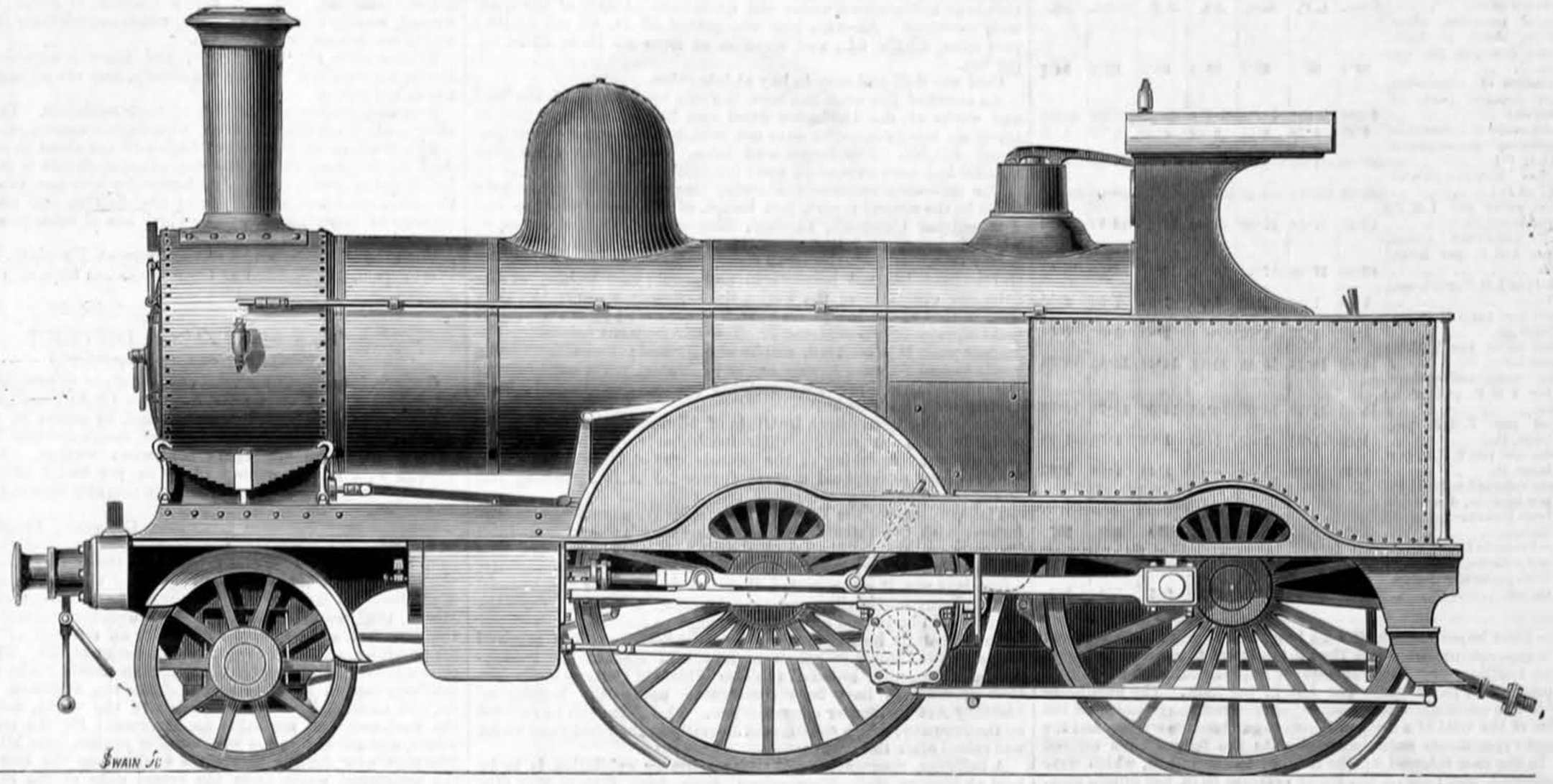
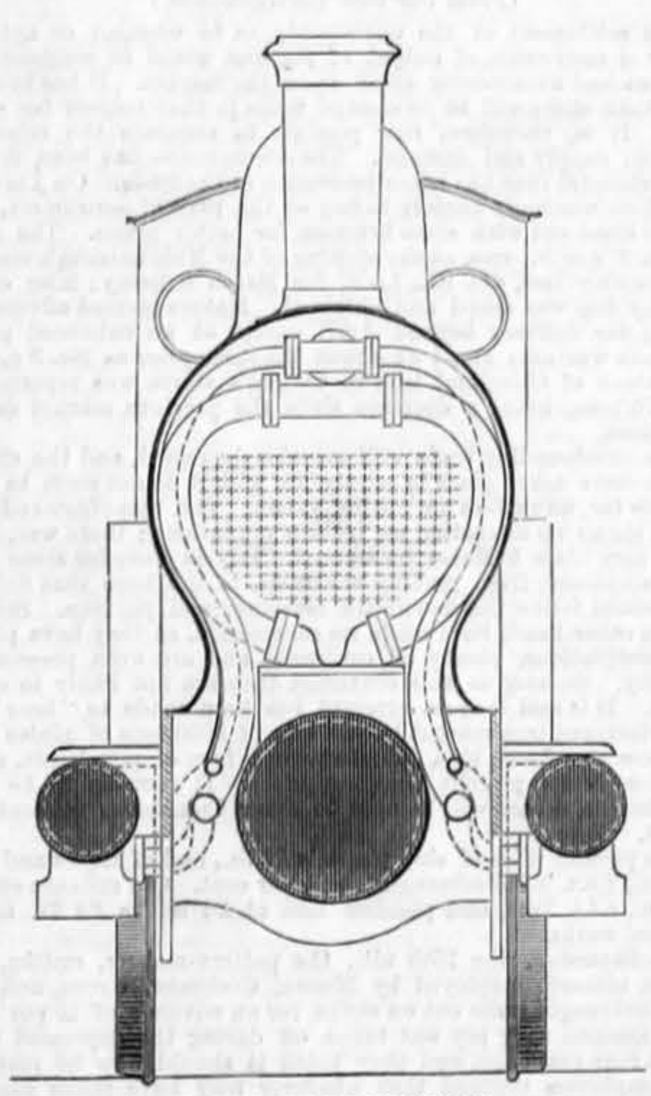
COMPOUND LOCOMOTIVE, LONDON AND NORTH-WESTERN RAILWAY.

MR. F. W. WEBB, M.I.C.E., ENGINEER, CREWE.



IN THE ENGINEER for Feb. 10th we described at some length the new compound locomotive invented by Mr. Webb, locomotive superintendent of the London and North-Western Railway, and constructed by him at Crewe. Above we give an elevation of this engine, which illustrates its peculiarities.

The engine has three cylinders, two high-pressure, one of which is shown, 11½in. diameter and 24in. stroke, which actuate the two trailing driving wheels. Under the smoke-box is placed a single-low pressure cylinder 26in. diameter and 24in. stroke, which actuates the leading driving wheels. The engines are independent of each other, save in so far as the rails may be said to couple the four driving wheels. The steam expanding from the high-pressure cylinder enters a system of pipes passing through the smoke-box, and acting as an intermediate receiver. The low-pressure cylinder slide valve is worked by Joy's patent valve gear, arranged precisely as in the engine shown to the



TRANSVERSE SECTION

members of the Institution of Mechanical Engineers, at Barrow-in-Furness in 1880. Reversing is effected by a hand-wheel on the foot-plate not shown.

The valve gear of the high-pressure cylinder is also Joy's, and closely resembles that illustrated in THE ENGINEER for Dec. 2nd, 1881, p. 401. The dotted lines show its construction. In a kind of box under the running board is fitted a disc, which may be said to resemble the plug of an ordinary stop-cock. In this plug is a curved slot as shown, the slot having the same radius of curvature as the length of the link leading from a die in this slot to the end of the valve rod. This link is coupled to the conecting rod by two bars as shown. The effect is that as the crank shaft revolves the die is caused to travel up and down in the slot in the plug. If the slot is set at angle with the vertical, the valve stem will obviously be caused to move backwards and forwards; when, however, the slot is vertical the valve has no motion imparted to it by the travel of the die. The plug has a lever arm attached to it answering to the handle of a tap. This lever is coupled to a reversing lever with quadrant, the top of which lever can be just seen over the side guard of the foot-plate. By this means the plug can be made to partially rotate, and so alter the angle of inclination of the slot that the engine will run forward or backwards. The means by which lead is obtained will be readily understood by any reader conversant with valve gear.

It is not too much to say that Mr. Joy's ingenious valve gear has rendered the construction of this fine engine possible. A link motion might indeed have been used, but not with any satisfaction. Mr. Webb states that this engine works ordinary passenger trains with a little over 23 lb. of coal per mile, which represents a saving of perhaps 20 per cent. in fuel on the ordinary consumption. We have already stated that this engine is beyond question the best type of compound locomotive ever constructed, and we shall be much surprised if a large number of such engines are not soon put into regular traffic. The only thing to militate against the extended adoption of the Webb engine is the possibility that repairs may be heavier than is desirable. On this point only opinions can be expressed, and we prefer to reserve ours until we have some experience of the working of the engine to go upon.

TRIAL OF ENGINES AND BOILER AT MR. E. HEYWORTH'S AUDLEY HALL WEAVING SHED, BLACKBURN.

WE have referred at length in another place to a report by Mr. Michael Longridge, M.A., from which we take the following extract :—

The object of the experiments were, first, to ascertain the weight of water used by the engines per I.H.P. per hour, also the weight evaporated by the boiler and economiser per pound of fuel burnt; secondly, to ascertain the effect of the steam jackets, collectively and separately; and, thirdly, by comparison with some experiments made by the company last year to check the results then arrived at.* The trials were commenced on Tuesday, the 27th October, and were continued till Wednesday, the 2nd November, with the exception of the Saturday and Sunday, on the former of which days the works stopped at mid-day. On Tuesday, the 25th October, the engines were worked without steam in the jackets; on Friday, the 28th October, with steam in all the jackets; and as these were considered to be the most important experiments, they were repeated on Tuesday and Wednesday, the 1st and 2nd November. On Wednesday, the 26th October, the jacket of the condensing cylinder only was in use; on Thursday, the 27th October, that of the receiver only; and on Monday, the 31st October, that of the non-condensing cylinder only. It would have been interesting to have tried the effect of working one day with the jackets of the non-condensing cylinder and the receiver in use, and another day with those of the condensing cylinder and receiver; but time did not permit. A preliminary trial was made on Monday, the 24th October, for the purpose of making the observers acquainted with their duties, but as the observations were not complete, they are not given. In tabulating the results of the trials an attempt has been made to follow the method indicated by M. G. A. Hirn, whose clear and practical exposition of the subject the writer here desires to acknowledge. Unless otherwise mentioned, the figures in the tables refer to a single stroke of the engines, the object being to eliminate the element of speed, and so render the results more easily comparable with those obtained from other experiments.

The engines are a pair of horizontals working compound, with a receiver between the cylinders, and the cranks at opposite ends of the shaft set at right angles. The non-condensing cylinder is fitted with a single slide valve, worked by an excentric, with a grid cut-off valve on the back, actuated by the governor through McNaught and Varley's motion. The regulation of the expansion is automatic. The condensing cylinder has a single slide valve, worked by an excentric. Both the cylinders and the receiver are steam jacketted with the boiler pressure on the sides, but not on the ends or steam-chests; these, as well as the connecting pipes, are well covered with non-conducting composition. There is a separate steam trap and drain pipe from the lowest point in each jacket. In ordinary working the jackets drain into a cistern from which the boiler is fed, but during the experiments these pipes were disconnected from the cistern, and the discharge from them received into separate boxes for measurement. The air pump, 21in. diameter by 23in. stroke, is worked by a bell crank, from the piston-rod cross-head of the condensing engine. The power is transmitted by a belt 3ft. 6in. wide, the drum being 25ft. diameter. The engines were made by Messrs. W. and J. Yates, of Blackburn, in 1878, and have run almost continuously since. The principal dimensions are :—

Diameter of cylinders	20in. and 34in.
Stroke of pistons	5ft.
Nominal number of revolutions per minute	48
Diameter of piston rods	3⅝in. and 3¾in.
Length of connecting rods	15ft.
Volume of clearance, smaller cylinder, front (8·25 per cent.)	0·870 c. ft.
Volume of clearance, smaller cylinder, back (8·37 per cent.)	0·913 c. ft.
Volume of clearance, larger cylinder, front (6·80 per cent.)	2·115 c. ft.
Volume of clearance, larger cylinder, back (6·85 per cent.)	2·160 c. ft.
Volume of space between cylinders	17·263 c. ft.
,, smaller cylinder, including clearance	11·62 c. ft.
,, larger ,, ,,	33·48 c. ft.
Relative volumes of cylinders	1 : 2·88
Internal diameter of steam pipe	6in.
Length of ditto	67·5ft.

The boilers are two in number, also made by Messrs. W. and J. Yates. They are of the ordinary Lancashire type, 30ft. long by 7ft. diameter, with two internal flues 2ft. 9in. diameter, tapering to 2ft. 3in. in the last ring at the back end. In each flue are five Galloway tubes. The grates, 2ft. 9in. wide by 5ft. 6in. long, are fed by Proctor's mechanical stokers. There is also a Green's economiser of 120 pipes. During the experiments one boiler only and the economiser were used for raising steam for the engines, the other boiler supplying steam for the donkey and for sizing and heating the works. The connection between this boiler and the engine and economiser was cut off by blank flanges on the steam and feed pipes, and the gases from the furnaces were caused to pass through the "by-flue" to the chimney by a partition wall built in the main flue. The boilers are covered with non-conducting composition and bricked over on the top; the front ends are also well covered. In fact every precaution is taken to prevent waste of heat by radiation. The leading particulars of the boiler used for the trial are as follow :—

Grate surface		30·25 sq. ft.
Heating surface :—		
Internal flues	515 sq. ft.	
Side flues, external	310 sq. ft.	
Bottom flues, external	110 sq. ft.	
		935 sq. ft.
Economiser		1200 sq. ft.
Total		2135 sq. ft.
Ratio of grate to heating surface, exclusive of economiser		1 : 31
Ratio of grate to heating surface, inclusive of economiser		1 : 70·9
Grate surface per I.H.P., taking I.H.P. at 320		0·094 sq. ft.
Heating ,, ,, ,,		6·68 sq. ft.

The gases, after leaving the internal flues, pass along the sides of the boiler, then back along the bottom, and so through the economiser to the chimney.

The duration of each day's trial was accurately noted by one of the observer's watches. It was nominally seven and a-half hours, viz., from about 8.45 a.m. to about 5.15 p.m., less one hour for dinner. The engines commenced running after the breakfast time at 8.30 and stopped at 5.30. They were therefore thoroughly warm, and drove the full load during the whole time of the trial, except during the time of stopping for dinner and starting again.

The drain taps on the cylinders and steam pipe were opened before breakfast in the morning, but not during the day, so that all condensed steam went through the cylinders to the hot well and tumbling bay. The boiler safety valves were loaded to 110 lb., while the working pressure did not exceed 90 lb., so that no steam escaped. The valves and pistons of the engines, and also the jackets, with the exception of that of the receiver, were tested. The smaller piston was not quite tight, otherwise there was no escape.

In what follows it is assumed that the boiler produced dry saturated steam, which contained 1 per cent. of moisture on entering the cylinder owing to loss of heat by radiation from the steam pipe; also that the loss by radiation from the cylinders and receiver was balanced by the heat produced by friction of the valves and pistons. These premisses being granted, we may now proceed to the conclusions, and in doing so it will be best to treat the engines and the boiler separately, beginning with the engines. The proper test of merit applicable here is the weight of dry saturated steam required to develope 1-horse power for one hour at the strap connecting the engines to the mill machinery; but inasmuch as the power required to overcome the friction of the engines alone could not be determined, we must be content with ascertaining the weight of feed-water and of dry saturated steam used per hour for 1-horse power developed in the cylinders, both as measured by the indicator in the ordinary way, and as calculated on the supposition

* Trial of the engine and boilers, at Messrs. Thomas Nuttall and Sons, Oak Mill, Farnworth.