NOTES ON ROAD TRIALS OF THREE EXPRESS
PASSENGER-ENGINES, CARRIED OUT ON THE
GREAT NORTHERN RAILWAY IN 1906.

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[*Selected for Publication.*]

The three Engines tested were, No. 1300, Four-Cylinder Compound, Fig. 2 (page 526); No. 292, Four-Cylinder Combined Compound or Simple, Fig. 3 (page 527); and No. 294, Two-Cylinder Simple, Fig. 4. No. 1300 was designed and built by the Vulcan Foundry Co., Newton-le-Willows; in general arrangement and dimensions it resembles the Four-Cylinder Compounds of the Northern of France Railway. Nos. 292 and 294 were designed by the author and built at Doncaster. The leading dimensions and ratios of the Engines are given in Table 1 (pages 528 and 529).

The trials from London to Doncaster (*see* Fig. 1) were so arranged that each driver and fireman, of the three sets of men selected, should run each engine for three weeks with the same group of trains (mostly express) in regular rotation. By this means it was intended that each driver should make the same number of trips with each engine on each train; thereby eliminating the personal equation and equalizing all conditions as far as possible. The drivers and firemen took great interest in the trials, and, as an additional stimulant for them to make each engine show to the best advantage, prizes were arranged

(*Continued on page 531.*)

FIG. 1.—Section of Great Northern Railway, London (King's Cross) to Doncaster.

FIG. 2.—Four-cylinder Passenger-Engine (Compound), No. 1300. Designed and built by Vulcan Foundry Co., July 1905.

FIG 3.—Four-cylinder Passenger-Engine (Simple or Compound), No. 292. Designed by the author, and built at Doncaster, March 1905.

FIG. 4.—Two-Cylinder Passenger-Engine (Simple), No. 294. Designed by the author, and built at Doncaster, May 1905.

Scale for Figs. 3 and 4, see Fig. 2.

TABLE 1 (continued on opposite page).

Leading Dimensions and Ratios.

	Engine No. 1300.	Engine No. 292.	Engine No. 294.
Makers	Vulcan Co.	G.N.R.	G.N.R.
Date first into Service	July 1905.	March 1905.	May 1905.
GENERAL:—			
Weight in working order lbs.	159,040	153,440	152,990
„ on Drivers . lbs.	82,880	80,640	80,640
„ in working order, } Engine and Tender . lbs. }	250,660	245,060	244,610
Wheel Base, driving . . .	8 ft. 6 in.	6 ft. 10 in.	6 ft. 10 in.
„ Total Engine . . .	28 ft. 3 in.	26 ft. 4 in.	26 ft. 4 in.
„ „ „ and } Tender . „ . . . }	49 ft. 6 in.	48 ft. 5½ in.	48 ft. 5½ in.
*TRACTION POWER	14,869	8,994	16,875
Traction power No. 292 work- } ing simple }	—	20,070	—
CYLINDERS:—			
Number	4	4	2
Kind	Compound	{ Compound or Simple }	Simple
Diameter and Stroke, } ins. high-pressure }	14 × 26	13 × 20	18½ × 24
Diameter and Stroke, } ins. low-pressure }	23 × 26	16 × 26	—
VALVES:—			
High-Pressure	6½ in. Piston	Balanced Slide	Balanced Slide
Low-Pressure	Balanced Slide	Do.	—
Greatest travel . . . ins.	5½	4½	4½
Outside lap ins.	—	HP. 1, LP. 1½	1½
Inside clearance . . . ins.	—	½	½
Lead in full gear . . . ins.	¼	HP. ⅛, LP. 1½	1½
WHEELS:—			
Arrangement	4-4-2	4-4-2	4-4-2
Driving diameter . . . ins.	80	80	80
„ journals, diameter } and length }	8½ × 9	7½ × 7	8½ × 9
Bogie diameter . . . ins.	38	44	44
„ journals, diameter } and length }	5½ × 9	5½ × 9	5½ × 9
Trailing diameter . . . ins.	44	44	44
„ journals, diameter } and length }	5½ × 10	5½ × 10	5½ × 10

* TRACTIVE POWER.—For the formulæ used in calculating the Tractive Power, see page 531.

(concluded from opposite page) TABLE 1.

Leading Dimensions and Ratios.

	Engine No. 1300.	Engine No. 292.	Engine No. 294.
Makers	Vulcan Co.	G.N.R.	G.N.R.
Date first into Service	July 1905.	March 1905.	May 1905.
BOILER:—			
Working pressure, lbs. per sq. in.	200	200	200
Outside diameter . . . ins.	63	66	66
Firebox, type	Narrow	Wide	Wide
" length and width			
outside ins.	120 × 48½	71 × 81	71 × 81
Firebox, plates, thickness . . . ins.	⅝	⅞	⅞
" water space . . . ins.	3 and 3½	3 and 3½	3 and 3½
Tubes, number, and outside diameter in inches . . . }	149—2½ Serve	248—2½	248—2½
Tubes, length	12 ft. 4 in.	16 ft. 0 in.	16 ft. 0 in.
*Heating surface, tubes sq. ft.	2,344	2,359	2,359
" " firebox sq. ft.	170	141	141
" " total sq. ft.	2,514	2,500	2,500
Grate area . . . sq. ft.	31	31	31
RATIOS:—			
Cylinders	1 : 2.70	1 : 1.96	—
Weight on Drivers ÷ Tractive Effort	5.5	8.96	4.78
Weight on Drivers ÷ Tractive Effort, No. 292 as Simple	—	4.02	—
Total Weight ÷ Tractive Effort	10.69	17.06	9.07
" No. 292 as Simple " " "	—	7.65	—
Tractive Effort × Diameter Drivers ÷ Heating Surface	473.15	287.8	540.00
Tractive Effort × Diameter Drivers ÷ Heating Surface, No. 292 as Simple	—	642.24	—
Total Heating Surface ÷ Grate Area	81.1	80.64	80.64
Tube Heating Surface ÷ Firebox Heating Surface . . .	13.79	16.73	16.73
Weight on Drivers ÷ Total Heating Surface	32.96	32.26	32.26
Total Weight ÷ Total Heating Surface	63.26	61.38	61.2
Volume of Cylinders in cubic feet	17.14	9.12	7.67
Total Heating Surface ÷ Volume of Cylinders	146.6	274.12	325.94
Grate Area ÷ Volume of Cylinders	1.8	3.39	4.04

* HEATING SURFACE TUBES.—In the case of the Serve tubes, the heating surface equals the actual area, including the ribs, exposed to the heated gases. In the case of the plain tubes the area on the water side is used.

TABLE 2.

Results of Trials.

	Engine No. 1300.	Engine No. 292.	Engine No. 294.
Miles run, Engine . . .	11,286	11,670	11,673
" " Train . . .	11,045	11,415	11,415
Speed, Average miles per hour	49.02	49.9	49.58
Weight of Train, Average tons	229.98	238.03	234.29
TON-MILES :—			
Total Train. . . .	2,540,130	2,717,112.5	2,674,420
Including Engine and Tender	3,803,030	3,993,812	3,949,110
Per hour " "	16,759	17,337	17,030
COAL USED :—			
Per engine-mile . . lbs.	44.86	43.02	44.31
Per train-mile . . "	45.84	43.98	45.31
Per ton-mile . . "	0.133	0.126	0.131
OIL USED :—			
Per 100 engine-miles . pints	7.34	7.18	6.22
Per 100 ton-miles . "	0.022	0.021	0.0184
Costs :—			
Coal—			
Per engine-mile . . pence	2.4	2.3	2.37
Per ton-mile . . "	0.0071	0.0067	0.007
Oil :—			
Per engine-mile . . "	0.165	0.16	0.14
Per ton-mile . . "	0.00049	0.00047	0.00041
Repairs :—			
Per engine-mile . . "	0.56	0.45	0.37
Per ton-mile . . "	0.0017	0.0013	0.0011
Total :—			
Per engine-mile . . "	3.125	2.91	2.88
Per ton-mile . . "	0.0092	0.0085	0.0085

based on the aggregate performance of the men, and not on that of any engine. The men ran each of the engines for one week prior to commencing each three-weeks' trial, in order to get thoroughly familiar with them.

The engines were put into the same condition of repair before the trials, and were treated in the same way throughout, and were supplied with the same quality of coal, namely, Yorkshire from the Barnsley bed. Careful account was taken of coal and oil used, time lost or made up, state of weather, weight and composition of trains, and cost of running repairs. An inspector rode with each engine during the trials. The results are shown in Table 2 (page 530).

Tractive Power.—The formulæ used in calculating the Tractive Power, see Table 1 :—

$$\text{For Simple} \quad . \quad . \quad . \quad \text{T.P.} = \frac{0.8 P d_h^2 s_h}{D}$$

$$\text{For Compound} \quad . \quad . \quad \text{T.P.} = \frac{1.6 P d_i^2 s_i}{D(r+1)}$$

$$\text{For No. 292 working Simple T.P.} = \frac{0.8 P}{D} (d_h^2 \times s_h + d_i^2 \times s_i)$$

Where D = Diameter of Driving Wheel, inches.

d_h = Do. High-Pressure Cylinder, inches.

d_i = Do. Low-Pressure Do. Do.

P = Boiler Pressure in lbs. per square inch.

s_h = Stroke of High-Pressure Cylinder, inches.

s_i = Do. Low-Pressure Do. Do.

r = Ratio of Cylinder Volumes.

Ton-Miles including Engine and Tender.—This figure is obtained by adding the total Train ton-miles to the Engine and Tender ton-miles. The result is used throughout the calculations.

Speed.—The average speed in miles per hour required for the three groups of Trains worked on the trials was 48.15 (or 51.28—47.16—46.01 respectively): the actual average speed of each Engine

showed that all three made up time, the one with the highest average speed making up the most.

Coal Used.—The coal used for lighting-up is included in these figures.

The Paper is illustrated by 4 Figs. in the letterpress.