, into which Fiat has put, as to design and construction, the very latest ideas in railway engineering.



These motor trains—designated as "type 080" and "type 083"—are each formed of three elements: a power car, a trailer in the middle, and another power car. Each power car is driven by a 505 h. p. OM type SBD engine mounted on the body of the car, under the floor.

The principal dimensions of the train are:

overall length	83.340	meters	(273′ 5″)
width of body	2.800	„	(9′ 2½″)
clear height in passenger compartments	2.200	„	(7′ 2½″)
distance between bogy pivots	19.700	„	(64′ 7½″)
wheelbase of bogies	3.200	„	(10′ 6″)
estimated weight in running order	(type 080)—146	metric tons	
	(type 083)—161	„	„
pay-load	16	„	„
number of seats	174	„	„

The OM type SBD engines have 12 horizontal cylinders arranged in two opposed banks of six. The transmission is mechanical, through a 5-speed synchromesh gearbox and a three-plate semicentrifugal clutch mounted directly on the engine.

The internal arrangement of each of the power cars gives two driving compartments, luggage compartment, two vestibules, two lavatories and seats for 64 passengers.

The trailer coach has two driving compartments, two lavatories, two vestibules and two passenger compartments for respectively 27 and 19 passengers, a bar and a kitchen.

The train thus has seating accommodation for a total of 174 passengers. The seats all face forwards, have adjustable backrests, and are equipped with stuffing, springs and upholstered in either rep or velvet. The inside wall surfaces are covered with synthetic material.

(Continued on page 26)

Brief History of Railway Research

On the 12th February, 1954, the Railway Testing & Research Centre, Lucknow, was formally inaugurated by Pandit Govind Ballabh Pant, Chief Minister, Uttar Pradesh. On the turning of the handle of a line Block Token instrument the main doors of the entrance to Research Centre Building opened automatically, revealing the inaugural marble plaque and a neon sign over the doorway lit up.

The Research Centre building consitists of 53 rooms totalling 30,600 square feet of covered space. Built in 15 months at a cost of $7\frac{1}{2}$ lakhs it houses the main administrative office, the testing laboratories, meeting hall, library, documentation and information wing and the photographic and document reproduction units. In the Research Yard laid at a cost of $6\frac{1}{2}$ lakhs, are located the "squeeze" and "impact" test sheds and ample stabling accommodation is provided for the Field Test Cars and their supporting staff cars. The yard is served by both Broad Gauge and Metre Gauge tracks.

PRIVATE enterprise under Government guarantee built and operated the early net-work of Railways in India. Though guided by British practice in general, each Railway Company patterned its equipment on the experience and tradition of Engineers in its own region of operation. By the early twenties of the century the Government of India had, in fulfilment of its term of guarantee, acquired most of the major Company-managed Railways and secured centralised control in one form or another over the entire railway system. Economy in a wider sense than became paramount. In railway construction, maintenance or operation the outlay on Track, Locomotives and Rolling stock absorbs by far the greater portion of finances. The greater the variety of equipment the higher is the cost of production of different types and the lower the degree of interchangeability of parts. The quest for economy drew attention to the need for standardization of equipment and better utilisation of local raw materials. The growth of new standards implied more precise knowledge of local conditions and resources—knowledge that only systematic research could provide. And so, in 1935, Research on the Indian Railways began when two Officers were assigned the task of determining the maximum loads existing engines could haul and the maximum speeds they could attain under various service conditions. This was done by means of a hydraulic Dynamometer Car acquired by the Ex: G.I.P. Railway in 1931, one of the few test cars of the kind then available on any railway in the World. Next followed investigations into mutual interaction between these locomotives and railway track. Quite logically, Research was orgainised at the time as a part of the Central Standards Office of the Railway Board, New Delhi, and so it remained till its recent separation. With independence came a shift in emphasis. The urge towards national self-sufficiency together with the enlarging of activities of the Indian Railways in the field of design and manufacture, brought in their wake the demand for more indigenous applied research in railway technology. To meet the new challenge a scheme estimated to cost about Rs. 3 crores was drawn up in 1948 for expanding the activities of railway research. To avoid duplication of the national research effort, however, the railway schemes implementation was postponed until the plans of the Council of Scientific and Industrial Research had taken shape. When the chain of National Research Laboratories was approved the original railway scheme was drastically cut down to cater for immediate objectives and to fit into the general pattern of technological research in the country as a whole. The Research Section of the Central Standards Office was reorganised and established, on 1st September, 1952, as a separate Directorate of the Railway Board with headquarters at Lucknow and two Sub-centres at Lonavla and Chittaranjan.

The Lucknow Centre carries out research on fuel, on the dynamic effects of vehicles on track and bridges, and riding quality and performance tests on locomotives and rolling stock assemblies and components. To supplement and permeate these activities a Documentation and Information Service has been provided which will in addition, publish Bulletins and summaries of important researches conducted in India and abroad.

The Lonavla Sub-centre tackles problems on Buildings, Foundation and Concrete Engineering as applicable to Railways; the Chittaranjan Sub-centre functions in close coordination with the Locomotive Works, in conducting Chemical and Metallurgical studies on Paints, Water-softeners, Lubricants, bronzes, metals and metal processing.

Briefly, the three main objectives now before the ailway Research Organisaion are :—

(i) Safety of rail travel combined with comfort

(ii) Self-sufficiency and

(iii) Simplicity and reliability of design leading to economy in construction, maintenance and operation.

The total track mileage of the Indian Railways is about 48,000 miles and annually about Rs . 20 crores alone is incurred on expenditure on track maintenance and renewals. Any economies, even to the extent of 1% or 2%, which Railway Reseach can bring about will pay very large dividends. Similarly, the annual coal bill amounts to about Rs. 32 crores and any savings in coal utilisation on locomotives will mean both substantial financial gain and better conservation of an essential industrial fuel.

ADMINISTRATIVE BUILDING AT LUCKNOW

The Administrative Building consists of a three storied main front block and intergral L-shaped stem. The main leg of the stem is doublestoried and the short leg singlestoried with provision for another storey.

(Continued from page 24)

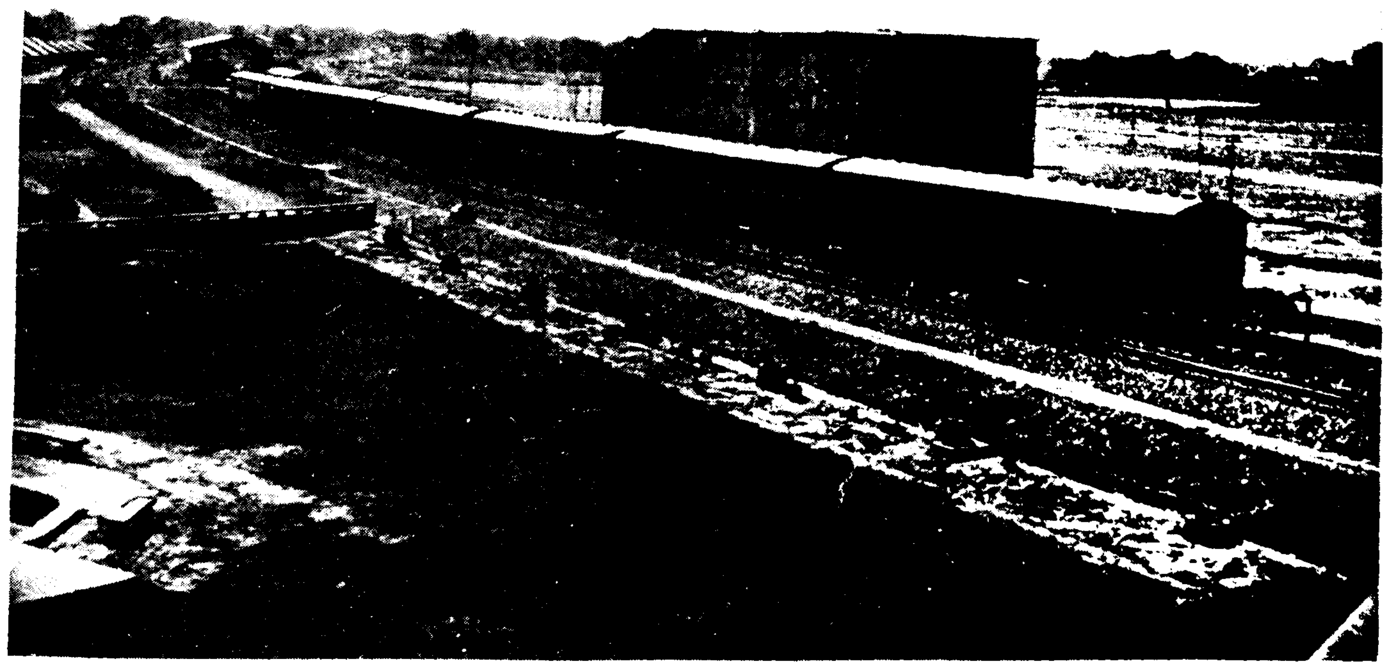
"Plastiriv" made by the RIV Company, Turin. The finish throughout is of the highest class.

The bar-restaurant equipment comprises, besides the bar and its fittings (express coffee machine, ice box, bottle bin, sink etc.), a kitchen for the preparation of hot meals. Holes are provided in the ends of the seat arms for the fitting of small tables for serving meals.

The standard train (type 080) is heated in winter by warm air, using the heat form the engine cooling water in the power cars, and hot water supplied, in the trailer, by a coal fired boiler and heat-convectors. The type 083 train has Stone air cynditioning equipment, cool in summer and warm in winter. The electric power required for this equipment is supplied by a 60 h. p. auxiliary generating set housed in the luggage compartment and consisting of a First type 364 A diesel engine direct coupled to a dynamo.

The Top speed of the trains is 120 km. (75 miles) per hour.

The trains can be split up, as there is a driving compartment both ends of each power car and trailer.



Research Yard.

The building provides a total covered space of 30,600 square feet and was built in 15 months, at a cost of Rs. $7\frac{1}{2}$ lakhs. On the ground floor are housed the Offices of the Field Units, the Model Room, the testing laboratories and the workshops. The second floor comprises the main administrative Offices, the meeting hall, library, documentation, reproduction and photographic laboratories. A self-contained three bedroom Rest House for visiting Railway Staff and trainees has been provided on the third floor.

So far only some of the equipment for the laboratories has been received and installed.

RESEARCH YARD

Yard at a cost of Rs. $6\frac{1}{4}$ lakhs the Research Yard is served by both Broad Gauge and Metre Gauge track taking off the Lucknow-Kanpur main line of the Northern & North Eastern Railways respectively. The layout is such that besides furnishing stabling accommodation for Field Test Cars, and their supporting Staff Cars, there is ample length and shedded accommodation for conducting impact tests on carriages and wagons. A "squeeze" test frame with dual gauge entry is located in the yard for the static testing of full-size carriage and wagon underframes and integral shells.

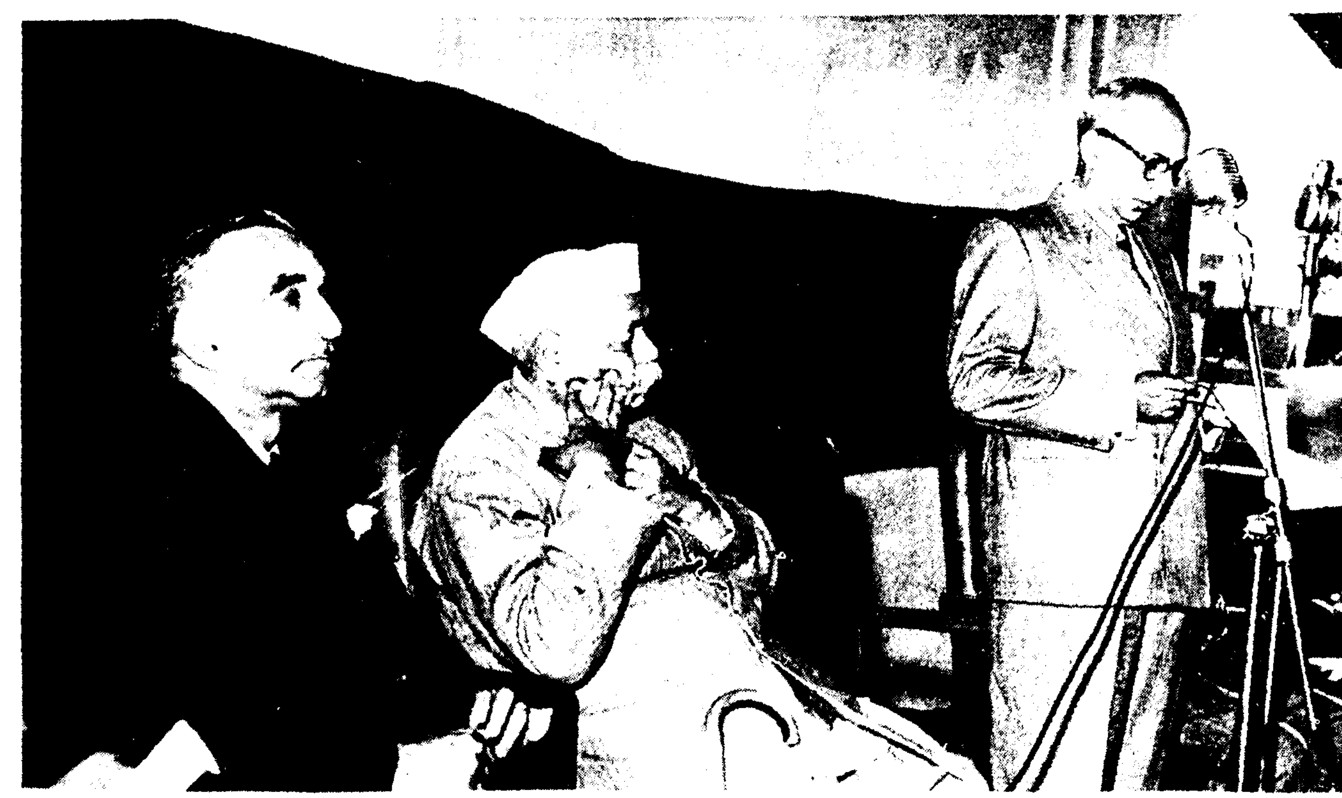
INSTRUMENT CARS OR MOBILE LABORATORIES

At present there are five field test units at the centre. one Broad Gauge Hydraulic Dynamometer Car Unit, three Oscillograph units interchangeable between Broad and Metre Gauge, and a Broad Gauge Fuel Test Car. A sixth unit—the Broad Gauge Track Recording Car—is manned and operated by the Central Railway and works to a programme framed in consultation with the Research Directorate over the entire Broad Gauge system of the Indian Railways. One metre-gauge hydraulic Dynamometer Car and a fourth Oscillograph Unit are on order abroad. One of the existing Oscillograph Units has been experimentally improvised for the conduct of Dynamometer trials on Metre Gauge locomotives.

PRIORITY RESEARCH PROGRAMME

A Priority Research Programme has been drawn up by the Research Controlling Committee—a railway brains trust representing leading technical and administrative

Mr. F. C. Badhwar, Chairman, Railway Board addressing the gathering.



Mr. S. L. Kumar, Director Research's address.

heads. In qualifying each problem for research, three checks have been applied, firstly, whether it will assist in progressing towards greater safety, efficiency and economy; secondly, whether it cannot be suitably investigated by any other laboratory or organisation in India, thirdly, whether fruitful results are likely to be achieved within two or three years.

The investigations that are either already in progress or have been accepted for the programmes are :—

On Permanent Way:—Determination of the latertal strength of secondary line turnout and of track assemblies with varying sleeper densities. Measurement of comparative stresses in rails and sleepers at joints with different positions of supports and of flange forces exerted by various classes of locomotives on sharp curves and on secondary turnouts. Welding of rail joints.

On Bridges:—Stress measurements in existing reportedly weak girder bridges on the Indian Railways which are programmed for replacement, to examine their suitability for continued retention in service with restricted load carrying capacity and lower speeds.

On Buildings:—Development of cheaper construction methods and materials for low-cost housing. Portable Huts.

On Concrete:—Design, testing and pilot mass production methods of sleepers; compilation of ready-reckoner charts for the Railways by experimental analysis of economical cement concrete mixes with broken stone and sand of different varieties. Experiments on the utilisation of bamboo reinforcement in unimportant structures. Use of loco coal ash as a puzzolana.

On Foundation Engineering:—Economical and durable foundations in shrinkable soils. Collection of data on shear strengths of Indian soils.

On Locomotives:—Oscillation and riding quality trial of metre-gauge locomotives on track turnouts with and without modifications. Comparative steam cylinder performance tests on the older types of Broad Gauge Pacific Locos. Trials with minor alterations in suspension details to obtain improved riding of the latest Pacific engines. Fuel, water consumption and performance tests of the latest standard metre-gauge engines. The economics of better steam raising with feed water heaters. Comparative strength of old and re-designed couplings and drawhooks. Development of new painting techniques using indigenous raw materials.

On Carriages and Wagons:—Load tests on certain prototype welded body wagons of the Broad Gauge. Laboratory and serice tests on rubber spring buffers. Development of improved painting schedules for rolling stock in railway workshops and the use of aluminium in primers.

On Materials, Processes and Reclamation Methods in Railway Workshops:—The development of substitutes for imported articles ranging from ordinary cleansers to waterproof adhesives, tannins, varnishes; the improvement by experiment of specifications for metals and alloys, the rationalisation of various grades of lubricants; the maximum reclamation of used material; the substitution of indigenous aluminium in bearing alloy specifications containing imported tin and zinc. Improvement of foundry and welding shop techniques. Development of indigenous paints for railway works.

On Locomotive Boiler Feed Water Treatment:—Improvement of existing water treatment media and development of more economical internal dosage systems.

On Measuring Devices and Instrumentation:—The design and manufacture of pressure cells for measurement of earth pressures in every situation; electro-magnetic detector assemblies and strain gauges for determining stresses, at ordinary and high temperature respectively, in components of Locomotives, vehicles, permanent way and other such elements. Experiments in handy rail flaw detectors. Alterations to the Hallade track recorders used by Railways for more sensitive recording of the riding qualities of track and vehicles.

INFORMATION SERVICE

An integral Documentation Service will direct the research effort in every detail, maintain liaison with other such Institutions, post it on all technical developments in the country and abroad and disseminate information on the achievements.

RESEARCH STAFF

LUCKNOW CENTRE

Dy. Director (Publication) : Shri M. N. Bery
Dy. Director (Civil) : Shri R. Basu Choudhury
Dy. Director (Mechanical) : Shri M. V. Kamlani
Dy. Director (Electrical) : Shri M. S. Murti

FIELD OFFICERS

Shri B. V. Mallya, Shri C. S. P. Sastry

and

Shri M. B. Ramchandani

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Dy. Director (Soil Mechanics) : Shri U. G. K. Rao

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ASSISTANT OFFICERS

Shri S. Ramanujam and Shri M. N. Bhide

RESEARCH ASSISTANTS

A. K. Bhattacharya, M. N. Rao and L. R. Fialho

S. L. KUMAR
Director Research

F. C. BADHWAR
Chairman, Railway Board.

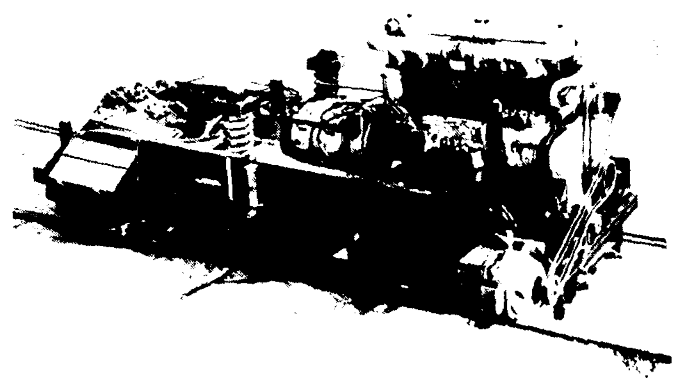
CONSTRUCTION OF RAIL CARS

PROBABLY few firms manufacture a wider range of rail cars than D. Wickham & Company, Limited., of Ware, Hertfordshire, England. They began specialising in these vehicles 30 years ago, their earliest efforts including extremely light two-seater cars for the Ottoman State Railways, inspection vehicles for Chile, the Sudan and the Argentine and 100 HP diesel shunting locomotives for the latter country,—a very ambitious effort for what was then a small firm of limited manufacturing resources.

Their efforts, however, were successful and the cars led to considerable repeat business, whilst the locomotives were operating in the Rosario Shunting Yards up to quite recently. Very early on they adopted welded construction for both frames and bodies and, realising quickly that avoidance of local stressing was essential, were speedily able to demonstrate to railways the many advantages of the system.

For the lighter cars they pioneered the blower-cooled engine and can fairly claim were the first to use this method of cooling, as they were to adopt spherical roller bearing axle boxes with underslung semi-elliptic springs, resilient rubber sprung wheels, under-floor horizontal diesel engines and, also appreciating that square tubular construction would enable the cars to be built extremely light in weight yet affording the maximum protection to passengers as well as more freedom from corrosion, accordingly embodied this construction almost from the start of entering diesel rail car construction.

They, in common with all makers, encountered both in inspection and passenger cars the problem of providing

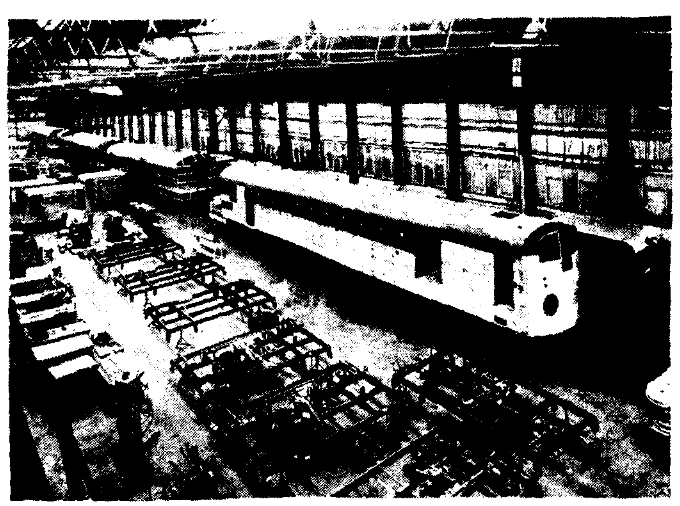


A typical Wickham rail car power bogie.

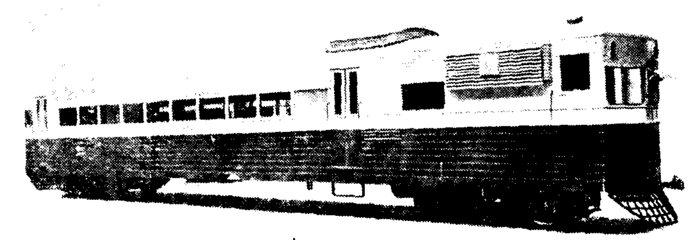
adequate cooling when the cars had to be operated in both directions in tropical countries, and those associated with remote control of engines and transmissions, especially where the cars were coupled together with one driver.

They tried different types of transmission, electric, hydraulic and mechanical, and found that all had their respective advantages and drawbacks. There, the mechanical was considerably the more efficient — and here the epicyclic type seemed the simplest and most compact, —the hydraulic the easiest to control, probably equally compact but requiring, because of its lower efficiency, a larger engine; the electrical was again less efficient, needing more complicated controls but facilitating multi-axle drives from one power unit. The disadvantages of the latter were the considerable space it occupied and, because of its lower efficiency, an approximately 50% larger engine than the mechanical, necessitating heavier construction—in which respect it paralleled the hydraulic type.

All factors considered, the mechanical, because of its greater efficiency and its ability, therefore, to use a smaller engine, appears best suited for many applications and, here again, as the bus or lorry type diesel engine is made in very large numbers, it is much less costly in proportionate horse-power than the larger types. Spares also are lower in price and, moreover, can usually be obtained from stock. Its use, however, entails many power units and consequently more complicated controls, but it offers, on the other hand, the advantage that should a power unit fail it does not prevent the cars from completing their journey, whilst at the same time considerably simplifying the overhauls.

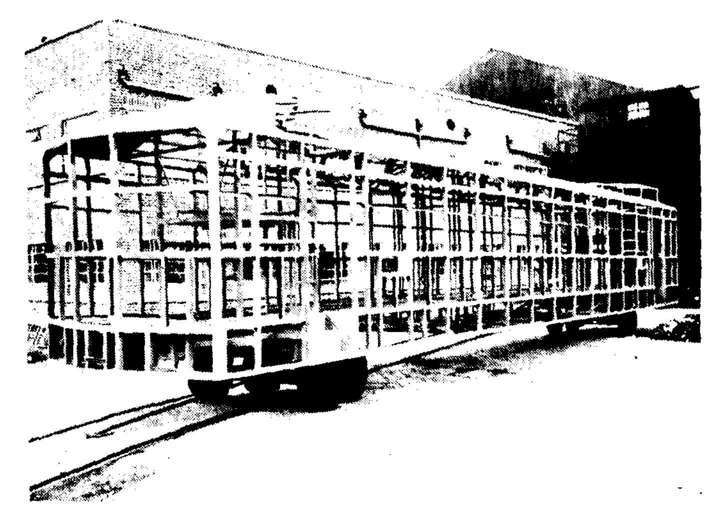


One of Wickham's rail car erecting shops.



Diesel-electric rail car (built in Wickham's works for the British Thomson-Houston Export Co., Ltd.) with Wickham body and machanical parts, B.T.H. electrical equipment and Davey Paxman engine.

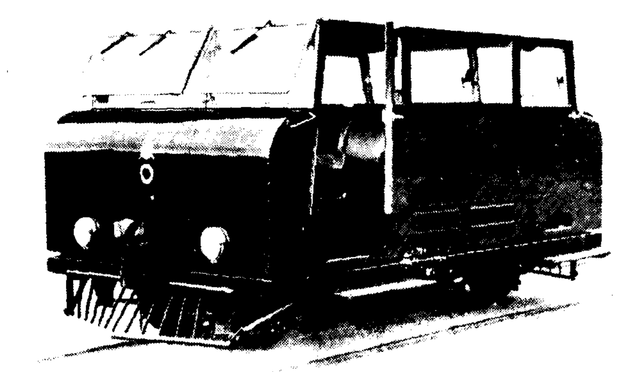
A question difficult to decide was whether the vertical engine powered bogie or the horizontal under-floor engine mounted under the carriage was preferable. The vertical engine bogie type took up a considerable amount of passenger or luggage space and was more difficult to cool for both direction running. It did, however, enable a power unit to be quickly replaced and so facilitated maintenance. The under-floor engine was easier to cool, gave greater floor space and helped, where the necessity arose, for driving more than one axle, but it was less accessible and might despite special attention to air cleaning, suffer more through exposure to dusty conditions. Where conditions require more power, Wickhams are collaborating with well-known engine makers and have available, therefore, engines suitable for most requirements.



A typical Wickham rail car body frame.

Having already mentioned D. Wickham & Company's preference for an epicyclic change speed box, it will interest the reader to learn that during their many years experience they have tried several types and, though they have had more difficulties with the Cotal they have always felt that the troubles that arose with these boxes in service were not inherent but were due to inability to contact with the French patentees through the war.

As nearly all the cars fitted with this transmission went overseas, it was a considerable time before their technicians could visit these countries and find what improvements were desirable, and once these were



The Wickham No. 40 Mk. II Inspection Car—known throughout the world for its comfort and reliability.

ascertained, it was quickly realised they could be easily effected.

Collaborating with the French, a considerably simpler design was evolved; it was found many parts could be simplified and made interchangeable, gear widths could be increased, and the oil distribution greatly improved.

At the same time, other types of epicyclic transmission were put in hand and tested, but at present the revised Cotal has the advantage of few working parts, easy maintenance and should be capable of years of service with the minimum attention.

The firm have also realised the advantages of automatic control and are thoroughly investigating the

(Continued on page 34)

AIR CONDITIONING IN RAILWAY HOSPITALS

By T. S. Rao, B.E., M.I.E.E. (Lond.), M.I.E. (India)

Chief Engineer, The Bombay Electric Supply & Transport Undertaking.

INTRODUCTION

INDIAN Railways are the largest of the nationalised industries with over 10 lakhs employees spread throughout the country. Staff welfare, therefore, forms one of the major responsibilities of Railway Administrations. In this connection, the importance of air conditioning the Operation Theatre as an aid to surgery and the wards for the comfort and rapid recovery of the sick employees and their families during the convalescent stage has been well recognised during the last few years. The operation theatres and wards of main Railway Hospitals in the Headquarters and District centres of individual Railway Administrations are therefore rapidly being air-conditioned. This article is intended to give a brief resume of some of the special features necessary for the proper air conditioning of the operation theatres and the wards.

PRINCIPLES OF AIR CONDITIONING

Air-Conditioning is the simultaneous control of all or at least three of the factors affecting both the physical and chemical conditions of the atmosphere within any enclosure. These factors include temperature, humidity, motion, distribution, dust, bacteria, odours, toxic gases and ionization. 'Comfort' air conditioning is the process by which simultaneously the temperature, moisture content, movement and quality of the air in an enclosed space intended for human occupancy may be maintained within required limits. The basic requirements for ensuring comfort conditions in any part of India may be determined on the basis of the following general principles :—

Temperature : Too great a difference in temperature between inside and outside the air-conditioned enclosure is undesirable on account of people catching cold or heat stroke by suddenly entering or leaving the air-conditioned room. Medical authorities advocate a maximum of about 15°F. temperature difference between the inside and outside.

For average Indian conditions, temperatures between 70°F. and 80°F. in summer and 60 F. and 70 F. in winter may be considered as satisfactory to ensure comfort conditions for the majority of persons in sedentary occupation.

Humidity : Low humidity results in chilling sensation due to too rapid evaporation of moisture from the skin and causes depressing, irritating and uncomfortable feeling owing to its drying effect on the respiratory system.

Too high humidity, such as experienced during the rainy season or in coastal towns, tends to slow down the invisible perspiration or evaporation of moisture from the skin with consequent feeling of discomfort and stuffiness. Relative humidity between 40% and 60% provides conditions best suited for comfort and good health. A relative humidity above 70% is considered unsatisfactory.

Air Motion : Proper air circulation is necessary for the rapid dissipation of body heat and for ensuring uniform distribution of temperature, prevention of stratification and concentration of body odours and stuffiness. Without air motion, the temperature will be much higher at the ceiling than at the floor line. Air at velocity ranging from 20 to 30 ft. per minute is sufficient to promote healthful and comfortable conditions. The air velocity should be sufficient to carry it to every part of the air-conditioned enclosure so as to avoid dead spots, but in order to avoid objectionable draughts, it should not exceed 50 ft. per minute, except in the vicinity of supply and return air grilles. The maximum temperature difference inside the enclosure should not exceed 2°F. for air velocity of 40 ft. per minute and over, and 3°F. for air velocity below 40 ft. per minute. There should be complete recirculation of conditioned air every 5 minutes. For Indian conditions, particularly in humid climates, a relatively higher air velocity should be provided to dissipate body odours and to prevent a feeling of stuffiness.

Purity of Air : The total minimum amount of outside air to be introduced in an enclosure is related to the number of persons in the enclosure at any one time, their occupations and the cubic contents of the enclosed space. It is essential to provide sufficient quantity of fresh air to keep the proportion of carbon dioxide produced by exhalation of persons within safe limits. It is also necessary to ensure that the air inside the air-conditioned enclosure is clean and free from contamination by poisonous gases or vapours, bacteria, organic matter, unpleasant smell resulting from dust, tobacco smoke, bad odours caused by body excretions, etc. Claustrophobia or "boxed-up" feeling is brought about in a small room with false ceilings. This can be remedied by providing suitable air filters on the fresh air and re-circulated air ducts and by increasing the quantity of fresh air and providing sufficient number of air changes. A supply of properly filtered air provides a most welcome relief to the occupants. For Indian conditions, the quantity of fresh air to the recirculated air should preferably be in the ratio of approx. 1 : 3 and the number of fresh air changes should not in any case be less than 2 per hour but preferably 3 to 4 changes per hour to ensure comfort conditions. Any feeling of discomfort due to stuffiness can be remedied by increasing the total quantity of air circulated by the air-conditioning unit or other means, such as a local fan, to give a gentle air movement.

Comfort Zone : A person may experience a sensation of warmth or cold under a certain combination of temperature, relative humidity and air motion, but when *any one* of these three factors is changed, his body would react with a definite sensation of comfort. The effect of variation of *any one* of these three factors can therefore be counteracted within limits by varying anyone of the other two factors. Such a condition of air, co-ordinating the simultaneous effects of temperature, humidity and air motion, is denoted by a comfort index called "effective temperature" and the range of effective temperatures between which the average person feels comfortable is called the "comfort zone". The comfort zone is a series of combinations of various temperatures, humidity and air velocities under which a feeling of comfort is experienced by a majority of persons. The comfort zone is usually indicated on a simplified Psychrometric chart giving graphically the important properties of the air.

BASIC DESIGN FEATURES

Proper air conditioning today maintains a higher room temperature with lower relative humidity which produces a condition of greater comfort and avoids sensation of chill.

The desirable indoor temperatures corresponding to given outdoor temperatures should be generally as follows :—

Outdoor temperature °F.	Indoor temperature F.	Relative humidity %
100	82	47
95	80	52
90	78	59
85	74	60

Interpolation within the above range is permissible.

(*Continued from page 33*)

problem of producing simple, easily understood mechanism to effect this. Bogies and suspensions have also their peculiar problems not the least being the ratio of tare to laden weight with these lighter vehicles.

After lengthy experience with both all coil spring suspension and coil and semi-elliptic, their views are that so far the best results are obtained by the use of self-aligning roller bearing axle boxes with underslung semi-elliptic springs, combined with the use of coil springs between bogie and bolster controlled by adequate shock absorbers. For some time past Wickhams' have been investigating the more extensive use of rubber and have certainly found rubber sprung wheels advantageous, both from the point of view of noise elimination and reduction of vibration.

Their bogies, for some time past, have been of the box section type, shaped so as to avoid local stressing. Here again, this is more costly than orthodox but it does avoid that bugbear of maintenance, the development of cracks and makes for robustness and lightness. Usually, they adopt clasp brakes throughout and have the final bevel drive on the fore axle.

One unusual feature peculiar to D. Wickham & Co., is their use of square tubes for body construction, a practice they have held to for over eighteen years despite the obvious increase in both marerial and labour.

They claim that the extra cost is well worth while, since to give equal strength with equivalent passenger protection by other methods would necessitate a 50% increase in weight. They use a low carbon square tube, panel both inside and out with metal sheeting and build the body integral with the underframe, are welding being used throughout.

During the many years cars so made have been in service no collision has ever resulted in severe injuries to passengers and the damage to bodywork could usually be easily repaired. This, they say, justifies the extra cost.

From small beginnings Wickhams have built up a world-wide reputation, have extended their manufacturing facilitsies until they have now one of the mast up-to-date and well equipped works of their size, and welcome at Ware all visitors who are interested in the construction of rail cars and their components.

In order to ensure proper comfort conditions, certain basic design features will have to be satisfied in respect of the air-conditioning plant including filters, as well as heat insulation of the walls, ceiling, door and window openings, etc.

The efficiency of the Air-Conditioning System could be improved by giving close attention to the following :–

Careful calculation of heat load, which should be based upon the cubic contents of the various rooms, the number of people in the room at any time and their occupations, the quantity, temperature and humidity of the outside air admitted for ventilation ; dissipation of heat due to electric lights, fans, heating appliances, etc.

Provision of proper heat insulation for the walls and ceilings, including provision of false ceilings where necessary, to eliminate heat losses, minimise outside noise and to ensure quietness. A blanket of warm air at the top of the room will give much more effective thermal insulation than a false ceiling of thick and expensive heat insulation.

Provision of spring-loaded doors and double glass air-tight doors, windows and ventilators, and dark coloured inside shades for the glazed windows directly exposed to sum, in order to reduce transmission of heat and prevent undue condensation of moisture on window panes.

Provision of efficient form of replaceable type of filters for cleaning the fresh air and recirculated air, such as cloth screens, glass wool, viscous oil or by electro-static means. The last named is the only filter capable of removing small particles, such as tobacco smoke, which contributes to the well-known "air-conditioned smell" of some installations.

Provision of mixing chambers and regulating dampers for mixing fresh air and circulated air in the desired proportion.

Provision of automatic controls for regulation of temperature and humidity to any desired figures.

Provision of proper foundations for the compressors and other heavy rotating machinery and vibration dampers inside the plant room to reduce transmission of vibration and noise.

Provision of proper insulation and jointing of all chilled water and refrigerant piping to reduce heat losses and to prevent any leakage of the refrigerant.

Provision of well-balanced quiet operating pumps, blowers and circulating fans driven by silent electric motors and flexible canvas connections for inlet and outlet air ducts in the rooms, to reduce the transmission of vibration and noise to the minimum.

Provision of a set of face and bypass dampers and controls for automatically regulating the air to be cooled or dehumidified and that required to be bypassed around the cooling unit, either during summer or during winter.

Provision of supply air grilles with adjustable vanes for controlling the quantity and direction of air motion, both longitudinally and transversely and return air grilles with adjustable means for regulating the quantity of return air from the rooms.

SPECIAL DESIGN FEATURES FOR THE OPERATION THEATRES

In hospital operation theatres, the following special design features should be provided :

All air circulation should be drawn from outside, which should be adequate to give 30 to 50 c. ft. of conditioned air per minute per person. The air velocity up to head level at any place inside the operation theatre must not be below 25 ft. per minute or exceed 40 ft. per minute and used cool air should not be circulated. Where, however, it is necessary to reduce the refrigeration load, the ducting can be so arranged that a separate G. I. sheet supply air duct is provided for conditioned air supply running inside a CELOTEX or asbestos-wood sheet return air housing for drawing return air, when anaesthesia or washing of the lungs are not being carried out and urgent preparation of the room is not necessary to meet cases of emergency. When 100% outside air has to be introduced, the return air opening in the room should be closed and the surplus air from the operation theatre should be exhausted by means of an air exhaust fan.

The door between the operation room and the sterilising room will have to be opened occasionally and the additional loss due to heat from sterilising equipment should be allowed for.

No machinery with moving parts should be placed inside an operation theatre.

The motors, starters, thermostats, humidistats and other control switches must be either completely enclosed in an explosion-proof enclosure or located where they are not in contact with recirculated air. All electrical devices should be most carefully mounted.

There is danger of explosion from static electricity generated by V-belts, flexible couplings and non-rubber mounted bearings in connection with air blower system. Consequently, all metal bearings should be mounted to the frame of air-conditioner unit and this, in turn, carefully protected by mounted connection. In addition, if V-belt drives are used for blowers, a glass spring brush should be placed on contact with belt and mounted to the frame of the air conditioner.

The refrigerant used in the air-conditioning equipment should be a harmless, odourless, non-toxic gas, and should not be inflammable and form any explosive mixtures with the usual anaesthetics used in modern surgery.

All electrical wirings should be of the concealed type and no exposed wiring or fittings should be provided in on operation theatre. All wirings and fittings should be adequately protected against electrical shocks and fire hazards.

METHODS OF AIR-CONDITIONING PLANT

The air-conditioning of the operation theatres and wards in a large hospital may be carried out by either of the following two methods, depending upon technical and economic considerations :—

Central Air-Conditioning Plant : A central plant comprising refrigerant compressor, condenser, water circulating plant for condenser, evaporator coil, chilled water tank, chilled water circulating pumps, etc. located in a separate room and chilled water circulating pipes and accessories with individual air cooling units, complete with cooling coil, fan, motor, fan wiring, grilles, etc. installed in each of the rooms to be air-conditioned to work in conjunction with the central plant.

Self-contained Room Air-Conditioners : Individual cabinet type air-conditioning plants to air condition each room independently comprising rifrigerant compressor, condenser, evaporator coil, fan, ducting, pipe connection, thermostats, humidistat, motor, switchgear, wiring, etc.

The central plant under A above should preferably be accommodated in a separate building outside the main hospital building so as to eliminate noise and vibrations. It should not however be too far removed from the main building, as that would entail a longer length of chilled water pipes and unduly increase heat leakage. The condensing units for the individual rooms may be located in the foundation or under the ceiling or roof so as to be completely out of sight and to facilitate maintenance from outside. These could be enclosed in small housing made from CELOTEX or other suitable insulating material with suitable access door and openings for fresh and return air. The housing should also serve as mixing chamber for fresh outside air and return air from the rooms.

The individual air-conditioning plants to air-condition each room under B above should preferably be of the standard self-contained type provided with evaporative condensers complete with recirculating pumps and suitable mix-up water tanks. Alternatively, water-cooled condensers with water circulating pumps and re-cooling arrangement for cooling the water of the conditioners may be provided.

AIR-CONDITIONING INSTALLATION AT THE RAILWAY HOSPITAL AT PERAMBUR (NEAR MADRAS)

In order to appreciate the special features of air conditioning of Railway Hospitals, a brief description of the air-conditioning installation at the Headquarters Hospital of the ex-M. & S. M. Railway at Perambur is given below :—

Extent of Air-Conditioning : The extent of the work comprised the air-conditioning of the Matrons Ward on the ground floor and the Operation Theatre, Officers' Ward, Central Ward and Left-wing ward on the first floor. The approximate volume of air to be conditioned and the normal loads were estimated as follows :—

Space	Cubic content in cu. ft.	People	Load in kW	O. A. for ventilation in C. F. M.	Total air in circulation in C. F. M.
Ground floor :-					
1. Matrons Office	4,950	10	0.5	100	505
First floor					
2. Ward (left wing)	18,980	45	2	450	3,800
3. Ward (Central)	9,650	12	1.5	200	1,960
4. Operation Theatre	8,200	5	1.5	1,320 summer 800 monsoon	1,370 800
5. Officers' Ward	4,800	10	1	100	810

Design Features: The air-conditioning plant was designed to be capable of maintaining:

(a) A temperature of 80 F. D. B. inside and 50 to 55% relative humidity when outside conditions are 100 F. D. B. and 80 F. W.B.

(b) An inside condition of 75 F. to 80 F. D. B. and relative humidity of 50% to 55% when outside conditions are 85 F. D. B. and 90% relative humidity.

To meet the above conditions, the total refrigerating load for the air-conditioning plant with 100% fresh outside air for the operation theatre was calculated to be 3,19,000 B. T. Us. per hour or approx. 27.6 tons of refrigeration.

Central Air-Conditioning Plant: The main air conditioning plant was installed in a plant room 11' x 18' x 12' high by the side of the bath room at the back of the Central Ward. The plant comprises:—

(a) ONE TRANE BW 25 Reciprocating Compressor, V-belt driven from a 30 H. P. electric motor and complete with suction and discharge shut-off valves and dual pressure control switch. The Compressor has a copacity of about 27.9 tons of refrigeration at 45 F. suction when driven at a speed of 580 R. P. M. and absorbing approximately 28.9 H. P. and is equipped with single step capacity unloader for making some of the cylinders of the compressor inoperative during light load conditions.

(b) ONE KN-1516 TRANE Evaporative Condenser, having a capacity of approximately 48 tons of refrigeration at 105 F. condensing and 43 F. suction and at 80 F. W. B. temperature of outside air. The condenser consists of a copper tube condensing coil, spray water nozzles, water eliminators, cylindrical steel receiver with shut off valves; a double inlet centrifugal fan, V-belt driven from $1\frac{1}{2}$ H. P. motor, a water collecting tank with make up water connection and float control, overflow and drain connection, and recirculating water pump direct coupled to 1/2 H. P. motor.

(c) ONE TRANE Dry Expansion Freon-12 water chiller 24" dia. x 14" long with 3" baffle spacing, capable of cooling 150 gallons of water per minute with refrigerant evaporating at a temperature of 45 F., the water pressure drop for the above rated capacity through the chiller being 11.9 lbs. per sq. in.

(d) ONE Mather & Platt water circulating pump, capable of circulating approx. 100 U. S. gallons of chilled water per minute against a head of approx. 90 ft. direct coupled to 3 H. P. motor.

(e) TWO ALCO thermostatic expansion valves with external equalizing connection and superheat abjustment for the water chiller.

(f) ONE System of Minneapolis Honeywell water chiller control consisting of necessary immersion type thermostats, electrically operated valves, etc. for maintaining the required temperature of the chilled water supply.

(g) TWO M. H. Humidistat "High-on" with glass bulb mercury switch for making and breaking contact, suitable for adjusting the temperature of the chilled water supply when humidity should tend to go up.

(h) Necessary insulated refrigerant pipings and fittings and valves for properly inter-connecting the water chiller and the evaporative condenser to the compressor and initial charge of refrigerant and oil.

(5) *Individual Air Cooling Units:* Six sets of Air Cooling Units or "Climate Changers" are provided for the Operation Theatre and various wards, having the following capacities and particulars:—

CAPACITIES AND PARTICULARS OF AIR COOLING UNITS

Space	No. of Units	Capacity Cu. ft. of air/min.	Air Inlet Dry bulb Temp F.	Air Inlet Wet bulb Temp F.	Air Outlet Dry bulb Temp F.	Air Outlet Wet bulb Temp F.	Quantity of Chilled water at 50 F. gal/per min.	H. P. of motor
Ground Floor								
1) Matrons Office	One	505	84	69.7	60	58.5	6	1/8
First Floor								
2) Ward (Left wing)	Two	1,900	83	69	61	59.5	18.5	1/2
3) Ward (Central)	One	1,960	83	69	62	60.5	17.5	1/3
4) Operation Theatre	One	1,370	100	80	62	60	38.4	1/3
5) Officers' Ward	One	810	82.5	68.8	60.5	59	8.4	1/6

Each air cooling unit comprises of:—

(a) One Trane horizontal model "Climate Changer" suitable for floor or ceiling mounting and complete with finned water cooling coils, double inlet centrifugal fan, face and bypass dampers, all assembled inside a pressed steel insulated casing. Also filter box with replaceable type air filters for the outside and return air.

(b) One set of modulating type damper controls for automatically regulating the quantity of air to be drawn through the cooling coils.

(c) One set of air supply outlets with adjustable vanes for controlling the quantity and direction of the inflowing air.

(d) Two numbers return air grilles with adjustable vanes for regulating the amount of air through each grill.

(e) One set of fresh air dampers with regulator for regulating the quantity of fresh air to be introduced inside the mixing chamber.

(f) All the above six units provided with necessary chilled water pipes, condensate drain pipes and other component fittings for properly interconnecting the "Climate Changer" units to the water chiller, the water circulating pump and the expansion tank on the roof.

(g) The "Climate Changer" for the Operation Theatre has, in addition, a set of G. I. steel ducting with vanes for introducing conditioned air and one set of "Calotex" housing round the G. I. sheet supply air duct for return air.

(6) *Maximum Power & Water Requirements:*

(a) Inside Plant Room	35.5 H.P.
(b) "Climate Changer" Fan Motor and Control.	
(i) Matrons Office	0.25 H.P.
(ii) Ward (Left Wing)	0.40 ,,
(iii) Ward (Central)	0.40 ,,
(iv) Operation Theatre	0.30 ,,
(v) Officers' Ward	0.20 ,,
Total ..	37.05 H.P.
(c) Average Power Requirements	25.0 H.P.
(d) Maximum Water Requirements	60 gallons per hour.

ACCEPTANCE TESTS ON AIR-CONDITIONING PLANT

A brief extract of the results of acceptance tests carried out on the air conditioning plant on the 10th and 11th April 1952 is given below:—

TEMPERATURE AND HUMIDITY TESTS

Description	Dry Bulb		Wet Bulb		% Humidity	
At 14-00 Hours	10-4-52	11-4-52	10-4-52	11-4-52	10-4-52	11-4-52
Outside Air	94	92	82	81	59	62
Matrons Office	75	76	65	68	58	67
Ward II (Large) Left Wing	82.5	80.5	71.5	72	58	66
Ward II (Small) Left Wing	82.0	81	71.5	71	60	60
Ward III (Central)	80.5	79	71.5	70	61	63
Operation Theatre	82.5	81	71.5	72	58	65
Officers' Ward F. F.	80.5	79	69.5	69	57	60

(Continued on page 40)

The first 380 kV power cable in Sweden ★

In the Harspranget power station the switchyard, which is above ground, communicates with the transformers underground via a 65 m (213 ft.) deep shaft, through which run the 380 kV cable connections. The technical problems which the manufacture of these cables presented, arose partly from the high voltage employed and partly from the high oil pressure at the lower end of the cables due to the head of oil which was superimposed on the pressure required at the upper end in order to achieve the requisite dielectric properties. High oil pressure used in conjunction with thin, hard-rolled paper for the insulation made it possible to restrict the cable dimensions to those of a normal 220 kV cable. The cable terminals used are of a new type, fitted with circular stacked capacitors for the purpose of grading the longitudinal voltage stresses.

WHEN the question of installing 380 kV cables in the Harspranget plant first came up for discussion, the prospects of achieving a successful installation seemed fairly good despite the very considerable step that this new voltage represented when compared with the highest cable voltages in experience, which at the time was 220 kV.

Because of the height of the shaft in which these cables would be installed, 65 m (213 ft.), the oil pressure exerted on the cable terminals at the lower end of the cable would be very high. In addition, the dimensions of these cable terminals would have to be large because of the high voltage. However, some previous experience had been gained with 150 kV cables installed in deep shafts at the Porjus station, and subsequently with 220 kV cables in comparable installations. Considerable operational experience had also been gained with capacitors subjected to higher dielectric stresses than would arise in the new 380 kV cables.

TECHNICAL CONSIDERATIONS

A considerable fund of practical experience had accumulated in the use of capacitors and cables which indicated two methods of improving the dielectric strength, namely by employing high pressure of the impregnating oil and by using insulation made up of thin, heavily callendered capacitor paper. A cable design incorporating both methods had been considered as far back as 1930, but the need for it did not arise until the 380 kV transmission project was being designed. It is a costly method, partly because capacitor paper is expensive, both in purchase and application, and partly because high oil pressure entails added expense.

It is appropriate to mention here that high oil pressure will increase the A.C. strength and A.C. life of impregnated paper, whereas thin, heavily callendered paper improves the impulse, D.C. and short-time A.C. voltage strength. The more cellulose fibres which can be

(Continued from page 39)

Air Circulation Test

Description	(a) TOTAL AIR Area of opening	Speed in Ft/minute	Air in c. ft. per minute	(b) OUTSIDE AIR Area of opening	Speed in Ft/minute	Air in c. ft. per minute
Matrons Room ..	8″×8″	1154	508	9″×2¾″ 0.17 sft.	234	40
Ward II Large Left Wing	13″×12½″ 1.13 sft.	1926	2176	14″×3½″ 0.34 sft.	706	240
Ward II Small Left Wing	13″×12¼″ 1.10 sft.	1796	1975	14″×4″ 0.388 sft.	740	287
Ward III (Central) ..	13″×12″ 1.08 sft.	2267	2448	14″×3½″ 0.34 sft.	998	339
Operation Theatre ..	13¼″×9-1/8″ (2) 0.84 sft. each	700	588×2 1176	14″×14″ 1.77 sft.	520	920
Officers' Ward First Floor	13″×12¼″ 1.10 sft.	946	1040	14″×3″ 0.29 sft.	466	135

CONCLUSION

The installation and commissioning of the Air-Conditioning plant for air-conditioning the Operation Theatre and Wards in the Perambur Hospital is an outstanding landmark in the care and well-being of the employees and their families on the Southern Railway.

★ *B. Hansson, B. Bjurstrom, R. Johansson and G. Axelsson, Liljeholmen Cable Works.*

squeezed in between the conductor and the lead sheath, the higher will be the strength. The effect of increased fibre quantity is partly offset, however, by increased dielectric losses and hence by a reduction of the A.C. strength. High oil pressure may therefore be used to compensate for this loss.

Thin and dense paper is thus not always an advantage, whereas high oil pressure has no drawbacks except for the difficulty of providing the mechanical strength in the cable and cable terminals that it necessitates.

By combining these methods with the best raw materials obtainable, by taking every possible care in the manufacture, by using suitable machines and generally by employing every dodge known to the cable trade, it should be possible to turn out a 380 kV cable with much the same insulation thickness and external diameter as a 220 kV cable.

The new 380 kV cables were required to comply with the test specifications for paper cables which at that time were in course of preparation. A rather severe stipulation had been included in the specifications, which for a long time influenced the design and manufacture of the cable and its accessories.

In the test specification it was suggested that each cable length should be tested with a D.C. voltage of the same magnitude as the impulse voltage used in the testing of transformers, circuit breakers, *etc.* According to the specification, this D.C. voltage should have the same value as the insulation class figure. It would have been preferable to test each separate length by subjecting it to an impulse voltage, but the high voltages and long lengths of cable would have entailed a testing equipment with a capacity beyond anything available and it was for this reason that the D.C. test was substituted for the impulse method.

The insulation class for 380 kV is 1775. It was generally agreed, however, that a D.C. test voltage of this magnitude would prove too high for the cable. Nevertheless, very high voltages were proposed at the time.

In testing 150 kV cables with D.C. it had been found that a discharge across the terminals could cause a secondary breakdown of the cable. At first it was thought that the rapid reversal, from negative to positive voltage across the dielectric, was the primary cause. An explanation which is likely to prove more correct, however, is that the D.C. voltage stresses mainly the paper fibres, which have a higher dielectric constant than the oil, whereas the A.C. voltage test mainly stresses the oil which, having a lower dielectric constant, tends to break down.

The primary object was therefore to design cable terminals which would stand very high test voltages and a cable which would not break down as the result of a flash-over on the terminals. One way seemed to be to divide the paper insulation and the terminals into two, three or four parts, each one of which could be designed according to known methods. Large capacitors, connected in parallel with the various parts of the insulation and located either inside or outside the cable terminal would serve to distribute the voltage evenly over the insulation and thus prevent too high a voltage gradient in the insulation nearest the conductor and across the terminal. As the cable required for the Harspranget station would be rather short in any case and the capacitors would be required for over-voltage protection and purposes of measurement, the method was economically justifiable. Tests carried out on a small-scale model showed that this grading of the stresses functions not only for the 50 c/s voltages but also under other conditions, for instance for rapid impulses.

This solution of the cable problem was resorted to mainly because of the high D.C. voltage test, but as the Swedish State Power Board were fully aware of the difficulties entailed in testing with this excessive D.C. voltage, they very obligingly acceded to a final proposal that the voltage test should only be carried out as an acceptance test at 850 kV, subsequent to the cable being installed.

The attempts to produce a cable and terminals which would withstand these high D.C. test voltages have, however, yielded some lasting results: a terminal which is probably superior to earlier designs and a method of making capacity-graded cables which may be used still higher voltages.

However, the need for employing these methods ceased when the test requirements were modified, and the actual cable was made without equipotential screens. The cable terminal, on the other hand, was designed as a condenser bushing in which circular, series-connected capacitors are stacked on top of each other. The bottom one is connected to the lead sheath and the top one to the cable conductor. Capacitors of this type possess a much higher capacity than can be achieved with the conventional design of conical capacitor winding.

MANUFACTURE OF THE CABLE

It has already been mentioned that every device known in cable making was resorted to in order to turn out a

380 kV cable with the dimensions of a 220 kV cable. Space does not permit a detailed description of how the materials were selected and tested or the meticulous care the engineers and workers had to devote to the making of this cable. A brief description is given, however, of the machines and methods employed.

All cable dimensions had to be severely restricted in order to allow lead sheathing and armouring of a cable which had to be flexible in order to facilitate winding it on to drums, transporting it and storing it. It followed therefore, that the diameter of the copper core had to be kept as low as possible, while still having a copper cross-section of 500 mm² (0.78 sq. in). It had to be extremely compact and yet had to have adequate radial passages for evacuation and drying and for the oil flow.

The cross-section illustrates the design of the core, insulating sheath and armouring. The inner core is built up of segment-shaped wire, which after stranding was drawn to a smaller size, forming a perfectly circular cross-section. This core being too compact to allow oil to flow through it, radial wholes of 2 mm (0.08 in.) diameter were drilled every foot of the length. Two more layers of flat wire with well-rounded edges were stranded around the central core and the entire core assembly was then drawn through a circular die, giving a slight reduction in diameter. The surface of the finished core proved so smooth that it was possible to omit the usual layer of metallised paper.

The inner paper insulation, which is subjected to the highest stresses, is composed of very thin and narrow paper tape. Altogether, 28 mm (1.1 in.) thick paper insulation contains 500 papers, all of which are thinner, narrower and harder callendered than any commonly used in high voltage cable. It follows that very high demands were placed on the taping machines.

The drawback with the traditional type of paper taping machine is that the tension on the tape varies with the speed of the machine, because of the friction of the paper pads when they are pressed against their supports by centrifugal force. Friction due to centrifugal force has been eliminated by placing the axis of the pads at right angles to the axis of the cable, and the paper tension is regulated by a lever which is located close to the cable.

Another new and important principle was applied in the making of this cable, the object being to prevent the cable from becoming porous after drying. The design of the cable aimed at introducing as much paper fibre as possible between conductor and lead sheath and to avoid porosity, which results in low impulse strength. In the paper taping machine, means were therefore provided for successive drying of the tapes immediately after they had been applied. Each new tape was therefore laid on a dry and partly shrunken diameter.

Because of the dry, hard state of the insulation, the cable cannot be coiled on to drums of small diameter before it has been impregnated with insulating oil which, to some extent, acts as lubricant. For this reason it was necessary to build drums with a diameter of 5 m (16 ft.) and an impregnating tank large enough to admit these drums. Another difficulty was that this tank, despite the large expense of the flat sides, should be able to withstand atmospheric pressure when evacuated. The sides were therefore strengthened with reinforced concrete.

A standard Robertson 1600 ton hydraulic press was used for applying the lead sheath. As the lead sheath was designed to have oil channels on the inside and an external deameter of 100 mm (4 in.) the finish was not as smooth as desired. A second sheath was therefore applied, having an external diameter of 110 mm (4.3 in) and the press proved capable of extruding this second sheath very satisfactorily.

DESIGN

The following data were specified for the cable:

Power transmission capacity at 340 kV........360 MVA

Maximum transmission voltage..............400 kV

Normal transmission voltage 380 kV

Maximum short-circuit power, 0.15 secs. 10,000 MVA

Difference in level between ends of cable approx. 70 m (230 ft.)

Temperature in the cable channel 10—12 C

Insulation class 1775 kV

Impulse test voltage on 10 m (33 ft.) length, 5 impulses 1775 kV

A.C. test on one completed cable length, 1 minute 450 kV

D. C. test after installation, 1 minute 850 kV

Dielectric losses at 155 kV between conductor and sheath 0.5 per cent

at 305 kV between conductor and sheath 0.6 per cent

Pressure test on cable, 24 hours 30 kg cm² (427 lb./sq.in.)

Pressure test on cable terminals, inner part 25 kg/cm² (356 lb./sq.in.)

Pressure test on cable terminals, outer part 10 kg/cm² (142 lb./sq.in.)

A preliminary estimate of the requisite cross-sectional area of the core gave 450—550 mm² (0.70—085 sq.in.) and a diameter of 28—32 mm (1.10—1.26 in.). This core when surrounded by a 28 mm (1.1 in.) thick layer of insulation gave a diameter of 85—90 mm (3.35—3.5in.) under the lead sheath. With insulation of this thickness, particularly when made of very dense paper, it is not sufficient to have only one oil duct through the conductor if the cable is to be evacuated and impregnated thoroughly in a short time. It was therefore decided to employ oil ducts also on the inside of the lead sheath. These ducts have the further advantage of preventing a vacuum from forming in the insulation under the most adverse operating conditions. The ducts were formed by grooving the inside of the lead sheath to a depth of about 2 mm (0.08 in.), which therefore necessitated a total thickness of about 5.5 mm (0.22 in.) of the sheath.

The armouring had to be designed to withstand not only the oil pressure to which it might be subjected in service and under test, but also the forces which arise when laying the cable. In service the maximum oil pressure in the cable amounts to about 10 kg/cm² (142 lb./sq. in.), whereas the test pressure is 30 kg/cm² (427 lb./sq. in.). A tape armouring with short lay takes the radial force on the sheath and another tape armouring with long lay takes the longitudinal force.

Stainless steel is an excellent material for this purpose, but as this kind of strip was not available in Sweden, it was decided to use copper instead. Copper strip of 1 mm (0.04 in.) thickness was used for the short lay, applied in two layers, the second one breaking joint with the first one. Thirty strips, 10 mm (0.4 in.) wide and 0.5 mm (0.02 in.) thick were used for the long lay and a final covering of copper strip 0.5 mm (0.02 in.) thick and with short lay, was used as a final binding and to give added mechanical protection.

Dielectric strength

With an insulation thickness of 28 mm (1.1 in.) the peak stress caused by the 1775 kV impulse test will be 110 kV/mm (2800 kV/in.) while the 450 kV A.C. test (one minute duration) causes a voltage stress of 28 kV/mm (710 kV/in.) to the lead sheath. The working voltage of 380 kV is equivalent to a stress of 13.6 kV/mm (345 kV/in.). All these stress figures are higher than any used hitherto. Nevertheless, they are considered permissible in view of the surface smoothness of the conductor, the thin paper insulation and the high oil pressure used, and the tests performed on the finished cable confirmed that it was able to stand up to the stresses.

Losses and heating

The losses occuring in a cable of this kind may be divided into three categories : I^2R losses in the conductor, dielectric losses in the insulation and I^2R losses in sheath and armouring due to induced voltages.

A load of 360 MVA at 340 kV corresponds to a current of 615A. The loss per phase in the conductors amounts to 0.167 W/cm (0.425 W/in.). With the compact paper insulation used in this cable, the loss factor amounts to about 0.0035, which at 380 kV gives a dielectric loss of the order of 0.10 W/cm (0.25 W/in.) per phase. The losses in sheath and armouring for the three phases amount to approximately 38, 15 and 50 per cent of the conductor losses when the distance between the cables is 250 mm (10 in.) and they are laid in a row. The total losses for the first phase will therefore be 0.33 W/cm (0.84 W/in.), for the second phase 0.29 W/cm (0.74 W/in.) and for the third phase 0.35 W/cm (0.89 W/in.).

In order to be able to calculate the temperature gradient, it is first necessary to know the thermal resistances, which are as follows. Between the conductor and sheath, 90° C cm/W (35° C in./W), and between the sheath and the surface of the cable, 10°C cm/W (4° C in./W). Assuming the coefficient of heat dissipation to be 0.006° C cm²/W (0.0009°C sq.in./W), thermal resistance of the outside of the cable becomes 25° C cm/W (10°C in./W).

As there is a certain amount of mutual heating of the cables due to radiation and conduction, and as the value of the coefficient of heat dissipation is not known with any accuracy, a figure of 50 has been used instead of 25°C cm/W (10° C in./W). The temperature rise for each of the three phases then becomes 39, 37 and 40° C respectively.

The ambient temperature in the cable shaft is about 12° C and hence the cable temperature may rise to 52° C. Those parts of the cable which are exposed to the air temperature in the open, 25—30°C, may therefore attain a temperature of 65—70°C. Although this temperature is not excessive for an oil-filled cable with a lower working voltage, it should be avoided as far as possible in this case. One method of reducing the temperature is to keep the losses down by insulating the sheath and armouring from earth at one end of the cable, thereby eliminating the losses in the lead sheath and the armouring and preventing the peak temperature from exceeding 60°C.

Because of the over-voltages which may occur in the cable it is necessary, however, to have both ends connected to earth. It was therefore decided to insert a resistance of about 1 ohm between the lead sheath and earth at one end of the cable. As the resistance in the sheath and armouring is only about 0.01 to 0.02 ohms, the losses in the sheath will only amount to a few per cent of what they would have been with direct earthing. Instead, a voltage will arise between the sheath and earth, which in normal service will amount to about 18V. A 10,000 MVA short-circuit, which entails a current of 16,700 A, raises this voltage to earth to about 500 V and in order to prevent the P.V.C. tape covering the armouring from breaking down under this voltage and damaging the armouring where the cable is clamped to the wall, additional rubber insulation is provided.

Oil pressure

The difference in level between the cable ends is 65m (213 ft.) and this produces a static oil pressure of 5.8kg/cm² (82.5 lb./sq. in.). Super-imposed on this is a pressure of 4 kg/cm² (57 lb./sq.in.) at the upper end of the cable, which produces a total pressure at the lower end of 10 kg/cm² (142 lb./sq.in.).

The pressure drop arising in the cable due to changes in cable temperature is less than 8.2 kg/cm² (2.8 lb./sq.in.), while a short-circuit with the cable cold (0°C) raises the pressure by about 5 kg/cm² (71 lb./sq.in.), so that the total pressure at the lower end amounts to 15 kg/cm² (213 lb./sq.in.). The duration of the short circuit is no longer than 0.15 secs. In the winter the temperature around the upper part of the cable and the terminal may drop to —40°C. In order to prevent the cable and terminal temperature from dropping so low as to prevent oil flow or causing an excessive pressure drop, air is forced up from the cable shaft around the cable and terminal, having a temperature of 10 to 12° C.

Cable data

The cable data ultimately decided on are given in the following table, which also includes the double lead sheath that it was found necessary to apply during the final stages of the manufacture.

Tinned, drawn copper conductor ..	500 mm² (32 sq.in)
Insulation, thickness ..	28 mm (1.1 in.)
First lead sheath, provided with oil ducts, thickness ..	5.5 mm (0.22 in.)
Second lead sheath, thickness ..	3.5 mm (0.14 in.)

Bedding for armouring : P.V.C. and compound	
First layer of armouring : Two strips of soft copper 55×1 mm (2.2×0.04 in.) lay ..	70 mm (2.75 in.)
Second layer of armouring, 30 lengths of hard copper strip 10×0.5 mm (0.4×0.02 in.) lay	1200 mm (47 in.)
Third layer of armouring, 2 soft copper strips 30×0.5 mm (1.2×0.02 in.), lay ..	65 mm (2.56 in.)
Serving of P.V.C. tape ..	
Diameter of outer lead sheath ..	109 mm (4.29 in.)
External diameter	118 mm (4.65 in.)
Total weight	58 kg/m (35 lb./ft.)

Cable terminals

The first step to be taken in the design of the cable terminals was to decide on the length of the porcelain insulators. Experiments carried out in the high voltage laboratary at Ludvika indicated that a free length of 3400 mm (134 in.) should be adequate for the purpose. The overall length of one such porcelain insulator would then amount to about 3650 mm (144 in.). Because of the difficulty of manufacturing a porcelain insulator of that length in one single piece, it was decided to use a joined design, the parts being joined in the usual way at Asea's transformer works. All the porcelains were tested at pressure of 10 kg/cm² (142 lb./sq. in.) and no failures were recorded.

The insulators were fitted with paper phenolic tubes for taking up the pressure inside the insulators. These tubes, with a length of 3000 mm each (118 in.), were tested to a pressure of 35 kg/cm² (498 lb./sq. in.) over a long period without showing any trace of leakage. The capacitors referred to previously were placed inside the tubes. Each porcelain terminated in a carona cage having a diameter of 1550 mm (61 in.) and a height of 880 mm (34.6 in.).

INSTALLATION

The delivery of 380 kV cables from AB Liljeholmens Kabelfabrik comprised six lengths, two of which were installed at Harspranget, two at Kilforsen and two were to be held in reserve. The Harspranget cables connect the single-phase transformers, housed in cells blasted in the living rock 65 m (213 ft.) below the surface, with the overhead power line. The terminals at the lower end are suspended from the ceiling in the cells and the cables are run through a common shaft up to the terminals in the switchyard in the open.

Because of the size of the drums on which the cables were wound, diameter 4.6 m (15 ft.) and width 1.9 m (6.2 ft.), it was found that the railway gauge was exceeded, even when the drums were placed as low as possible in the special trucks, normally used for transporting heavy transformers. The railway transport therefore had to be effected by special train.

In order to facilitate lowering the cable down the shaft and to prevent the oil from leaking out of the cable during installation, the outer cable end on each drum had been fitted with a 4 m (13 ft.) long protective steel tube. These temporary pressure-tight steel terminals allowed the cable to be paid out without any risk of damage. The heavy and bulky laminated tube terminals were then fitted when the cable had been installed. Another advantage of providing these protective casings was that the installation work could commence as soon as the cables arrived on the site.

At first the cable drums were run up to the shaft entrance. Various mechanical appliances had to be employed to facilitate lowering the cable through the shaft, which was a particularly complicated task. Care had to be taken to see that the cable was not exposed to undue bending at any point. The vertical portion of the shaft is 47 m (154 ft.) deep and the weight of the corresponding cable length amounts to about 2.5 tons. The weight of the cable was taken by a steel wire, fastened by means of cable straps and turnbuckles so as to distribute the weight along the wire.

The procedure for fixing the terminals was essentially the same as for all oil-filled cables, but the high oil pressure and high voltage called for greater care in supervision.

While the installation work was still in progress, the capacity of each condenser was checked, and a contact device built into the protective sleeve facilitated checking the total capacity after the bakelite tube and porcelain had been fitted in position.

The oil system in each cable is divided up into three sections. The high-pressure section consists of the cable with the inner portions of the terminals, the oil pressure in which is maintained by a pressure tank located above ground. The other two systems include the outer portions of the upper and lower terminals and their tanks. At the top end of the cable the pressure i about 5 kg/cm^2 (71 lb./sq.in.) and in the porcelain about 1 kg/cm^2 (14 lb. sq.in.).

CABLE TESTS

As there were no cable specifications in existence for testing cables of this voltage, the test specifications for the 380 kV cable were composed in collaboration with the customer. The Swedish standard specification SEN 37 was adhered to where applicable.

The most important tests are the impulse test at 1775 kV, the A.C. tests at 50 c/s, covering a withstand test at 450 kV for one minute applied to the entire length of cable and measurement of the dielectric losses both before and after the test, a puncture test carried out on a short length of cable, pressure and voltage tests at 850 kV D.C. for one minute on the installed cable.

Impulse test

This test was carried out on a short length of cable, the two ends of which were fitted with capacitors, pressure tubes of laminated paper and porcelain casings. The corona cages were then fitted to the ends of each terminal. A test length of 19.5 m (64 ft.), including the cable end enclosed by the terminal, was bent into a U-shape over a radius of 2.75 m (9 ft.). The total capacitance, including the capacitors, was 5120 $\mu\mu$F.

The impulse test was carried out in the high voltage laboratory at Ludvika, using an impulse battery with a rating of 3600 kV and 90 kWs. This test was made with negative impulses, partly as a withstand test at a voltage of 1775 kV and partly as a breakdown test. A cathode ray oscillograph was used for checking the voltage and wave shape. Owing to the high capacitance of the test cable, it was not possible to achieve the normal waveform of 1/50, the shortest attainable wave front that could be reached without excessive front oscillations being 2 μs.

After calibration with a sphere gap, the withstand test was carried out with five impulses at 1775 kV 2/50 and after as short intervals as possible. Because of the comparatively long time required to recharge the impulse battery to this high test voltage, only one impulse could be obtained every other minute. No fault indications were to be found on the oscillograms and hence the cable was accepted as complying with the requirements for insulation class 1775.

After the withstand test the voltage was increased in a few steps, up to the breakdown voltage. The cable was subjected to one impulse at 1865 kV and another one at 1855 kV. For neither of these voltages did the oscillograms indicate any fault in the cable. Then the voltage was increased to five impulses at 1950 kV and the oscillograms showed a front breakdown at the first impulse.

Alternating current tests at 50 c/s

One of the cable lengths delivered was fitted at each end with guiding capacitors and bakelite pressure tubes, but without outer porcelains, for the purpose of measuring the dielectric losses and the cable capacitance, at voltages of 155, 220 and 305 kV, using a Schering bridge. Afterwards, a withstand test was made at 450 kV A.C. for a period of one minute. A final measurement of the losses was then made, using the same voltages as before. The losses, measured before and after the withstand test, amounted to 0.34 per cent at 155 and 220 kV and 0.36 per cent at 350 kV.

A short length of cable fitted with complete terminals was then subjected to an A.C. test in steps of 25—50kV until breakdown occured. The initial test voltage in this case was 435 kV and each fresh voltage was impressed for a period of one minute. The oil pressure in the cable was 4 kg cm^2 (51 lb. sq.in.). Ultimatley, breakdown occured at 782 kV after 14 seconds. Before making this test the dielectric losses in the capacitance of the test piece were measured and found to be the same as for the full length of cable.

Pressure test

Each cable was tested for 24 hours at an oil pressure of 30 kg cm^2 (427 lb. sq.in.). An attempt was also made to determine the bursting pressure, using a short length of cable on which the armouring had been safely secured at both ends. At 79 kg cm^2 (1124 lb./sq.in.) the armouring broke away at one end. The bakelite tubes were pressure tested at 25 kg/cm^2 (356 lb. sq.in.) for 24 hours and the porcelain at 10 kg/cm^2 (142 lb. sq.in.) for the same period.

TESTING OF THE INSTALLED CABLE

After the cables had been installed they were subjected to a D.C. test at 850 kV for one minute. This voltage was supplied by a six-stage rectifier in cascade connection, capable of giving a voltage of 1200 kV. Oil-insulated selenium elements, enclosed in bakelite tubes, were used for this purpose. The blocking voltage for each rectifier element was 200 kV. The rectifier was set up in the open, between two cable terminals and was fed from a 25 kVA converter set.

(Continued on page 47)

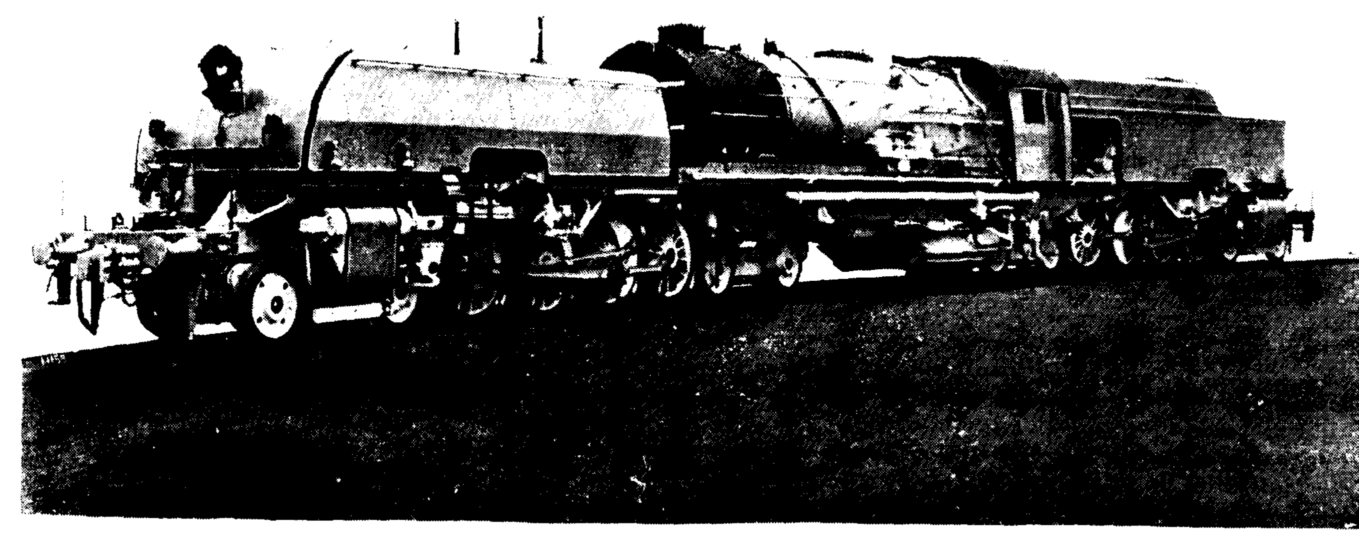
THE BEYER PEACOCK CENTENARY

By Our London Correspondent

THIS year is the centenary year of Messrs. Beyer Peacock and Co., Ltd. and marks the completion of one hundred years in the development and progress of locomotive building. In 1854, the private company of Beyer Peacock was founded by three principals, Charles Frederick Beyer, Richard Peacock and Henry Robertson. Twelve acres of ground were purchased at Gorton, a suburb of Manchester, adjacent to the Manchester, Sheffield and Lincolnshire Rly. Later, other purchases of land were made up to railway limits. The total site then covered about thirty acres.

In this factory the company has designed and manufactured all types of steam locomotives and during the two world wars the plant produced many different types of armaments. Since the firm started so soon after railways as a public form of transport took their rise their production has developed in parallel with the world's railway systems. It is therefore proud of the contribution it has made both in locomotive design and production methods. Manchester is renowned for its craftmanship and locomotives bearing the name of Beyer Peacock are to be found in every part of the world's railway systems. Many locomotives, built over half a century ago, are still running today.

The company's traditions of engineering skill, craftmanship and design have been carefully preserved throughout the years. In 1902 it became a public corporation and is now many times the size of the original enterprise. Since 1932 Beyer Peacock and Co. Ltd., have expanded their activities into other fields so that the Beyer Peacock Group now includes various wholly owned subsidiary companies with factories in East Anglia, Southern and Western England. These cover the manufacture of a wide range of mechanical and civil engineering products, industrial refrigeration, machine tools, agricultural and food machinery and many domestic and export supplies. The association company of Metropolitan Vickers-Beyer Peacock Ltd. has a new factory at Stockton-on-Tees for the production of electric, diesel electric and gas turbine electric locomotives. The Directors of Beyer Peacock and Co. Ltd. for many years have practised the principle that leading export firms should familiarise themselves

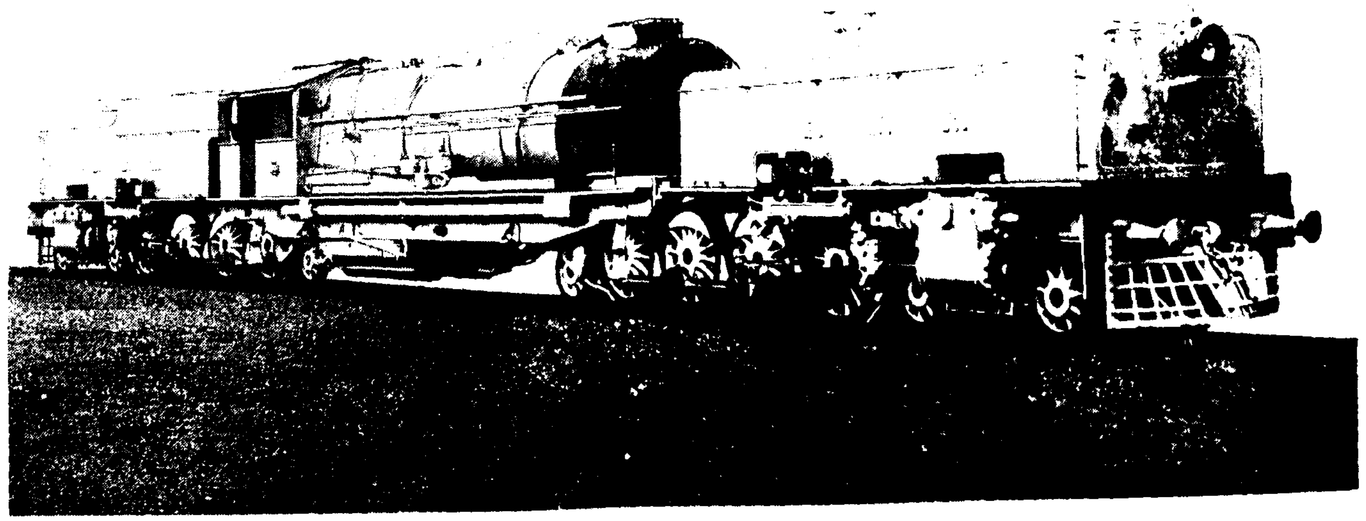


4-8-4 plus 4-8-4 locomotive supplied by Messrs. Beyer, Peacock & Co. Ltd., to the New South Wales Government Railways, Australia.

(Continued from page 46)

The high voltage D.C. was measured directly by means of an oil-insulated voltage divider having a total resistance of 1100 megohms. In order to eliminate corona losses, the voltage was carried from the rectifier to the terminals by an aluminium tube with a diameter of 15 cm. The whole test equipment was housed in a tent, one flap of which could be folded back when testing.

The cables successfully withstood this voltage and the tests were satisfactorily concluded despite the temporary nature of the outdoor testing rig. (Asea Journal)



4-8-2 plus 2-8-4 Beyer Garratt locomotive supplied to the former Bengal Nagpur Railway.

with world market conditions by personal contact and there is no doubt that this principle is strongly commended.

The name of Beyer Peacock has a world wide association with its speciality the Garratt articulated locomotive introduced in 1907. Following this development many examples of this type of locomotive have been produced and used on overseas railways. They are particularly suitable for the ardous conditions of grade and load that these railways require.

The introduction of Beyer Garratt locomotives played an important part in the improvement of traffic conditions on the former Bengal Nagpur Railway. As it is known, this railway served at vast area embracing no fewer than five coalfields and extensive mineral deposits of iron ore, manganese and limestone, the whole yielding a heavy traffic and calling for the most efficient means transportation. Such important undertakings as the Tata Iron & Steel Company's Works, the largest in India, the Bengal Iron Company and the Indian Iron and Steel Company are situated on this railway's lines, while through traffic in other commodities, such as grain, timber, salt, cotton etc. and a large pilgrim traffic intensify the problems of operation.

In 1926, with the object of testing the claims of the Garratt locomotive, two eight coupled engines of this type were obtained from Beyer Peacock and Co. Ltd. They were placed in service on the Adra—Chakhar-dhapore section where they proved able to handle the 1,650 ton loads previously hauled by two engines. After three years experience with these engines a further sixteen of the 4-8-0 plus 0-8-4 type and designated Class 'N' were ordered for use. These locomotives were so satisfactory that others were supplied. Similar locomotives have also been supplied to the busy railways of Australia and to many other parts of the world.

COLOMBO PLAN TRAINING IN U. K. FOR PAKISTANI RAILWAY ENGINEER

Among the latest arrivals to join the other 200 or so trainees now in Britain under the Technical Co-operation Scheme of the Colombo Plan is Mr. Ahmad Abdur Rahman, a District Mechanical Engineer from Pakistan. He is at present at the Derby locomotive works studying various aspects of railway engineering.

Mr. Rahman will spend six months in British Railways' locomotive workshops — three months at Derby and three at Crewe, Cheshire — followed by visits to firms manufacturing steam-locomotive equipment.

INDIAN STANDARDS INSTITUTION NOTES

THE Indian Standards Institution has circulated for comments a draft Indian Standard Specification for Graphite Flake. The requirements laid down in it are intended to ensure uniformity in the quality of graphite flake to be used in the manufacture of lubricant greases.

For determining the fineness of material, British Test Sieves have been prescribed. The Indian Standard Specification for Test Sieves is shortly to go to press, and the corresponding mesh numbers in it will be specified when the draft is finalized.

* * *

An Indian Standard Specification for Grease, S No. 3 has been published by the Indian Standards Institution. This grease is used for the lubrication of high speed ball and roller bearings.

The requirements detailed in the standard relate to the ingredients of the grease, the percentage of moisture and volatile matter in it, the consistency of the worked material, etc. The standard, besides giving reference to relevant methods of test in IS: 310—Indian Standard Method of Sampling and Test on Lubricants Part II (which is under preparation) also details tests for stability and resistance to mechanical breakdown (Rolling stability).

This standard has been prepared by ISI's Lubricants Sectional Committee which includes nominees of important oil interests in the country as also representatives of Government departments and Council of Scientific and Industrial Research.

This standard is now available for sale with the ISI at a price of Re. 1/-.

* * *

A standard for insulating oil for transformers and switchgear (low viscosity type) has been prepared by the Indian Standards Institution.

This standard prescribes requirements and methods of test for insulating oil used for the immersion or filling of transformers, switchgear, motor control gear and other electrical plant in which oil is used as an insulating medium or for heat transfer.

The standard also details in appendices the method of sampling of insulating oil, tests for tendency to sludge and for development of acidity, methods for determination of loss on heating and for the determination of pour point and of electric strength.

This standard has been formulated by ISI's Lubricants Sectional Committee which includes nominees of important oil interests in the country as also representatives of various Government departments and Council of Scientific and Industrial Research.

This standard priced at Rs. 2—8—0 is now available for sale at ISI's office at 19 University Road, Delhi 8.

* * *

The Indian Standards Institution has circulated to interested parties in the country draft Indian Standards for: Crow-Bars and Claw-Bars, Axes and Adzes.

The proposed Standard for Crow-Bars and Claw-Bars confines itself to plain carbon crow-bars and claw-bars used by the railways and crow-bars intended for general use as well as by the railways. It covers three types of crow-bars and one type of claw-bar.

The projected Standard for Axes for hewing, cleaving or chopping trees, wood, etc. is intended to regulate the manufacture of the three most popular types of axes.

The draft Standard for Adzes lays down the requirements for and is intended to regulate the manufacture of the 5 most popular sizes of adzes.

* * *

A draft Standard Specification for Wooden Separators for Lead Acid Storage Batteries has been circulated for comments to interested parties in the country by the Indian Standards Institution.

The need for standardization of battery separators was emphasized at a meeting in 1950 attended by the manufacturers of batteries and battery separators and a representative of the Forest Research Institute. There are at present about twenty different sizes of battery separators in use. It is expected that standardization will help reduce the multiplicity of design and bring about simplification in the manufacture of separators.

This draft standard covers the requirements for wooden battery separators used in low and heavy lead-acid storage batteries. The species of Indian timber detailed in the draft have been recommended by the Forest Research Institute on the basis of its experiments. When further research results become available, additions may be made to the list of various types of timber specified in the standard.

Some battery manufacturers do their own grooving and finishing and therefore prefer the supply of veneers instead of ready made separators. This standard does not specify the veneers separately but the specifications governing the quality and other requirements of the separators can be used as the basis for checking the quality of veneers. Certain battery manufacturers prefer to treat the separators themselves, and this standard may, therefore, be used for the purchase of untreated separators as well.

* * *

Shri T. T. Krishnamachari, Central Minister for Commerce and Industry and President of the Indian Standards Institution inaugurated the first meeting of the high-level Structural Steel Sectional Committee at Calcutta on Saturday, 13 February 1954.

This Committee set up by the Indian Standards Institution under the Chairmanship of Sir J. J. Ghandy, Resident Director, Tata Iron and Steel Co. Ltd., is expected to suggest economies which can be achieved through standards in the present methods of the use of structural steel. It is estimated that the present practices result in an annual wastage of approximately 1,50,000 tons valued at nearly Rs. 9 crores at the rate of imported steel.

The Committee includes representatives of the Institution of Engineers (India), The Indian Institute of Architects, Tata Iron and Steel Co. Ltd., Steel Corporation of Bengal Ltd., Mysore Iron and Steel Works, Braithwaite, Burn and Jessop Construction Co. Ltd., J. C. Gammon Ltd., International Lightweight Steel Structurals and Bridge and Roof Co. (India) Ltd., as also nominees of the Railway Board, Engineer-in-Chief's Branch, Ministry of Commerce and Industry, Development Wing, Roads Organization, Ministry of Transport, Central Public Works Department, Indian Roads Congress and other interested Government Organizations.

The Technical Co-operation Administration of the USA has also made available for the work of this Committee the services of a firm of consultants namely, Ramseyer and Miller of New York who have considerable experience in the field of production of steel and design and erection of strutures. Mr. M. L. Goldsmith of Ramseyer and Miller will be stationed in India for the duration of the project and their Senior Engineer, Mr. J. R. Miller will be coming out to India from time to time to supervise the work and render such advise and aid as may be necessary. Also, the Railway Board have loaned for this purpose to the Indian Standards Institution one of their outstanding structural engineers, Shri T. V. Joseph. The Committee formed at the recommendation of the Planning Commission has been asked to suggest a revision of the present standards for the production of heavy sections, standardization of light weight sections, popularization of the use welding and rational code for the use steel generally. It would also direct experimental research and investigations aimed at a better understanding of the behaviour of steel structures.

* * *

The Indian Standards Institution has announced the publication of a Standard Specification for copper wire, a basic material for electrical industry. The copper wires covered in the Standard of the bare annealed variety, plain and tinned. These wires are specifically intended for winding electrical machinery and apparatus. This standard for annealed copper wire is scheduled to serve as a basis for further standards in respect of insulated and covered copper wires.

The standard specifies three different sizes of wires. It prescribes the size which is to be given first preference and the size which is to be given second priority apart from indicating sizes which are not recommended for general use. It recalls that copper wires of the guages commonly used in telegraph lines, whose unauthorized possession is an offence, fall within the category of wires not recommended for general use.

This standard also specifies resistance for different sizes of wire and the standard weight, and prescribes a minimum elongation to ensure proper annealing of the wire. The basic constants of copper used in this standard are in accordance with the recommendations of the International Electrotechnical Commission.

This standard has been formulated under the direction of ISI's Electrical Conductors and Insulators Sectional Committee which includes nominees of the Central Water and Power Commission (Power Wing), Metallurgical Inspectorate, Tatanagar, Engineer-in-Chief's Branch (Army Headquarters), Government Test House (Alipore), Directorate General of Posts and Telegraphs, Railway Board, as also representatives of All India Pottery Manufacturers' Association, the Federation of Electricity Undertakings of India, Fan Makers' Association of India, Indian Electrical Manufacturers' Association, Eastern Committee of the Overseas Rubber Cable Manufacturers' Association and other important manufacturers.

RAILWAY OFFICIALS' GAZETTE

SRI. K. SWARUP, DY. CHIEF MECHANICAL ENGINEER

Shri K. Swarup.

Mr. Swarup has been deputed by the Government of India to Switzerland to supervise the technical details connected with the setting up of the Integral Coach factory at Perambur through the technical cooperation of Messrs. Swiss Car & Elevator Manufacturing Corporation Ltd., Schlieren-Zurich, one of the greatest manufacturers of Railway Coaches of world reputation.

After graduating in Science from Agra University at the early age of 19, he joined the Railways as a Special Class Apprentice in the year 1929 and was appointed as an Officer on probation on the ex-East Indian Railway in 1935 after passing the A. M. I. Mech. E. Examination. He was commissioned in the Army in 1940 and rose to the rank of Major in the Corps of Indian Engineers. He was awarded the title of M. B. E., in the Birthday Honours of 1943 in recognition of his services. Later in 1943, he was recalled by the Railways.

On return to the Railways, he worked for about eight years as a Works Manager in Lillooah and Alambagh Carriage and Wagon Shops of ex-E. I. Railway and was selected in 1951 to go to the U. S. A. and Canada to specialise in Production Engineering. After a short spell on the North Eastern Railway where he worked as Regional Mechanical Engineer, he was posted to the Integral Coach Factory as Dy. Chief Mechanical Engineer in charge of the Mechanical Department.

This factory will produce 350 all-steel welded carriages a year a turn-over of Rs. 4 crores a year.

MORE BRITISH TECHNICIANS FOR CHITTARANJAN

EXPERTS' SERVICES PROVIDED

More British technicians are coming to India to further the assistance the U. K. is already giving, in both technical aid and the supply of components, to the locomotive factory at Chittaranjan.

The British locomotive manufacturing industry has collaborated with the Government of India in this project, and British technicians have already visited the works, which now employ 4,000 men and at which, the Indian Government announced recently, production is to be stepped up to 150 locomotives a year. At the end of 1953 a British team of three rate-fixers and five operator-demonstrators came out to Chittaranjan under a year's contract under the Techinical Co-operation Scheme of the Colombo Plan. It is in continuation of this aid that the British Government is now meeting a further request by India, again under the Colombo Plan Scheme, for the services of 13 more specialists for a period of two years.

Three of the vacancies are being filled by the renewal of contracts of three members of the previous team who are at Chittaranjan—Mr. R. S. Jordan (foundry rate-fixer), and Mr. G. Newberry and Mr. J. A. Brown (heavy machine tool demonstrators). Eight others are now coming from Britain, and the filling of the two remaining vacancies is under negotiation.

Among the five who left for India on March 25 is Mr. N. E. McNeice, from Motherwell, Lanarkshire, who will be demonstrator-instructor at the technical school at Chittaranjan. An engineering draughtsman with Messrs.

(Continued on page 52)

BOOK REVIEW

"BRITAIN—AN OFFICIAL HANDBOOK"

Prepared By The Central Office of Information, London

WE have received a copy of the latest publication prepared by the Central Office of Information, London entitled "BRITAIN AN OFFICIAL HANDBOOK". The book is nicely bound and is packed with interesting information on various aspects of life in Great Britain today. The book is divided into various chapters for the purpose of elaborate treatment of each facet of British life and a thorough historical study is provided in each respect with upto-date information and statistical data. The book is on sale now and can be had of the Regional Information Officer, British Information Services, Mercantile Bank Buildings, Fort, Bombay.

In short a factual handbook of some million and a half words has been produced in London which will answer all your queries. It also provides in condensed easily readable form a wide range of basic reference material dealing with British Government and administration, the national economy, transport and communications, labour and management, social welfare, religion, science and the arts, broadcasting and the British press.

About Transport and particularly about British Railways we give here below some interesting information :—

Britain has more railways per square mile than any country in the world, except Belgium and British Railways are now the busiest in the world. They run 40,000 passenger and goods trains daily, carrying nearly three million passengers a day and about three quarters of a million tons of freight each weekday.

About the Locomotive Industry in Britain today :—

Britain was the first country to develop the locomotive railway and British Engineers pioneered railway development in all parts of the world. Locomotive Industry i. e. Locomotives and rail vehicles provided exports to Britain valued at nearly £.37 million in 1952, an astounding figure which goes to the credit of the industrialists engaged in the manufacture of these vehicles.

The Locomotive Industry is divided into two sections today: One of these comprise the locomotive works of the main British Railways and is engaged in building and repairing locomotives and rolling-stock for their use; the other consists of private firms providing locomotives for export purposes only.

During 1952, 759 Steam Locomotives were manufactured of which 210 were pressed into the service of the British Railways, 299 were exported to the railways of the world and the remaining 50 were of a particular type suited to Industrial requirements.

Similarly 651 Diesel and Diesel-Electric Locomotives were manufactured during 1952 which 62 accounted for the use of the British Railways, 182 for industrial purposes and the remaining 407 for export to the railways of the world. It will thus be seen that inspite of the devastating effect of world war II British Locomotive Industry has not only regained its former strength but has improved the export figure considerably to the astonishment of all concerned.

(Continued from page 51)

Colvilles Ltd., steel manufacturers, of Motherwell, Mr. McNeice has also been teacher of engineering subjects to apprentices at Coatbridge Technical College.

Others who are coming with Mr. McNeice are Mr. D. McIntosh, welding engineer from Dunfermline, who has been with the Naval Construction Research Establishment, Rosyth, since 1947; Mr. J. A. Cameron, fitting and erection shop rate-fixer with Cammell Laird & Co., Ltd., engineers and shipbuilders of Birkenhead, since 1946; Mr. A. Mitchell, who, after serving with the North British Locomotive Company Ltd., Glasgow, has since 1947 been with Robert Stephenson and Hawthorns Ltd., of Darlington, and is coming out as a heavy machine tool demonstrator; and Mr. G. McCaffrey, who has been process engineer for smithy and forge with the North British Locomotive Company Ltd. and will work at Chittaranjan as a smithy and forge rate-fixer.

Flying to India on March 27 are Mr. A. J. Heel, from Leeds, and Mr. A. Thoms, from Liverpool. Mr. Heel, who was from 1946 to 1953 at the Royal Ordnance Factory at Barnbow, Leeds, is coming out as a light machine tool demonstrator. Mr. Thoms, a grinding-machine demonstrator, has for the past two years been foreman with the firm of D. Napier & Son Ltd. of Liverpool.

Last of the party from Britain, leaving on April 1, is Mr. J. Aird, who was with the North British Locomotive Company Ltd. for 10 years, being latterly in charge of the Tool Development and Methods Department, and who will be a boiler shop rate-fixer at Chittaranjan.

MACHINE SHOP SUPPLEMENT

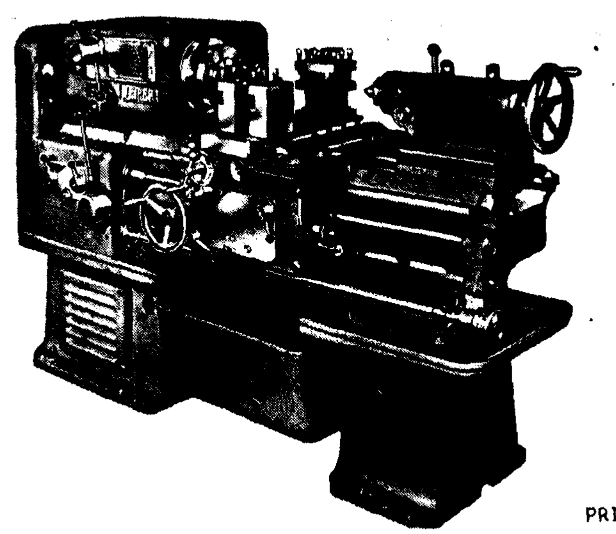
This section deals with some interesting aspects of the Machine Tools Industry and also with some important range of manufactures, both foreign and indigenous, employed in the Workshops of our Railways. Wherever possible, important working details supported by photographs and data relating to the equipments are given.

THE MACHINE TOOL INDUSTRY

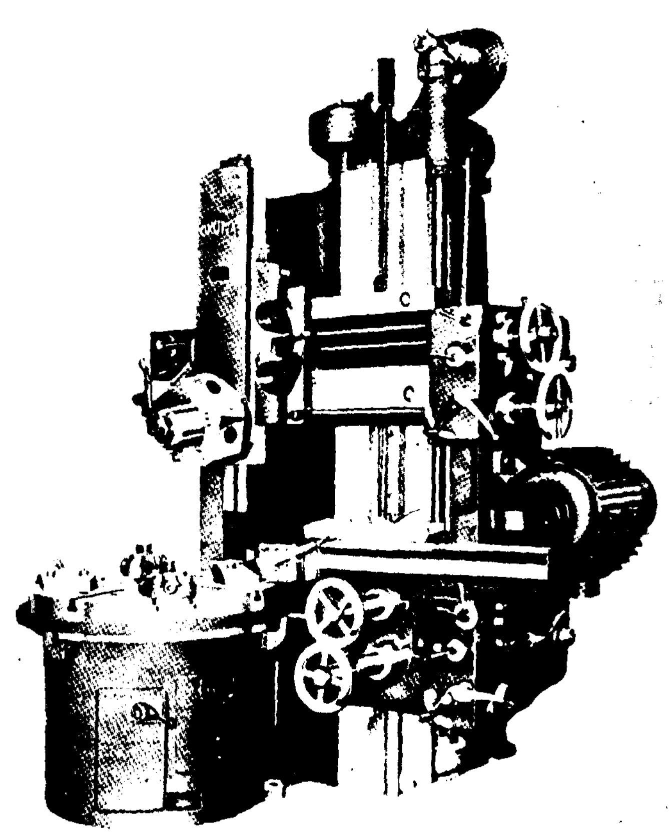
By A. J. Gibbs Smith

WITH its fifteen principal private works, the imposing government undertaking at Ambernath, and the smaller Bangalore works devoted to the production of machine tools, the value of India's output in this field is destined to expand enormously in the near future. During the last three years, it has been 26 lakhs Rs. (£ 1.9 million) in 1950, 47 lakhs (£ 3.5 million) in 1951, and 42 lakhs (£ 3.1 million) in 1952. In this latter year it exceeded the Japanese output of 1,600 million yen (21.2 lakhs Rs.), and it was also larger than that of a number of European countries such as the Netherlands, Denmark, and Austria; but some indication of the field which is open before the Indian industry can be gauged from the value of imports during the same period, which was: 1950, 325 lakhs Rs. (£24.3 million), 1951, 252 lakhs (18.9 million), and 1952, 311 lakhs (£23.3 million).

To-day, even the layman is beginning to appreciate that this is the industry upon which all industrial production mainly depends and its development and its maintenance of a competitive position are matters which vitally concern railway and all other engineers. For the purpose of comparison, a survey has recently been undertaken with the object of presenting a bird's-eye view of the stage of development, the price-level, and the exporting capacity of this key industry in the western countries, and as the data upon which the survey has been based has been furnished either by official statistics or by the Makers' Associations of the countries concerned the find-



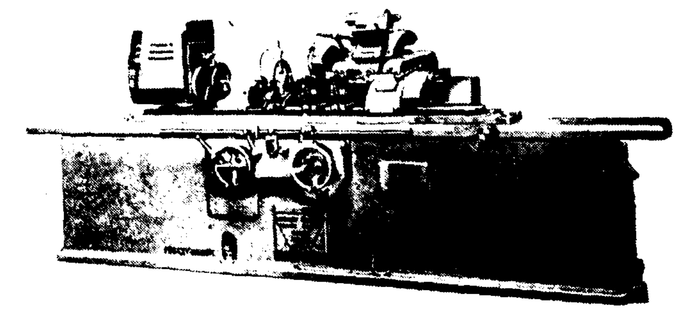
A modern German production lathe (Ferd. C. Weipert, of Heilbronn a. N.)



Japanese vertical boring and turning mill, whose design is admittedly based upon the German Schiess mill. Japanese annual capacity in machines of this type is estimated at about 66 machines of a total weight of some 718 tons. (Hitachi Seiki K. K. No. 2, 2-chome, Marunouchi, Chiyoda-ku, Tokyo)

ings are sufficiently objective to be deserving of study by every engineer concerned with the manufacture, the purchase, or the use of machine tools. The total production value in the twelve countries covered had, by the end of 1952, been pushed up to some £663 million per annum, giving employment to a labour force of some 237 thousand workers, and Table 1 gives a summary which will permit a ready comparison of the position in any of the territories named.

Taking the various countries in the order as presented, production in the U.S.A. accounted for about 60% of this total output already referred to, although the labour force was only a quarter of the total. During the last three years, the value of the production has been nearly quadrupled as compared with the £109 million in 1950, in spite of which the domestic requirements of this



A well-known English make of Grinding Machine (Keighley Grinders & Machine Tools, Ltd., Keighley)

country have been so enormous that during 1952 machines to a value of £17.6 million were imported. This amount, though trifling compared with the total American production, is yet greater than the total volume of exports from many of the other countries mentioned in the table.

In Canada, there are only about 11 makers, whose total production has approximately doubled since 1950 when it was £2.8 million.

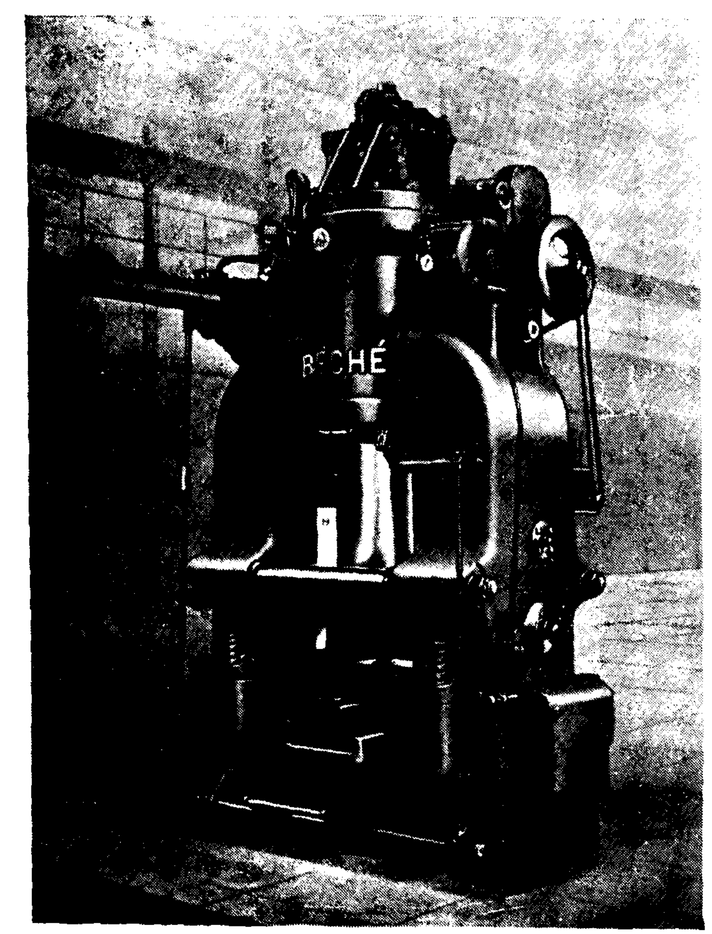
Production in the United Kingom has increased from the 1950 level of £40.5 million by about 50% during the same period, during which prices have hardened somewhat, the amount of the price increase being about 21%. Even so, British machine-tool prices remain the lowest of any of the countries under review. The heavy government buying for the defence programme has considerably upset the normal situation here, for although exports in this line amounted to £22.3 million, exports were for the first time surpassed by imports, which latter during 1952 amounted to £36.5 million, the main sources of supply being the United States 46%, Western Germany 22%, Italy 8%, and Switzerland 7½%.

In France, the value of machine-tool production has practically doubled compared with the 1950 level of £23.4 million, but this increase is mainly due to increased prices which have risen from an average of £437 to £700 per ton, the actual increase in production, as indicated by the tonnage, being a little over 13%.

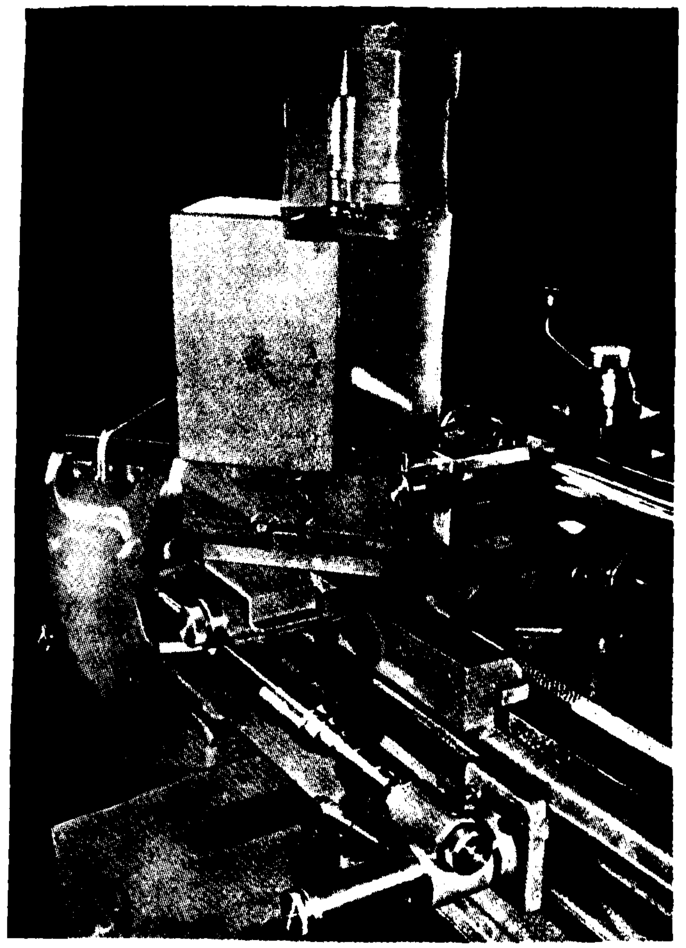
It is probable that the recovery of the German machine-tool industry was first brought home to the average engineer outside that country on the occasion of the First European Exhibition held in Paris in the autumn of 1951. During the last three years, production has doubled, considered on a tonnage basis, and exports have increased from 37% to 57%. Average prices during the same period have increased from £417 per ton to £569/t. British imports of machine tools from this country in 1952 were £13 million, the price average being £690 per ton, the most important class being those represented by grinding and honing machines, the total value of which was £1.48 million, the average value being £832 per ton.

No official data exists in Switzerland respecting the total value of production in this line, but the figure quoted in the table is an estimate by the Societe Suisse des Constructeurs de machines, and probably represents an increase of about 50% over the last three years considered on a tonnage basis.

The position in Italy has been marked by an increase in exports during 1952 to 15.6 thousand tons, but in making a comparison over a three-year period it has to



The heavy machine-tool industry of western Germany is now once more in evidence. A new high-speed forging hammer, 1600 mkg., 220 blows per minute, for connecting rods (Bech & Grobs G. m. b. H., of Hueckewagen)



A French coping lathe (Etabts. A. Caseneuve S. A., La Plaine Saint-Denis.

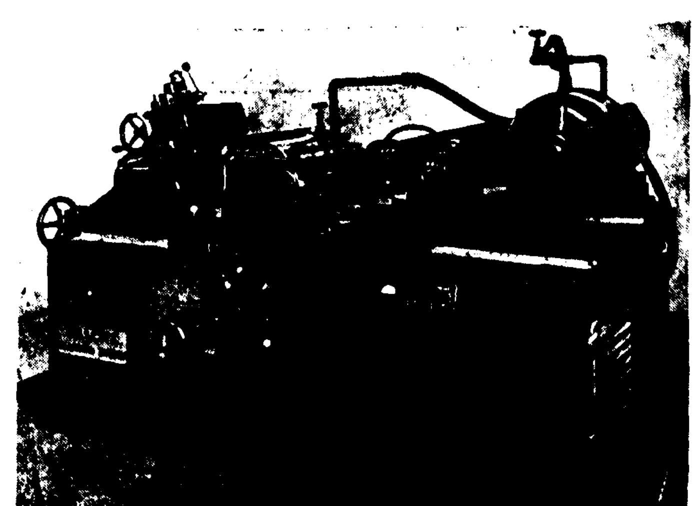
be borne in mind that exports for 1950 were at the low level of some 10,000 tons. In spite of the advance recorded by the table, Italian exports have not yet regained the high-water mark of 17 thousand tons reached during 1948. During 1952, the United Kingdom imported Italian machine tools of a total value of £4.59 million, weight being 5748 tons representing an average price level of £800/t.

Belgian production was nearly double that of 1950, during which latter year it was some £3.5 million. British official statistics show that machines value £2.9 million were taken by the United Kingdom, the price for which averaged £647 per ton. Of these, heavy lathes formed the most important individual class, numbering 537 machines of a total weight of 1622 tons.

Austrian production has not increased to any marked extent during the last three years, and its machine-tool industry is still characterised by a low productivity figure per worker.

In examining the situation in Sweden, the enquirer is somewhat hampered by the fact that very few manufacturers make machine tools their exclusive production, and there is a considerable volume made in the smaller engineering shops alongside other engineering products. However, in this country about 20 firms are responsible for somewhat more than 80% of the total production in this line. The value of production has somewhat more than doubled during the three years under review. During the first six months of 1953, the United Kingdom imported 168 Swedish machines of a total value of £308,000, the most important individual class being grinding machines.

From the basic figures recorded in the foregoing survey, it would be tempting to conjecture the probable course of events in the future, but this will not be done by the writer who has preferred to confine himself to definitely ascertainable facts. Forecasts in this field, such as the report of the Machinery Committee of the Organisation for European Economic Co-operation, have shown how markedly actual results can differ from forecasts and estimates, even when the latter are based upon the data and information available at ministerial levels. Certain tentative conclusions may certainly be drawn from the figures included in this survey, but any such estimates must take into account the practical completion of the imported tool programme of the United States and the United Kingdom, which implies that demand, prices, and general conditions in most countries will tend to revert to a more normal pattern than the one which has been apparent during the last two or three years.



A Swedish contreless grinder, of which large numbers are at the present time being exported (Malcus Holmquist, Halmstad)

TABLE—I MACHINE TOOL PRODUCTION FOR 1952 IN WESTERN COUNTRIES

		U.S.A.	Canada	U.K.	France	West Germany	Switzer-land	Italy	Belgium	Austria	Sweden.	Den-mark	Nether-lands
WORKERS	.. thou.	65	2.3	42.1	22.1	65	10	15	4	2.9	—	—	1
PRODUCTION	..thou.t.	—	—	151	56.7	170	20(2)	25	—	2.4	—	—	—
value	..mil. £	402	5.5	62	45.4	86.4	25(2)	17.1	6.3	2.2	10	1.4	0.3
per man	.. £	6168	2400	1500	2054	1330	2500(2)	1140	1589	743	—	—	—
value per ton	.. £	—	—	410	800	506		684	—	900	—	—	—
EXPORTS	..thou.t.	—	—	48.7	19	87.6	13.5	15.6	7.3(1)	0.29	8.9	—	—
value	.. mil.£	43.5	1.3	22.3	13.6	49.9	17	10.7	4.7	0.4	4.8	1	—
per cent	.. %	10	23	36	30	57	67	60	74	20	48	74	—
value per ton	.. £	1230(1)	—	458	700	569	1257	812	647(1)	1513	543	—	—

1. Based upon exports to the United Kingdom. 2. Estimated by the Makers' Association. 3. 1951 figures. 4. Year ending June 30, 1952.

Adaptability of Dowding & Doll's Range of Machines

PATENT SPUR GEAR GENERATING ATTACHMENT FOR THE SHAPER

APART from keeping the Shaper fully employed, either on circular shaping, small internal gears and the like, when the Attachment is used as an ordinary dividing head, or on work where a better quality is desired than that obtained from ordinary milling cutters, consider what an advantage it would be to be able to cut shoulder pinions, bastard pitches, pinions of long addendum, special pressure angles, or to be able to generate involute gauge forms by means of straight sided "V" tools from which to produce cutters. The Attachment is regularly used for such purposes. When not required on the Shaper, the Attachment can be used as an ordinary dividing head on the Miller by locking the change wheels or, with the additional fitting as illustrated below, for spiral milling. The two banks of change wheels in series enable a very wide range of leads to be dealt with; indeed, with hand feed at the worm shaft leads below 1" are easily obtainable.

The only permanent alteration to the Shaping Machine is the cutting of a spline in the cross feed screw to receive a pinion, the existing feed motion being used.

Spiral fitting for the Milling Machine is an extra.

Dividing is effected by hand, through driving plate and plunger mechanism, the worm being adjustable for wear.

⁂ ⁂ ⁂

The Matterson Patent Bevel Gear Generating Attachment for the Shaper cuts 4 D. P. in cast iron full depth from the solid at one generating pass of the bevel. The whole design of the machine is robust, coupled with simplicity for ease in manufacture, enabling the article to be produced at a reasonable price.

The 6" size is arranged to bolt to the vertical face of the table, whilst the 12" size bolts to the table top.

The generating motion is produced by two Worm Divers, interdependent, through change gears selected for each pitch angle, provision being made for taking up wear in the teeth of these gears, and end wear in the worm shafts.

Adjustment is provided, together with gauges to bring the Tool and Gear Blank into correct relation, and adjustment for the angle of tooth below the pitch line is obtained independently of the setting for the pich angle, suitable graduations being provided in the both cases.

The dividing is effected by hand, but a Semi-Auto-Feed Motion is provided.

Tables showing angles, etc., for the preparation of blanks, will be sent with each attachment, and simple "V" tools, ground from the bar to gauge provided, can be produced at small expense, a sample being supplied.

Work Mandrels of any diameter can be furnished, though one is supplied in the inclusive price with both sizes of attachment, and Collets can be supplied.

When cutting Skew Bevel Gears, the tool is merely "Offset" an amount to give the mean angle required, with a certain modification in the setting of the tool.

A number of parts subject to rough usage are hardened and replacements of any piece in the event of accidental damage can be effected at short notice, the manufacture being standardised.

Two systems of slotting are adopted in the 6" attachment to suit tables having vertical or horizontal slots. It is necessary to state whether the slots in the table side are vertical or horizontal. A Spur Gear Attachment is also made.

⁂ ⁂ ⁂

DOWDING V8 UNIVERSAL GEAR HOBBING MACHINE

The Dowding V8 not only effectively replaces the small and medium sized Continental machines; additional features give it an even wider working range. Ease of operation and accessibility for quick change-over of jobs encourage its use for a large variety of components, including spur gears, helicals, worm wheels, serrations, ratchets, film and chain sprockets and, if necessary, with an auxiliary tangential hobbing head, worms and high lead worm wheels.

For many years, Dowding & Doll's name has been closely associated with gear hobbing, over 1,000 gear hobbers having been sold and serviced by us in the United Kingdom alone. This rich experience was drawn upon to the full in designing the Dowding V8 Gear Hobber, and today this successful machine has earned numbers of repeat orders from discerning users. Already there are batteries of four to eight machines in various parts of the country.

It is the only machine for use where consistently accurate gears are required with a high rate of production....

....and it is worthy of note that gears are regularly cut on this machine having a cumulative pitch error not exceeding one minute of arc (the equivalent of 0.00087" on a 6" dia. pitch circle.)

⁂ ⁂ ⁂

DOWDING V4 UNIVERSAL GEAR HOBBING MACHINE

The Dowding V4 universal gear hobber has been specially designed for the rapid and accurate production of small meter, clock and instrument spur gears, helical gears and worm wheels. The robust construction of the machine, its built-in accuracy and fine finish, are fully reflected in its dependable performance on production.

GENERAL DESCRIPTION

Rigid design and construction make it possible to take full advantage of the hobbing principle, resulting in extreme accuracy of pitch and form. The smooth, continuous indexing motion gives shockless working with absence of reciprocating movements, allowing maximum output by eliminating time losses due to idle return and indexing movements. Even distribution and uniformity of load, results in long, trouble-free working life, machine wear being reduced to a minimum. The machine is extremely versatile, and simplicity of setting and operation enable a wide variety of gears to be cut rapidly and economically.

DESIGN AND CONSTRUCTION

Design is based on modern engineering practice, all components are of substantial proportions the materials having been carefully selected, and machined to exacting standards of accuracy. Particular care has been taken to ensure that the helical and spiral bevel drives are of the highest precision. All shaft bearings are ground and run in bronze bushes, resulting in rigidity, smooth and quiet working. A differential unit is incorporated and ensures, irrespective of the face width or number of teeth to be cut, that the spiral angles of mating gears are absolutely the same and that gear axes are parallel.

MAIN DRIVE

The main drive is "V" belt from a 1 h.p. motor totally enclosed in the cabinet base of the machine. The direction of rotation is changed by a reversing starter.

HOB SPINDLE DRIVE

The drive to the hob spindle is continued from the main drive housing through spiral bevels, helical gears and pick-off gears which give a range of four hob speeds, chosen to give the best results on all work within the capacity of the machine. Smooth, shockless drive to the hob is ensured by a large balanced flywheel which can be mounted at the top of the vertical main shaft or, when cutting gears with a helix angle not exceeding 20 on the end of hob spindle. The hobbing head which can be set to any desired angle from 0 to 60 (greater angular adjustment can be provided if required) to accommodate right or left hand helical gear is mounted on a vertical saddle of robust dimensions. The saddle slides on wide vee guide ways on the main column and is provided with adjustment for smooth and rigid traverse. Overhang of the hob spindle from the vertical saddle has been reduced to a minimum, and provision is made for axial adjustment of the hob.

INDEX DRIVE

Index drive to the work table is taken from the main drive through change gears, according to the number of teeth to be cut, and a high tensile steel precision ground 4 start worm and mating phosphor bronze worm wheel of extreme accuracy, the index unit running in a totally enclosed oil bath. As an optional feature a single start index drive can be fitted enabling gears to be cut with a cumulative pitch error not exceeding one minute of arc (the equivalent of 0.00087" on a 6" dia. pitch circle.)

FEEDS

The feed drive, both to the hob saddle and to the table carriage, is by means of change gears and worm gearing. The latter give a uniform, smooth transmission at very low speeds. A wide range of feeds is available, so that the most suitable can be chosen for any material and any desired finish.

OPERATION

The operation of the machine is very simple and the few controls are placed in a convenient position, reducing operator fatigue to a minimum. All external change gears are totally enclosed by quickly removable covers.

WORK MOUNTING

The work spindle has a No. 3 Morse Taper bore, and for holding work arbors of small diameter or gears which are solid with the shaft, a collet type attachment is supplied as standard equipment. The well-proportioned work arbor support arm carries a bayonet type centre which can be replaced with a pressure sleeve and is particularly useful when cutting gears with a small bore. A special work support allowing additional clearance is available for hobbing high angle gears.

METHODS OF WORKING

Spur gears and other work with teeth parallel to the axis are hobbed by feeding the hob parallel to the axis of the component, the hob and gear rotating in the ration of: number of teeth in gear to number of starts in hob. The maximum helix angle which can be cut on worm wheels, using the standard hobbing head, is 6 —8 ; for higher angles the special cross feed head must be used.

Helical gears are hobbed by the addition of an auxiliary rotation of the gear to the relative movement between the hob and work. This additional rotation corresponds to the helix angle of the tooth, and is obtained by means of a differential gear drive with a complementary change gear sytem. The maximum diameter of helical gears which can be hobbed on the machine diminishes as the tooth angle increases.

* * *

DOWDING H7 HORIZONTAL GEAR HOBBING MACHINE

This machine, our latest development for high precision production hobbing, has been designed and built out of a wealth of practical experience covering many years. It fully meets the present day demand for a powerful, robust machine, trouble-free in service, and which will at the same time maintain the highest precision both in pitch and form.

The extensive range of application covers long spline and serrated shafts, spur and high angle helical gears, etc., such as are used in the automobile, aircraft, mining, machine tool, diesel engine and other industries.

GENERAL CONSTRUCTION

In this powerful hobber the elimination of vibration has received special attention. The massive bed is strongly ribbed and designed to withstand very heavy cutting loads. All the gear drives, bearings and shafts are heavily proportioned to ensure minimum wear and long life under all conditions. Rigidity and freedom from backlash are such that climb hobbing can be successfully employed resulting in longer hob life, improved finish and faster output.

INDEX DRIVE OF WORK SPINDLE

The index drive of the work spindle has been specifically designed to ensure lasting accuracy and to prevent backlash. Drive is taken through change wheels and a high precision 6 in. diameter phosphor bronze worm wheel mating with a hardened and ground single start worm, which is easily adjusted to ensure correct meshing of the worm and worm wheel. The high tensile steel, hardened and ground work spindle is mounted in close grained meehanite bearings, the cutting pressure being taken on a ball thrust race. The spindle is bored 3 in. dia. to accommodate long shafts or special work holding equipment, including air or hand-operated collets. The whole index unit is totally enclosed and runs in an oil bath.

HOB DRIVE

The drive to the hob spindle is taken from the main drive housing through spiral bevels, helical and pick-off gears, giving a choice of six speeds. All speed change gears are readily accessible at the rear of the machine.

HOBBING HEAD

The two hobbing heads illustrated are available, a choice of either being supplied with the machine. The standard head is designed for the production of high-angle helical gears. The heavy-duty head, which has a fly-wheel mounted on the end of the hob spindle, gives smooth cutting when producing heavy spline shafts. The standard head, subject to variation dependent on pitch, helix angle and design of the component to be produced, swivels through 120°, and the heavy-duty flywheel head will swivel 45° right or left hand. Graduations in degrees and minutes permit fine angular setting of the hob, the adjustment being accurately and rapidly obtained through a hand-operated worm and worm wheel. For positioning the hob, the hob spindle is provided with 2" axial adjustment through a hand-operated rack and pinion.

WORE TABLE

Is a wide well-ribbed casting, having the top working surface inclined towards the hobbing head to give additional resistance against the cutting pressure; it is mounted on a transverse saddle which runs on two widely spaced vees on the bed of the machine. The table moves on one dovetail and one square slide, with taper gib adjustment. After setting "depth of cut" position the transverse saddle can be firmly locked by means of a knurled hand control operating on wedge cams at each side of the saddle. A well proportioned tailstock, having a spring loaded centre for ease of work loading, is mounted on the left hand end of the work table.

FEED

The feed drive to the work table is taken through change gears and a very accurate lead screw with thrust races and double lead-screw nuts. These double nuts eliminate all backlash so that the work can be produced by orthodox and climb hobbing methods. The feed is disengaged automatically by control stop, or by hand. The provision of six change gears enables the user to select the most suitable rate of feed for the material being cut and the finish required.

DIFFERENTIAL

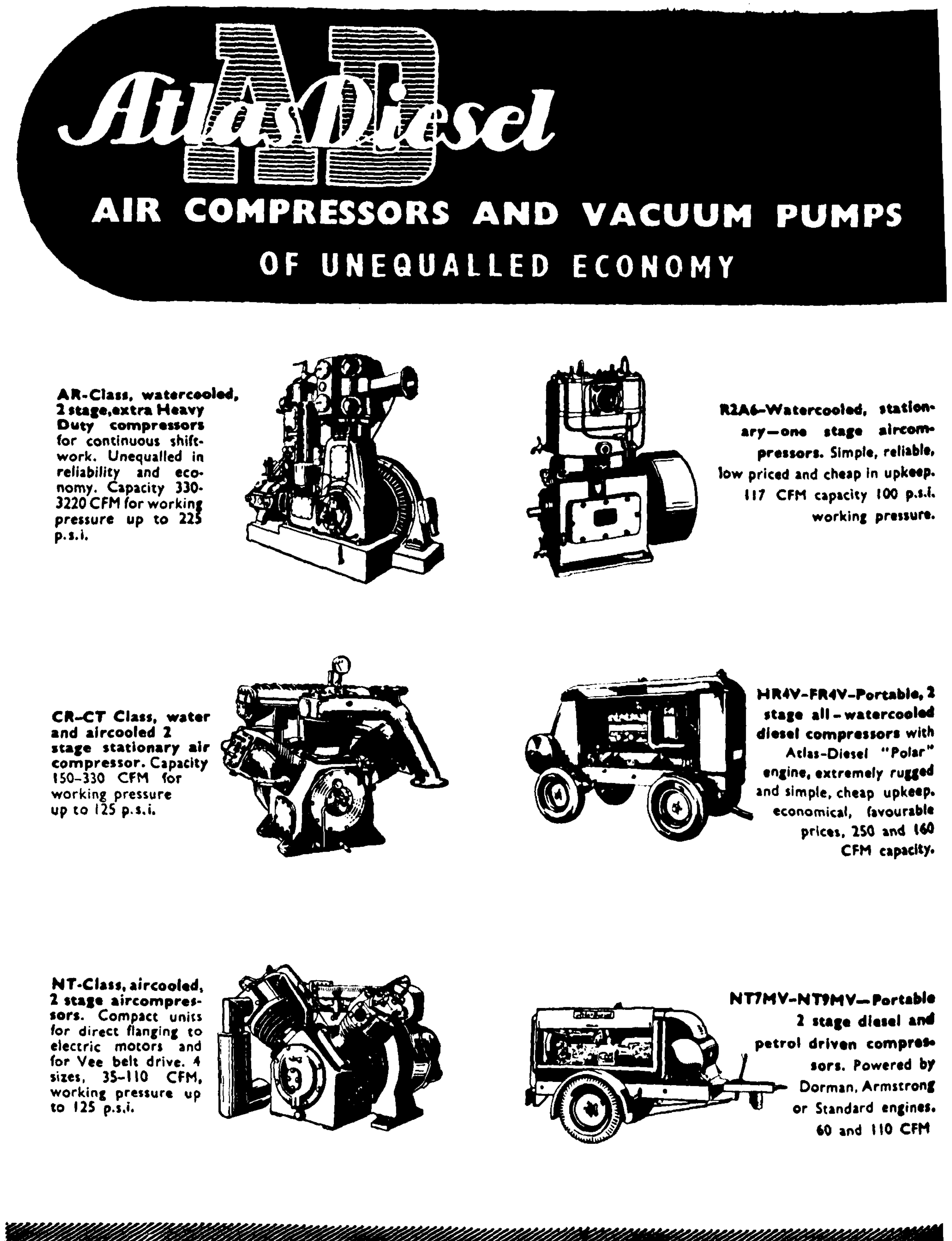
The DOWDING H7 is fitted as standard with a differential mechanism which enables helical gears to be hobbed irrespective of the number of teeth to be cut and varying rates of feed. For hobbing spiral gears it is only necessary to take into account the pitch and helix angle required, and a simple calculation enables the correct change wheels to be selected ensuring uniform contact over the full width of the gear teeth produced.

LUBRICATION

Is by an electric gear pump supplying a header tank situated in the mainhead casting and then by gravity feed to all bearing surfaces, internal machine gears, change gears and indexing worm and wheel. Surplus oil is collected and returned to the sump where it is filtered and re-circulated.

COOLANT

A 1/8 h.p. electric centrifugal pump delivers a copious supply of coolant through an outlet nozzle which has a 1/2" diameter bore.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AR-Class, watercooled, 2 stage, extra Heavy Duty compressors for continuous shift-work. Unequalled in reliability and economy. Capacity 330-3220 CFM for working pressure up to 225 p.s.i.
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Atlas Diesel
PNEUMATIC TOOLS
OF HIGH EFFICIENCY
Pistol grip metal drills, up to 1/2". Pistol grip screwdrivers up to 1/4". Pistol grip tappers up to 3/8".
Air blocks, capacity 1000-11000 lbs.
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Riveters, clipping hammers, Rivet Bursters.
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EVEREST

Steam & Pneumatic Hammers & Drop Forging Equipments

B. & S. MASSEY, LTD., have provided the Indian railways with a great number of steam and pneumatic hammers and several types of drop forging equipment for use in the different railway workshops. They are manufacturers of the world's greatest range of forging plant and have had almost a century of experience in this field of activity.

In general, forgings required by the railways can be put into two categories—parts, such as locomotive and wagon axles, locomotive connecting rods and the numerous smaller forgings made under forging, hammers; and drop forgings, which include drawbar hooks, buffers, wagon forgings and signal forgings, made under drop hammers.

For the manufacture of axle forgings an A-form hammer, steam or air operated, as shown in Fig. 1 is available. This type of hammer is made in 3-ton, 4-ton, 5-ton and 7-ton sizes. It is a short stroke, high speed hammer, specially made for this class of work and designed on very sturdy lines to resist the side stresses caused by the use of swaging impressions arranged off-centre; the palletts generally incorporate several swages and great rigidity of the standards and the guides is needed. From the illustration it can be seen that the tup is guided by loose slides of robust construction, which can be adjusted to prevent side movement of the tup. The drive is by handlever, positioned so that the driver has a clear view of the work being done at both sides of the hammer, and Masseys handworked expansion valve gear is fitted which secures maximum economy with sensitive and absolutely safe control. The hammer will strike light or heavy blows with long or short strokes. The tup can be lifted quickly to the top of its stroke without danger of the piston striking the cylinder cover, and can be held in the suspended position. There is no jar or shock to the operator's hand, the cut off motion of the expansion valve being a rotary one, entirely independent of the up and down movements of the handlever.

Figure 2, gives an illustration of an Arch Form steam or air hammer as used for making large locomotive forgings. This hammer is also fitted with the rotary expansion valve gear and works in much the same way as the axle hammer already described, except that it is designed to give longer and heavier blows to suit the greater variety of forging work. It is very suitable for making large connecting rods, locomotive side rods, etc. and its form allows the use of the many and varied tools needed for forging these parts. This type of hammer is made in sizes up to 10 tons, and many such machines are in existence, doing excellent work.

Figure 3, illustrates a Rigby type hammer without slides. This type of machine provides the smith with maximum working space above and around the anvil block and is generally well liked by blacksmiths. It can be driven by steam or air and is fitted with the rotary expansion valve gear. It is made in sizes up to 3 tons, and it will be seen that the piston rod is of large diameter and of a special design which provides maximum strength.

Another type of steam or air hammer used for the many smaller jobs required on the railways is shown in Figure 4, and is called the Overhanging Form, with Slides. This type of hammer has double standards fitted with adjustable slides so that the tup is well guided, and it is particularly suitable for types of work which subject the tup to severe side thrust and therefore demand close guiding in the lower part of the stroke. These hammars are made in sizes up to 1 ton falling weight.

Figure 5, illustrates a motor-driven "Clear Space" pneumatic power hammer. These machines are made in sizes from 2-cwt. to 4-cwt. and are designed to deal with practically all the types of forgings which, in the past, were made under steam hammers. The 2-cwt., 3-cwt. and 5-cwt. sizes are provided with a footlever in addition to the handlever, so that for a great deal of work the services of the hammer driver can be dispensed with and the smith is able to work the hammer himself, and can therefore regulate the control as he wishes, to strike just the type of blow required. A wide range of blows can be struck including continuous automatic blows or separate single blows, the force being varied as required. Definite single blows can be given without first lowering the ram on to the work, and as a separate movement of the handlever must be made for each single blow, there is no fear of a second accidental blow being given. The ram can also be put into the hold-down position and used for holding down work for bending etc. The standard drive in all cases is through veeropes from a motor carried on slide rails secured to a separate foundation. In the 2-cwt., 3-cwt. and 5-cwt. sizes the drive is direct from the motor to the flywheel; in the 7-cwt. and larger sizes the crankshaft is driven through steel gearing from a high speed shaft running in roller bearings carrying the grooved flywheel. The

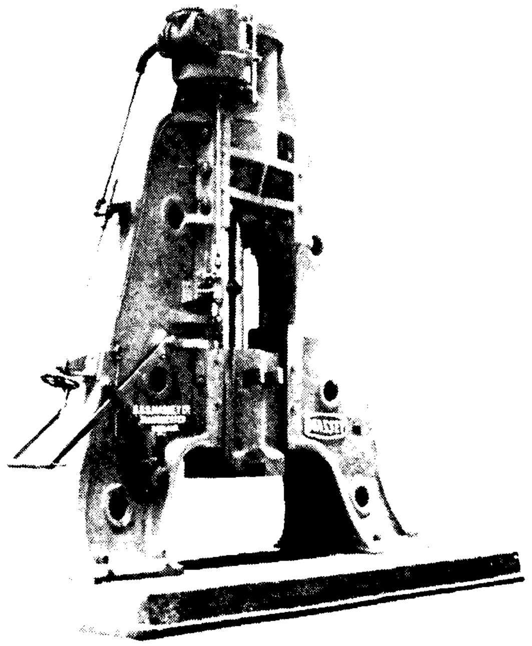


Fig. 1

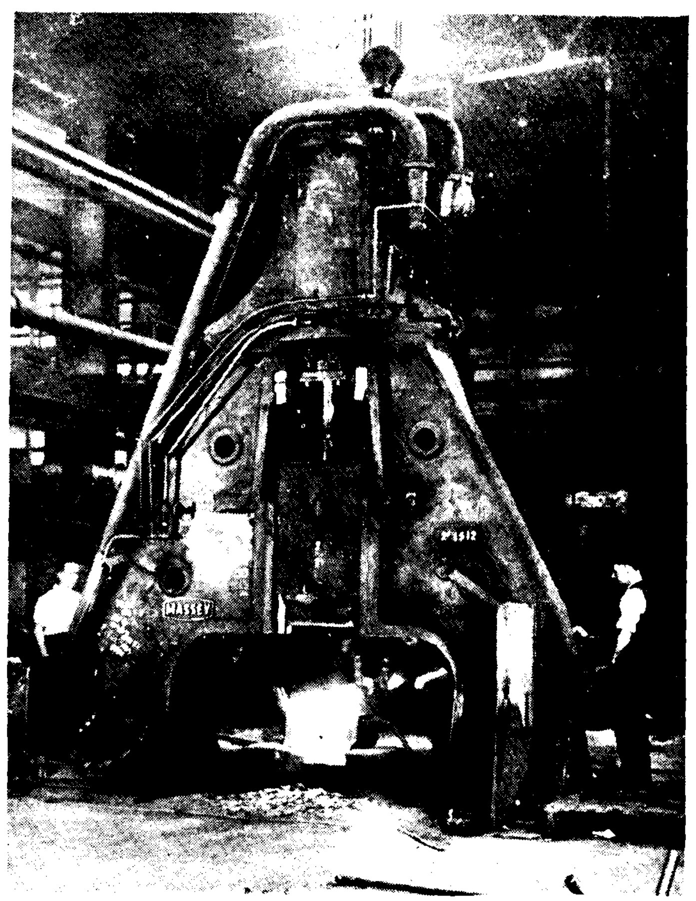


Fig. 2

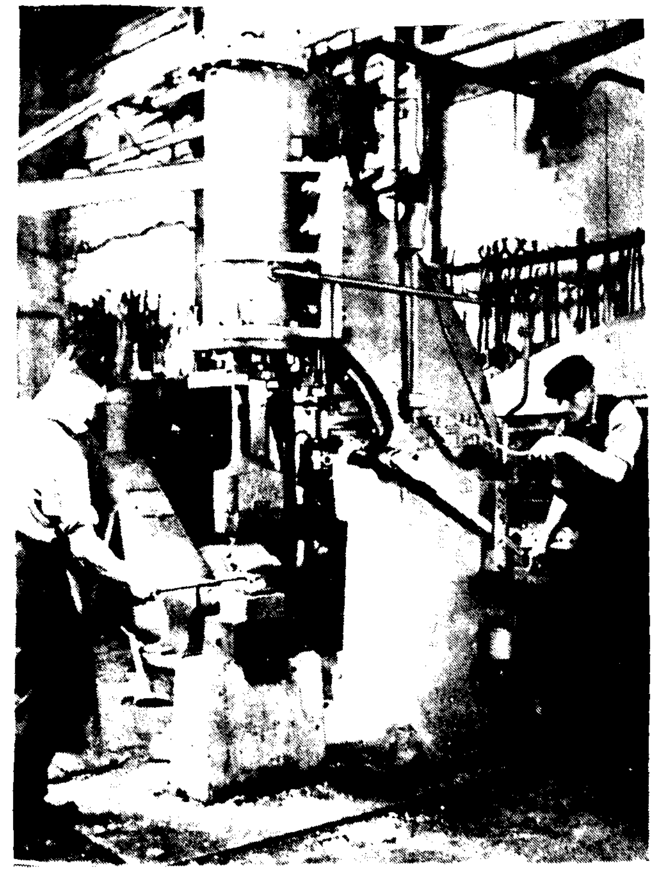


Fig. 3

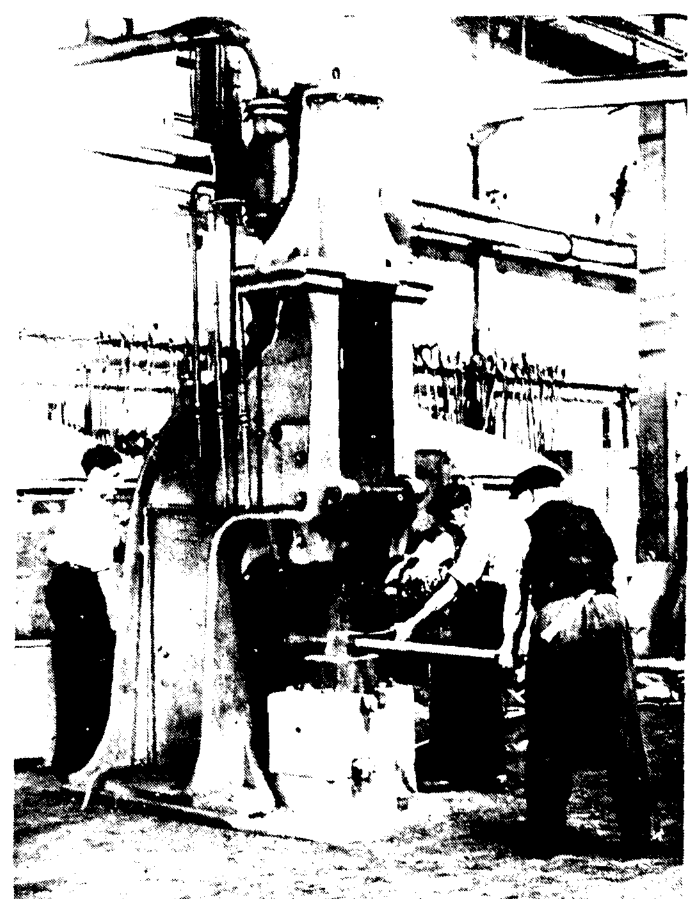


Fig. 4

Fig. 5

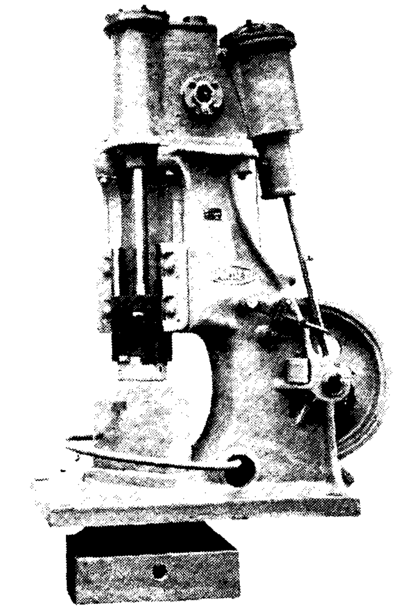


Fig. 6

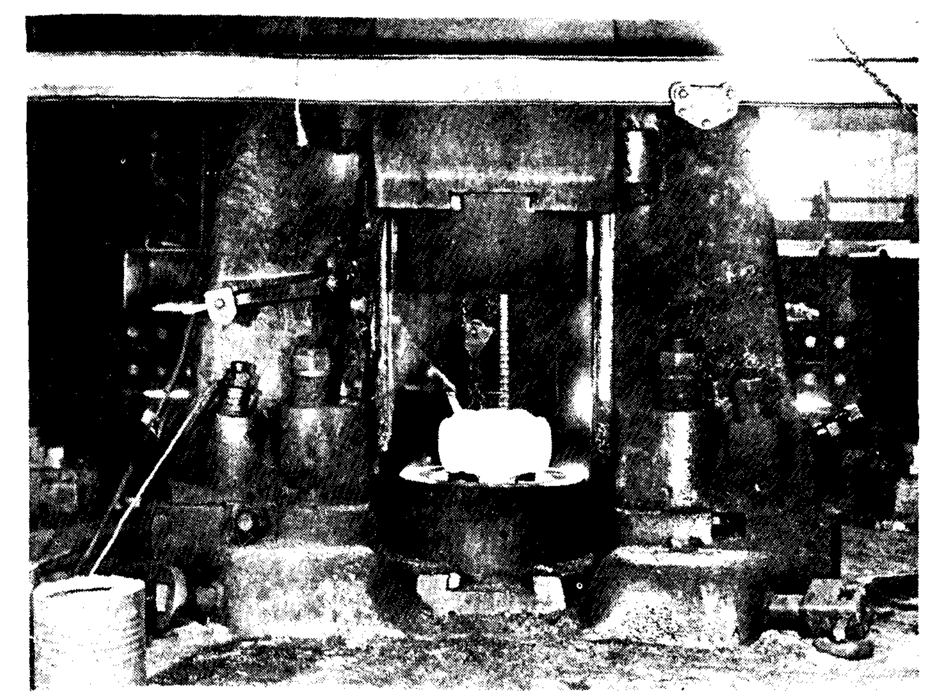


Fig. 7

Fig. 12

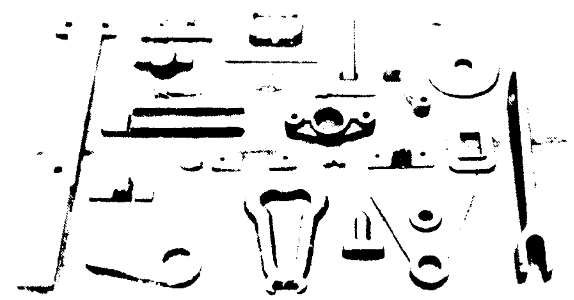


Fig. 11

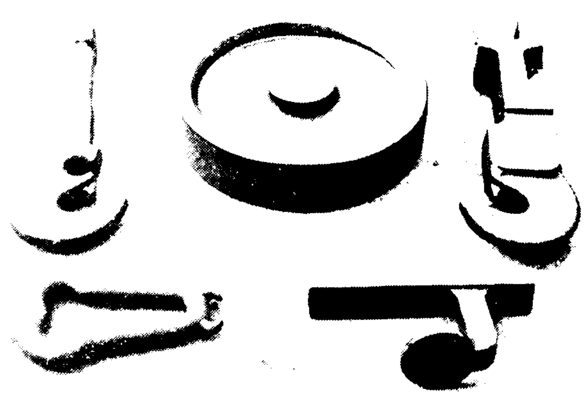


Fig. 13

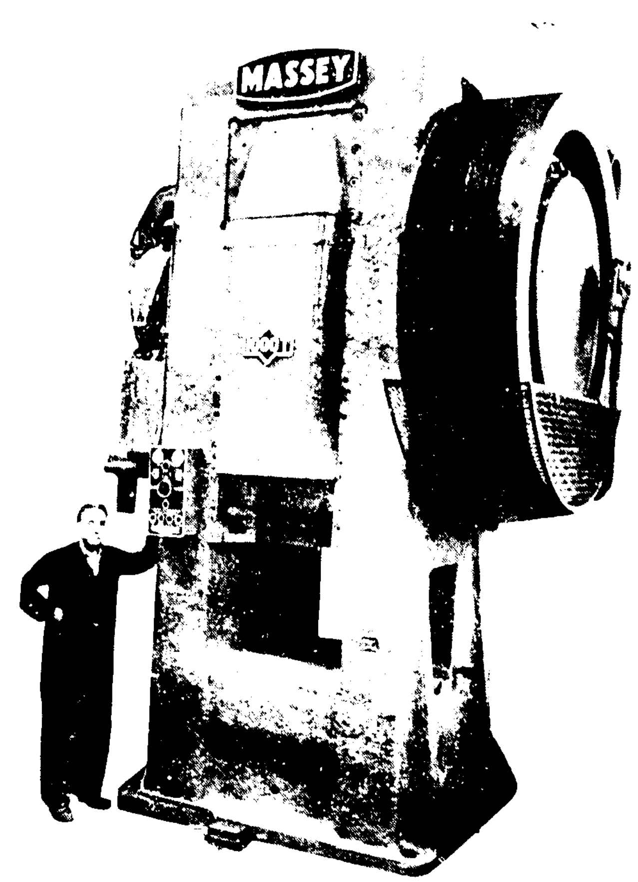


Fig. 15

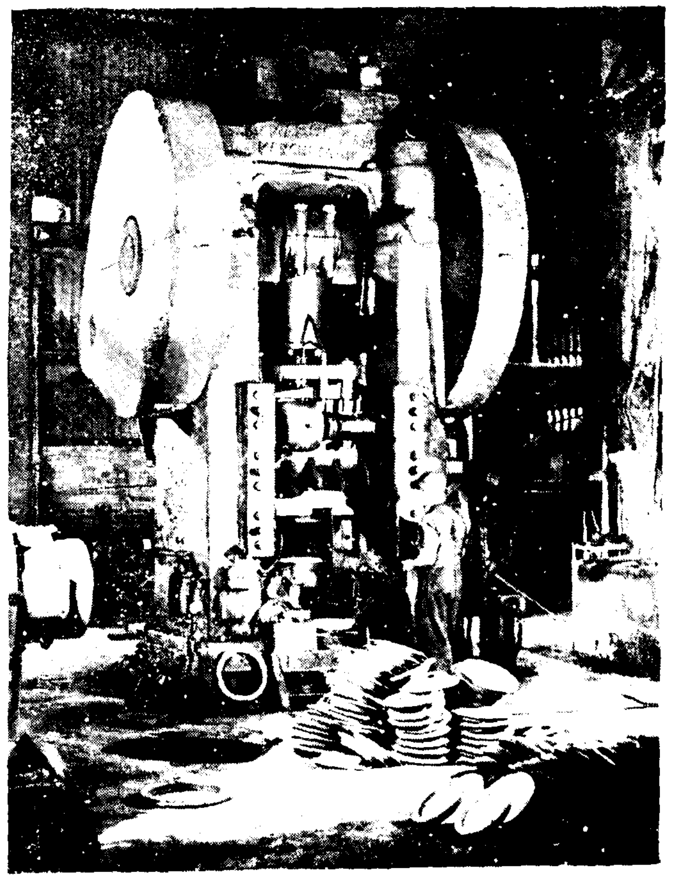


Fig. 16

gearing is arranged within the standard and runs in an oil bath, and an oil pump fitted in the sump and actuated by the crankshaft provides automatic lubrication.

Figure 6, illustrates a motor-driven pneumatic power hammer of the overhanging form 'With Slides', available is sizes from 1-cwt. to 20-cwt. The general working principle is similar to that of the "Clear Space" type previously described, but the standard is fitted with separate slides which guide the tup. This type of machine is used for offset forging, such as tapering ship's packings, tapering springs, etc., where the side thrusts are advisable to have the tup guided close to the work.

The electrically-driven pneumatic power hammer is greatly favoured for its cleanliness and economy, and in countries where coal is expensive it has almost completely superseded steam hammers.

Another advantage of these pneumatic hammers is that they can be positioned in any part of the works where most convenient, as considerations such as proximity to boiler or compressor plant an arrangement of steam or air pipes need not be taken into account and because the hammer can be switched on and off as required, further economy is effected in power consumption.

Any of the smaller hammers already mentioned can be used for doing preparing work for drop hammers when long jobs are being drop forged, such as connecting rods, brake levers, shackles etc., where there is a great disparity of section and the preparatory forging work, if done on a drop hammer, would be much too slow.

So far we have dealt wholly with large and small straightforward forging work, which is often required in relatively small quantities and would not justify the making of special dies and tools. When parts are required in large quantities it is wise to adopt mass production methods, using dies and tools fitted in drop hammers. Figures 7 & 8 illustrate a friction drop hammer of the Bridge type; which is suitable for drop-forging drawbar hooks, buffers and the largest forgings required in railway work. The tup is lifted by a form of friction clutch. The lifting gear is motor driven and the friction drum is water cooled to dissipate the heat generated by the friction clutch. The drop hammer is actuated by a pullcord which encircles a capstan bush on the lifter shaft and is attached to a camlever which tightens the friction band around a revolving drum to lift the tup. When the pullcord is released the tup and the top die deliver the blow upon the heated steel which is positioned in the bottom die. The tup is guided by two steel guides securely fastened to the anvil block and held together at

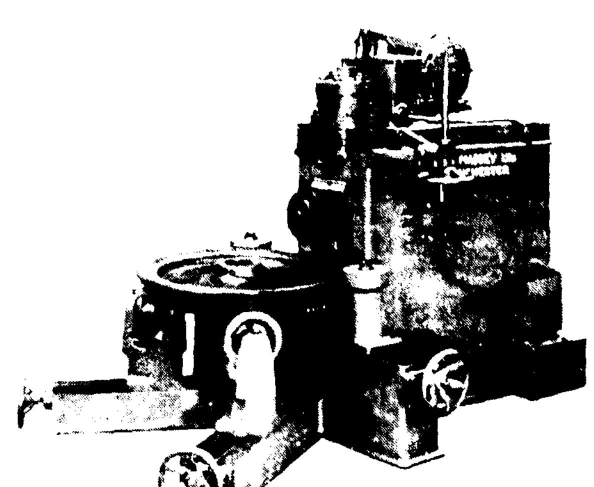


Fig. 17

the top by two tiebolts. The standard anvil block weighs about 20 times the weight of the tup and is made of cast iron; sometime cast steel is used when the work is very severe.

The bottom die is keyed into a dieholder, which can either be keyed into a dovetailed recess in the anvil block or held in position by poppetts fitted in the anvil block. In the case of the dovetail method, great accuracy is required in making the dies and the impressions in the top and bottom dies should be machined so that they will register correctly when the keys are driven home, as only minor adjustments can be made by means of the keys. When poppetts are used considerable adjustment can be made in setting the dies and less care is needed in their manufacture.

The smaller friction drop hammers can be used with a top die weighing up to 40% of the weight of the tup, and in the case of 5-ton and larger drop hammers the top die can weigh up to 50% the weight of the tup. The tup is attached to the lifting mechanism by a nylon belt; the adoption of nylon for this duty has proved eminently successful—the working life of belts of this material has proved in practice to be at least three times that of hair belting. These machines are occasionally supplied in batteries as shown in Figure 9 which illustrates a four-hammer battery.

Friction drop hammers of the self-contained form as shown in Figure 10 are used for the production of smaller forgings. The motor is mounted on the headgear, and a vee rope drive is employed. This type of drop hammer is made in sizes up to 40-cwt. and is generally fitted with automatic gear controlled by footlever so that the drop hammer can be operated by the stamper without the need of an assistant. The automatic gear incorporates a hold-up gear which holds the tup at the top of its stroke between heats without consuming power. These machines are fitted with strong, robust standards, which permit the use of multiple dies when these are required for roughing and profiling before the final stamping operation. The lifting mechanism is by a friction clutch similar to that used in the Bridge type friction drop hammers and by manipulating the footlever, the operator is able to give long full blows or short quick blows, such as are often used during the preparing operations. These drop hammers are also fitted with separate slides, securely bolted to the standard, and these can be adjusted to take up any wear in a very short space of time. Figure 11 illustrates a Marathon drop hammer which is the latest type of the self-contained form and embodies various improvements, including gearless drive, shock-insulated headgear and improved guiding.

Although railway forgings are not usually required in sufficient numbers to warrant the installation of such machines, mention ought to be made of the ram type double acting drop hammer, driven by steam or air, as shown in Figure 12. This is a machine of rugged construction, mostly used for mass production work, and it will be noted that the ordinary small diameter piston rod has been replaced by a ram of substantial diameter. This machine strikes faster and more powerful blows then a friction drop hammer of similar size. It has special advantages for stamping long jobs which need a considerable amount of preparing. The short quick blows delivered on the side of the multiple dies quickly reduce the section to a suitable dimension, thereby allowing the work to be produced at a great speed.

Figure 13 & 14 represent a selection of typical railway forgings as made under Massey friction drop hammers.

Mechanical forging presses as shown in Fig. 15 are also being used for the manufacture of drop-forgings when the quantities involved are large enough to justify the installation of these comparatively expensive machines.

Figure 16 illustrates a Tiebolt type trimming press as used for removing the fin from drop-forgings. It is not possible to make drop-forgings using just the right amount of material so the extra material is squeezed out to form a fin which must be afterwards removed either hot or cold. A trimming press is designed on straightforward lines as the work it is called upon to do requires strength and sturdiness.

The frame is made of tough cast iron and held together by four large diameter steel bolts shrunk into position. The crankshaft is a manganese molybdenum steel forging of substantial proportions running in replaceable phosphor bronze bearings. The clutch is of the direct air operated, friction type ensuring smooth starting and providing a very high controlled torque capacity.

Presses of 550-ton size and less are provided with a side ram which can be used for auxiliary operations such as shearing the forging from the bar or for bending or coining the stamping to size.

The lower trimming tool is normally secured in a cast iron bolster made in halves, each half being adjustable and bolted to the table. The ram is dovetailed to receive the top tool. The connecting rod is adjustable so that a range of tools of varying thicknesses can be used.

Lubrication is by a multi feed oil pump except for parts required infrequent lubrication which are provided with grease gun nipples.

This type of press is made in sizes from 120-tons to 750-tons capacity, and a " Solid Frame " trimming press is also available in sizes from 30-tons to 200-tons.

Figure 17 shows a Massey Tyre Fixing Rools. When retaining rings were first introduced for fixing the tyres on locomotives carriage and wagon wheels, the closing of the lip of the tyre on the retaining ring was done by men using heavy sledge hammers. The modern method is to close down the lip of the tyre by rolling instead of hammering, this process being more uniform and ensuring a better job.

The tyre rests on the lower roll and on two supporting rollers adjustable along the arms of the machine and is positioned by two guiding rollers which are adjusted by a signle hand wheel. The upper operating roll which closes down the lip of the tyre is keyed to a shaft provided with a worm wheel. A pump driven from the worm shaft delivers the oil; a small movement of the handwheel controlling the oil pressure lowers the operating roll on to the tyre and a further movement applies sufficient pressure to roll the lip securely on to the bevelled retaining ring.

These tyre rolls have been used with the greatest success and are in operation in most of the leading railway works.

The illustrations show only a few of the machines supplied to the railway industry and further information will be gladly supplied to interested parties.

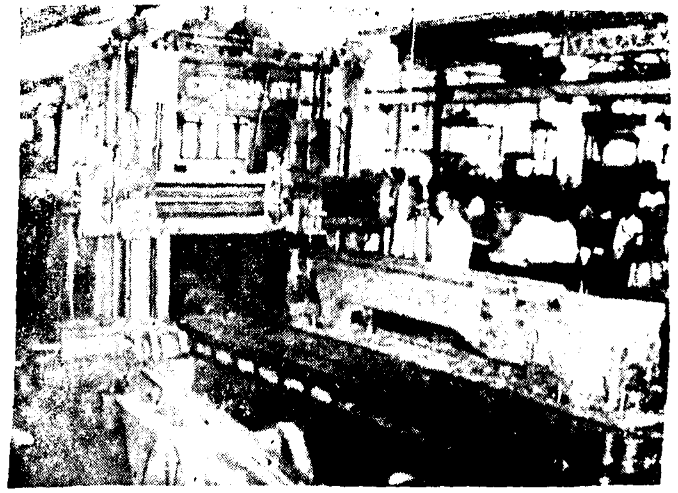
MANUFACTURE OF GEARED HEAD LATHES

By An Observer

THIS is to outline to the readers the manufacturing technique involved in the production of Geared Head lathes and in connection the author has perforce to describe the manufacturing procedure of M/s Mysore Kirloskar Ltd., Harihar, the famous house of Machine Tool builders; whose kind permission for publication of their methods is sought and obtained.

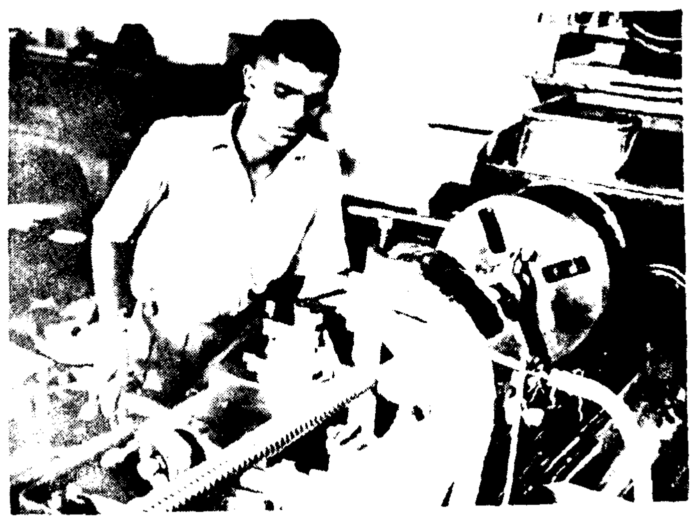
Lathes as the readers are aware, form the most versatile of Machine Tools, and no wonder, all manufacturers of Machine Tools pay particular attention to the development of this class of machines. It is the constant aim of all manufacturers to keep abreast of modern design which tend to make these machines more productive, more easy to operate and last in accuracy over a period of years and M/s Kirloskars spare no pains as may be seen from the review as under, to keep up to the trend. These are necessary that the machine should be robust enough to take the heaviest cut in practice, should maintain accuracy, should be fool proof in operation, and yet be cheaply produced. Besides these spares and parts should permit of ready assembly and ensure interchangeability. To achieve these, standardisation in processing, materials, etc. are necessary and the fabrication methods should be arranged accordingly.

To describe the manufacture of R. L. type lathes, castings of beds, saddles, etc. are produced with particular care to ensure that the grains are fine, the analysis is up to standard practice, and the physical quality of the castings are up to the mark, and the castings proper are free from blemishes of any kind. To ensure these, the charges of the cupola are controlled by



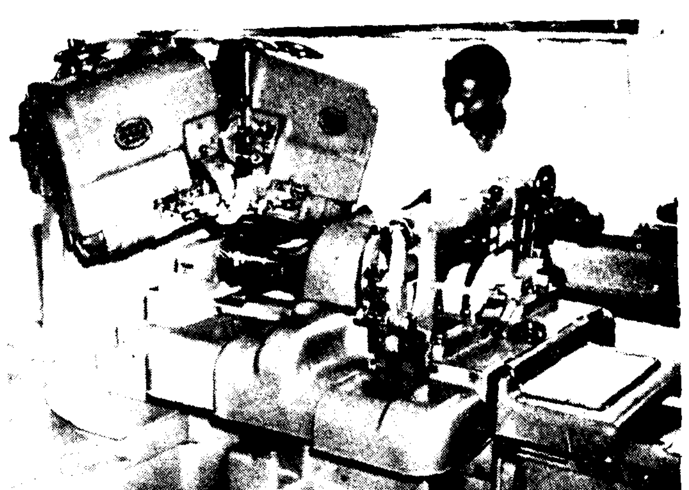
Finis planing of lathe bed. Note the gauge for setting tools.

Assembly of geared Headstock of RL lathe by experienced technicians.

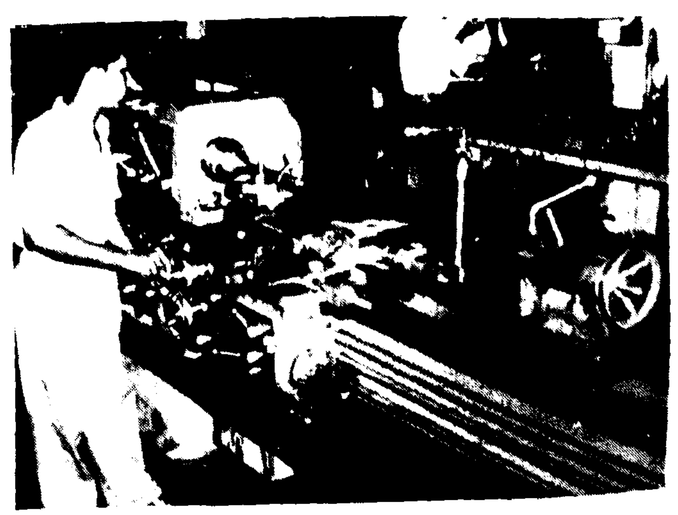


Accurate finishing of leadscrew on Lodge and shipley lathe with master leadscrew.

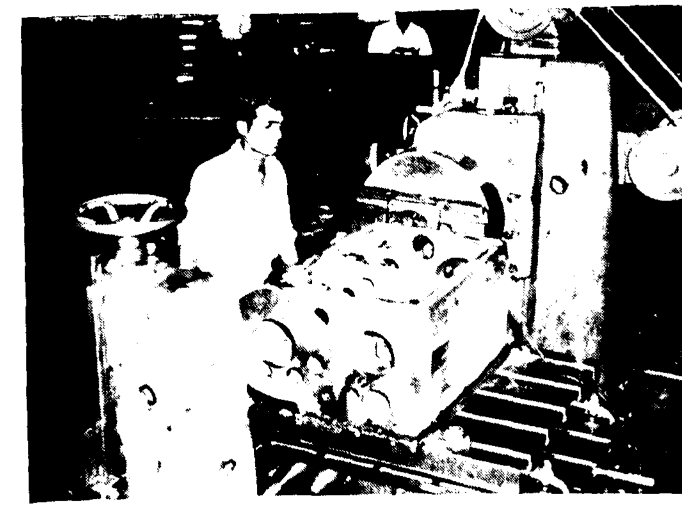
Batch of RL lathes under erection.



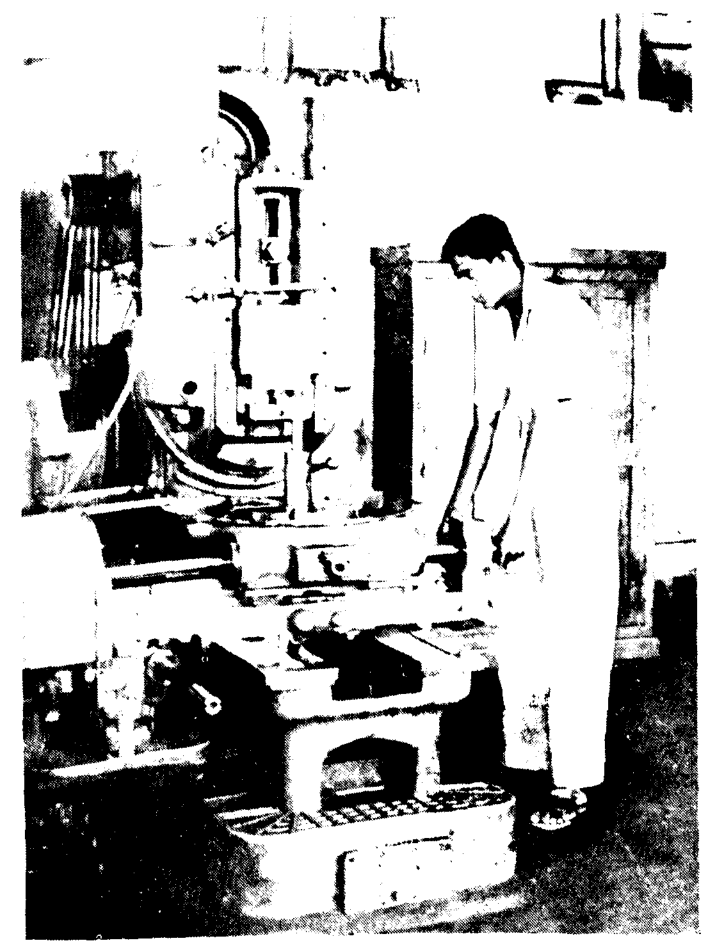
Griding of spiral gear on "Maag" precision gear grinding machine to high accuracy.



Alignment testing of RL 2 type lathe in progress. All tests confirm to DR. SCHLESINGER charts.



Boring of Geared Headstock body on Richard Horizontal boring machine.



Accurate gears are cut by generating process on "Maag" precision gear cutting machine.

experienced technicians who decide upon these charges after elaborate testing of specimen castings for analysis, tensile traverse strengths, wear hardness, etc. The important castings such as bed/saddle etc. from the foundry are then artificially seasoned for relieving casting stresses, whereafter they are sent to Machine Shop. In the Machine shop these castings are rough machined and left in the open for a further seasoning for some months.

Later on they are taken for finish machining. They come to the planers, all electric, where they are accurately finish-planed. Particular care to ensure freedom from clamping stresses and displacement of Gap piece under cut is taken in the finish-planing operation, and some .005" of material is left for the final operation of grinding. Beds are then ground finished to an accuracy of a split thousandth of an inch on the High precision Mattison Grinder. The beds are then ready for the fitting of saddles, Aprons, Feed Boxes and other appurtenances. The headstock casting is provided with a flat and V seating for location in position on the bed. The head stock with its locating surfaces completed is mounted on a fixture which has similar location as the bed. The fixture together with the headstock is then mounted on Richards Horizontal boring machine for all boring work to be completed. The head stock is bored very accurately so that all holes therein are in correct alignment in horizontal and vertical planes with respect to location and that the holes themselves are within admissible tolerances. Feed Boxes, Aprons etc. also similarly bored in the Richards borer. Saddle castings are planed in a gang on planing machines and every care not to distort the castings in clamping is taken.

LEAD SCREWS

These are manufactured in a separate section as they require a high degree of accuracy. The lead screws are first rough machined and allowed to weather. Later on they are finished in a special lathe equipped with a master lead screw of guaranteed accuracy. All precautions to avoid local heating under cut, bending of the screw, etc. are taken, so that the screw is finished smooth and accurate. The screws are thereafter tested with special measuring devices and used if in order.

GEARS

The gear blanks are from alloy steel forgings accurately machined before they are sent for gear cutting. All gears are cut by generating processes in modern machines which are regularly checked and maintained in perfect order, so that gears may be turned out accurately. The generating process ensure correct involute profile for the gears with all its advantages. The completed gears are tested for all their details, VIZ, centre distance, concentricity, pitch and smooth running etc. with the aid of special testing devices. Sliding gears are chamfered at engaging ends on a Hey gear tooth rounding chamfering machine, so that they may engage smoothly. The rounding chamfering of teeth is carried out by a high speed pencil type milling cutter as the work is rotated. Simultaneously the work is given a cam controlled axial movement to produce automatically the rounding required on the ends of teeth. Head stock gears which run at high speeds are case-hardened by High Frequency induction Hardening process and then finish ground on a Magg gear grinding machine. This helps to make sure noice-free performance.

Spline shafts are cut on Newark hobbing machine with special hobs the material used being En. 8. These spline shafts are finally ground on Orcutt spline Grinder to very close limits. Corresponding mating parts for spline shafts are internally broached on Edgwick Horizontal Broaching machine.

Now with all components ready the various sub-assemblies such as Head stock, Apron, Feed Box, Tail stock are fabricated. The head stock spindle is bedded in its bearing very carefully and correctly adjusted. The same is allowed to run for a number of hours to ensure that it does not run hot. The bearings/spindles are then opened and examined for scoring etc. and if in order the assembly is considered acceptable.

The gear assemblies are run in mesh to ensure that they are noice free and have good teeth bearing. All parts are checked for fitting to appropriate limits. All these sub-assemblies are then mounted in position on the lathe bed and the complete lathe assembled. The lathe as a whole is then transported to the testing section. Here the Headstock Tailstock are properly aligned and adjustments for bearings and other fittings are carried out. The machine is then tested to Schlesinger's limits and practical trials taken. After ensuring that the machine is satisfactory in performance and all other respects it is sent for painting, packing and despatch.

It may thus be seen that the machine tool construction embodies all the refinements of Engineering processes and only the best workmanship has a place. It is indeed a matter of pride that Kirloskars are having all necessary plants and availing the most modern technique in the building of lathes and nothing is left to be desired. Let us hope that their endeavours to make our country self-sufficient in lathes and save our foreign exchange, will be crowned with success.

Precision Grinding in Railway Workshops

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

TECHNOLOGICAL advances in railroading which have made possible to-day's high train speeds, greater pay-loads, and increased safety, have also brought a demand for rolling stock components finished to a greater degree of accuracy and concentricity. To this end precision grinding plays an increasingly important part in railway workshop practice, not only for locomotive and rolling stock maintenance but also for construction. In short the introduction of precision grinding in railway workshops has revolutionised production.

The rapid increase in grinding applications during the past several years has been due to the fact that this process will remove metal faster than any other comparable method and, at the same time, produce the required degree of dimensional accuracy and surface finish, and limit of accuracy obtainable being 0.001".

ADVANTAGES

It is appropriate, before proceeding further, to describe briefly the advantages of Grinding and Grinding Machines over other methods of production specially with regard to their application to the finishing of some of the rolling stock components.

The grinding process eliminates the ridges and furrows from the surface of steel part, thus giving a greater bearing area. Machining operations leave behind "hills and valleys" on the surface, constituting the high and low ridges of the metal. These may not be seen outwardly due to the flowing of a skin of metal over them as a result of frictional heat and pressure combined. Consequently although the finish looks, the piece when put to work and has to withstand severe stresses or prolonged service wear, this false surface crumbles or spalls and the clearances then become inaccurate. Grinding to a considerable extent removes the "flowed" surface and at the same time gives a sound finish combined with accuracy.

By grinding it is possible to produce satisfactory mating between two adjoining surfaces. Steam-tight joints such as those required on the surfaces of regulator valves, pipe flanges, etc., can be readily obtained. After grinding the component are ready for assembly without the need of lengthy hand finishing operations which are generally required when other machinery methods are employed.

It is possible with a rough and a fine surface grinder to obtain the final dimensions more quickly than with many other processes and with a much finer surface texture than that generally given by the meral-cutting tool. This has led to the wide application of grinding in producing flat surfaces on many locomotive motion parts, such as slide bare, expansion links, and coupling rode etc.

Ground bores are far more accurately concentric and have a much longer life than bores finished with a cutting tool. For these reasons, grinding is being extensively used in dealing with cylinders, liners, piston valve bores and connecting rod bores. In such cases where these bores have to be re-trued, the precision grinding machine will bring the bores to true roundness and parallelism with far less wastage of metal than is possible by any other machining method.

Grinding is the only means of finishing, and correcting, minor 'movement' of the steel caused by heat-treatment, of case—hardened articles, tempered tools etc., since the metal is too hard for cutting tools.

Hand scraping to obtain accurate alignment of the main surfaces and edges of horn cheeks is a lengthy and expensive operation calling for special skill on the part of the fitter. A Horn Cheek Grinding Machine can be usefully employed in facing-up and re-aligning the hard, burnished surfaces which are difficult to penetrate by hand tools, in a fraction of the time required for hand scraping.

Grinding is capable of rectifying dimensional errors left by previous machining operations and restoring service parts thrown out by reason of superficial blemishes. Errors in the roundness of a stell rod are scarcely to be detected by measurement since they can be seen from the appearance of sparks which will be thrown round the entire circumference of a true spindle of steel.

GRINDING WHEEL TYRES

For maintenance efficiency and the sweetness of running, the precision grinding has to-day occupied the place of tyre turning in one of the largest railroad shops of America. It has been observed that on application of

(Continued on page 83)

DESIGN OF A V-BELT

As you well know, a V-belt derives its name from the V shaped cross section in which it is built. A V-belt operates in V grooved sheaves normally, and obtains its driving ability from the wedging action in the grooves. Although all V-Belts have similar appearing cross sections relatively speaking, they may vary in size, length, and top width. Insofar as actual belt construction is concerned a belt has three major component parts; the envelope, the compression section, and the tension layer.

ENVELOPE

The envelope is used to tie the belt together as a unit. It further protects the inside of the belt, particularly the tension layer, from wear, abrasion, and weathering action. The envelope is generally made of square woven, bias cut cotton fabric, folded in plies around the V-Belt. It may consist of 1, 2, or 3 plies, depending on the manufacturer and type of belt. It is not intended that the envelope perform any function other than those just pointed out. It is a popular misconception that the envelope adds strength to the V-belt. Actually the envelope is cut and built into the V-belt in such a manner that it stretches or gives when tension is applied. Thus all of the load is transferred to the inside of the V-belt, or more correctly, to the tension layer.

TENSION LAYER

This is a layer of cords built into the V-belt parallel to the top and bottom, and applied longitudinally in the belt. If a V-belt is cut open, the cord layer will generally be found a little above a point midway between the top and bottom of the V-belt. There is no fixed spot for this layer to be built into V-belts, and its relative position will vary between manufacturers, and even between different cross sections from the same manufacturer. The tension layer may consist of a single layer of major type cords, and in this type the entire cord layer consists of a single piece of cord wound helically in the belt. The tension layer may also consist of multiple layers of cord fabric. In general, the Goodyear line features a single layer of major type cords in belts under 120", and multiple layers of cord fabric 120" and over. For special applications we also carry a limited line of V-belts under 120" with multiple layers of cord fabric. Each type of tension member has its own advantages and where given the drive details Goodyear applies whichever is most suitable for that particular application. In most respects, synthetic cords have demonstrated a superiority over cotton for tension members. Rayon is the most popular for general use. Others are in use or being intensively studied. When the drive space is particularly limited, or when minimum stretch is required, V-belts made of a single layer of steel cables in the tension layer are recommended. These steel cable V-belts have a much higher load carrying capacity than standard V-belts. As you may have gathered by now, the sole purpose of the tension layer is to carry the load and transmit the power.

As tension is applied to a V-belt, the envelope and rubber in the belt stretch minutely, and the entire load is thrown on the tension layer. It is the characteristics of this layer that determine how much horsepower the V-belt can transmit and how much the belt will stretch throughout the life, A V-BELT CANNOT STRETCH WITHOUT THE TENSION LAYER YIELDING IN SOME MANNER.

COMPRESSION SECTION

The Compression section is in the lower portion of the V-belt, and is so named because it is under compression or is pushed together as the belt flexes over the pulleys. Its primary purpose is to give support to the tension layer. It also transmits the load to the tension layer and gives the V-belt body and shape. Correct design of the compression section will insure maximum support to all the cords in the tension layer. This compression section may be either all rubber or it may contain some fabric. When it does contain fabric, this fabric does not contribute to actual tensile strength or load carrying ability of the belts since, as pointed out above, this is all in the tension layer.

Whether or not the compression section will have fabric depends on the manufacturer of the belt and on the application. Goodyear may or may not use this fabric filler depending on the particular application on which the belt is to be used. In general, however, the Goodyear standard line features all-rubber compression section V-belts under 120" and fabric compression section in V-belts 120" and over. There are exceptions to this general rule, notably the Steel Cable line 120" and over, which features all-rubber compression section.

(Continued from page 4)

Grinders, Atlas Machine Tools etc. in England. Why! manufacture of spindles and textile looms for the expansive textile industry forebodes great future.

Let an industrial board advise Government of India. It will be of little value if it contains big-wigs of the industry only ; neither can officials of the cadres of Secretaries, Joint Secretaries and Deputy Secretaries deliver the goods. Engineers, Workers and Designers alone can plan for prosperity in this sphere.

A study of the careers of many government servants reveal that despite many of them being sent abroad on roving tours of short duration, little use is made of them on their return to develop particular " spheres " where they attain proficiency. They very soon turn their heads to a routine job. Of course it is appreciated these are passing phases consequent on improper and incongruent selection of personnel and weightage being given to one in the lime light, rather than choice of right men of approved merit and who show a fad for administrative technique of men, machinery and methods. But, let us take a bold step. Let us revitalise by building up our Machine Tool Industry. Let this be our aim in the year 1954. It shall bring us glory, glitter and wealth. If 1952 was a " Water age " 1953 a " Steel Age " let 1954 be " a Machine Age " in the first five-year development projects for India's prosperity and economic superiority in Asia.

Continued from page 79

broad profile cutters made up of high speed tools there is a tendency of tyre surface's skin to be torn up and loosened to a considerable depth. The skin thereby loses its molecular structure and hardness, becomes much less resistant to the cracking and constant pounding effect of severe railway service, and within a short time shows signs of serious divergence from a true and reliable profile. The grinding process however enables the surface treated to keep its sound structural hardness in contrast to the marred and loose surface resulting from the turning operation, thus assuring much stronger resistance to wear. Moreover by grinding it is possible to remove the hard braked spots easily and through minimum removal of material as a result of which considerable tyre material is saved representing an economy of profiling wheel sets.

GRINDING Vs. BURNISHING AXLE JOURNALS

On the question of the grinding of Railway Axle Journals, there is an alternative which is used in a number of Railway Workshops, i. e. Burnishing by means of hardened steel rollers and claim is made that this produces a better finish than grinding.

Burnishing produces a smooth finish but not necessarily an accurate finish. It is a well known fact that in a railway bearing there are two distinct movements, there is the transverse movement (or peripheral) and a lateral movement which is commonly termed " hunting " in railway circles. Consequently, the bearing and the journal must be accurate in both directions and grinding of the journals is the only method yet known which can guarantee this accuracy.

Burnishing, although it may produce a smooth surface and a fairly accurate one in the transverse plane, produces a " screw-threaded " deformation of the axle journal and during the lateral motion of the rolled stock this screw-threading sets up friction and generates additional heat.

On the question of production, with grinding, naturally, a great deal of water is used both as a coolant and a cleaning element, and the surface produced by grinding is practically unaffected by the presence of small particles of dust etc., because these are continually washed away by the coolant. In burnishing, however, the presence of dust is an anathema because if this dust gets between the surface of the journal and of the burnished roller it is likely to cause scoring in one or both with rather disastrous results.

One other significant point in regard to this matter is the outlook for the future. There is, of course, a tendency to convert all rolling stock to either ball or roller bearings and it is a well known fact that a ball or roller bearing must be mounted on a ground journal. We have never heard of a ball or roller bearing axle box manufacturer recommending that the ball or roller bearings should be mounted on a burnished axle journal. This is natural because a burnished journal is not sufficiently accurate to take ball or roller bearings.

In consequence, from the above it will be seen that if in the next 10 years there is a move to convert rolling stock to ball or roller bearing axle bearings, Burnishing Machines will become redundant, whereas Axle Journal Grinding Machines will still be as economically useful, even more so than ever. Consequently it can be said that the Grinding Machine is the " Machine of the Future ".

RAILWAY TRAINING CENTRES

There are at present 7,167 persons under training at various railway training centres in India, Shri O. V. Alagesan, Deputy Minister for Railways and Transport, stated in reply to a question in the House of the People. He said that these persons include apprentices and other recruits who were undergoing training for appointment to various posts on railways, and serving railway employees who were undergoing refresher and promotion courses.

They were given theoretical and practical training required for filling various posts on the railway e. g. guards, drivers, station masters, signallers, booking and parcel clerks, ticket collectors, train examiners, firemen, permanent way inspectors, skilled workers, journeymen, chargemen, and assistant mechanical engineers.

* * *

BRITISH RAIL-COACHES FOR INDIA

The first eight of 100 railway coaches which are being built for the Southern Railway in India by a British firm have been shipped from Newport.

Each coach is 58 feet long and weighs 12½ tons. It is expected thet Newport will handle similar regular shipments until the completion of the contract.

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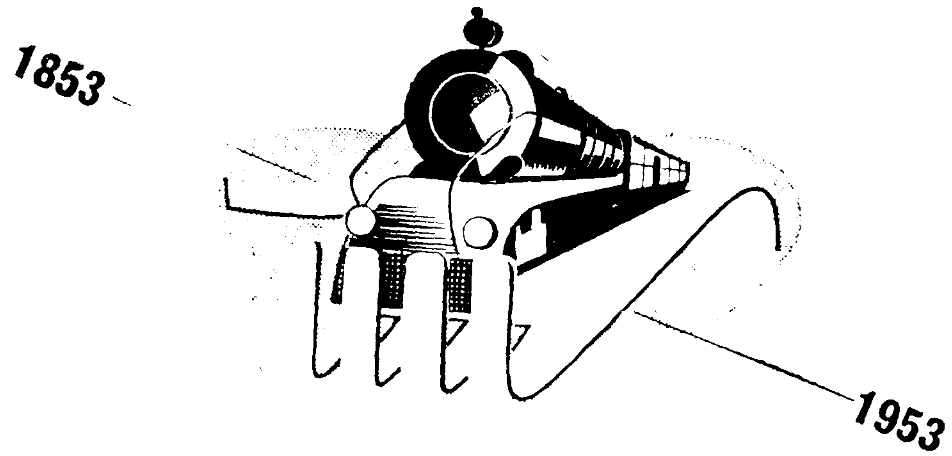
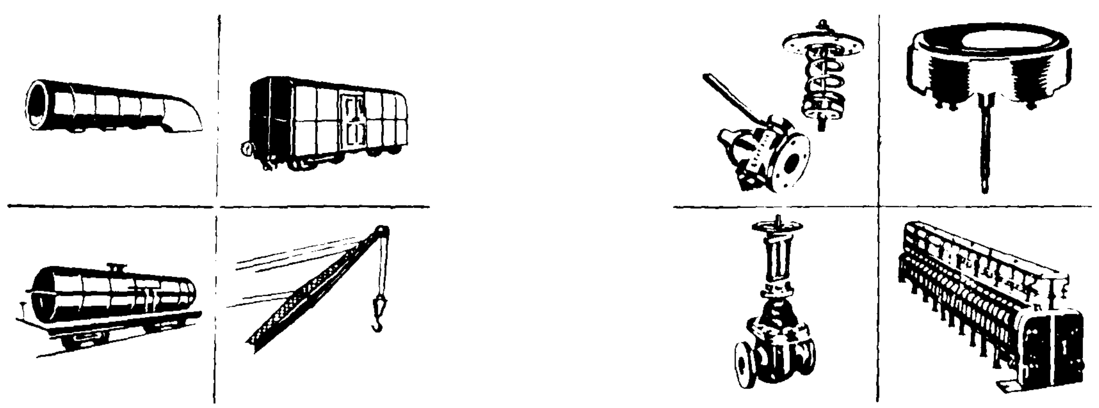


ADVANCING WITH THE TIMES



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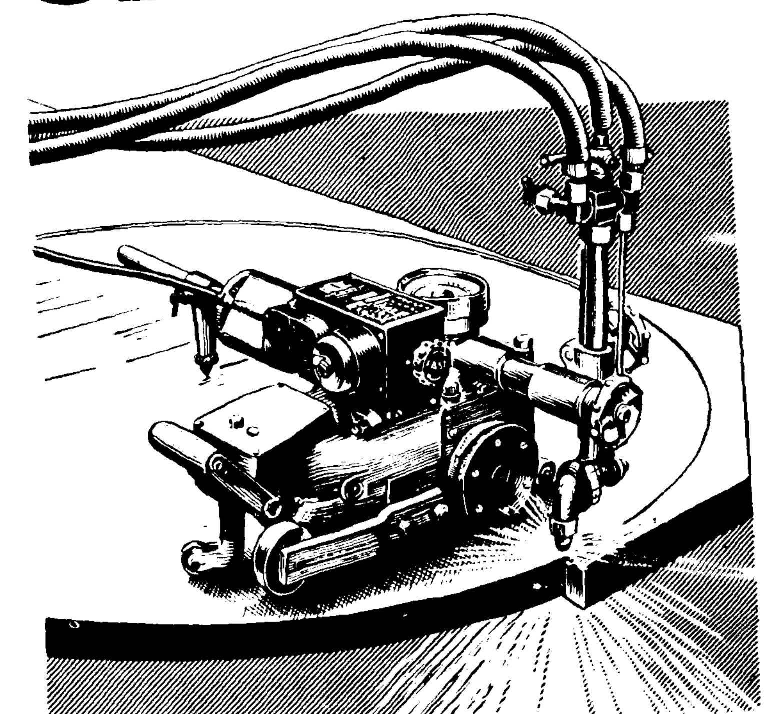

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