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“Experiments on the Tractive Resistance of Loaded Railway-Wagons.”

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THE following is an account of some experiments made in order to determine the tractive resistance of 10-ton, 20-ton and 30-ton railway-wagons, loaded to their full capacity. The experiments were carried out chiefly on the straight road, a few only being made on a curve.

The wagons experimented with were:—

	Tons.	Cwts.	Qrs.
Six 10-ton wagons, 9 feet wheel-base, with grease-boxes, } total weight	94	5	1
Six 10-ton wagons, 12 feet wheel-base, with oil-boxes, } total weight	99	7	1
Three 20-ton wagons, with oil-boxes, total weight	84	18	3
Two 30-ton “ “ “ “ “ “	88	14	3

—each train being loaded with 60 tons of pig-iron. The various wagons employed are illustrated in *Figs. 1*.

The experiments were made on the Lancashire and Yorkshire Railway between St. Luke's Road and Burscough Bridge, this being the most suitable place owing to the nature of the permanent way and the exposed character of the surrounding country. The experiments on the curve were made at Barton, on the St. Luke's and Hillhouse branch. The curve forms almost a quarter of a circle, of 1,820 feet radius (27·6 chains), and is on the level.

In carrying out the experiments on the straight, a dynamometer-car was used. The positions of the regulator and the reversing-screw on the engine were marked for each trial and were not altered during the whole of the run, thereby eliminating the acceleration which would be caused by altering the power of the engine. On this line, where the gradients are very slight, constant speeds could be maintained for 2 or 3 miles. On the curve the wagons were propelled by an engine until the desired speed

was attained; the wagons were then slipped and allowed to travel round the curve, the distance travelled being marked every 10 seconds until the vehicles passed off the curve. In order to determine the relative resistance of each train, it was decided to run the trains at speeds varying between 30 miles per hour and 50 miles per hour, as lower speeds would not show a sufficient difference between the resistances, on account of the small weight

Figs. 1.

of the trains. On the straight, ten trips were made with each train, in order that a fair idea of the comparative resistance of the different trains experimented with might be obtained.

The results of the experiments made on the straight are plotted in Fig. 2, and it will be seen that the resistance per ton is highest with the 10-ton wagons of 9 feet wheel-base, which were fitted with grease-boxes. When hauling this train the wagons were in

a constant state of oscillation, which would augment the resistance considerably. The 20-ton wagons ran very steadily, but the high resistance per ton may be accounted for by the area exposed presenting a more effective surface to the wind. The 10-ton wagons of 12 feet wheel-base, which were fitted with oil-boxes, ran exceptionally well both on the straight and on the curve, this being noticed whilst the trials were in progress and before the results had been tabulated. It will be seen that the curve closely approaches that for the 30-ton wagons, indicating either the easy running of the 10-ton wagons or the high resistance of the 30-ton wagons. From observation it was concluded that the resistance of the 30-ton wagons was rather high when going round curves,

Fig. 2.

owing to the excessive deflection of the sole-beams, due to the load, causing the friction-blocks to bear hard on the bogie and prevent it from turning with sufficient ease. This fact is also shown by the results of the run on the Barton curve, plotted in *Figs. 3*, the 10-ton wagons having a resistance of 1·3 lb. per ton less than that of the 30-ton wagons. But, since it is the horse-power required to haul a paying load that has to be taken into account, these resistances must be taken in conjunction with the load hauled. Thus, since the ratio of the load carried to the tare is,

for 10-ton wagons of 9 feet wheel-base	. . .	1·75 to 1
„ 10-ton „ 12 „ „ „	. . .	1·52 „ 1
„ 20-ton „	. . .	2·4 „ 1
and „ 30-ton „	. . .	2·09 „ 1
		2 B 2

it follows that if the resistances per ton were equal, [the 20-ton wagons would require the least power to haul a given load, the 30-ton wagons a little more, the 10-ton wagons of 9 feet wheel-base still more, and the 10-ton wagons of 12 feet wheel-base the most of

Figs. 3.

all; but it will be seen that the resistances vary in quite a different ratio. At 40 miles per hour they are the following:—

for 10-ton wagons of 9 feet wheel-base	16.35 lbs. per ton
„ 10-ton „ 12 „ „ „	12.8 „ „ „
„ 20-ton „	14.4 „ „ „
and „ 30-ton „	12.4 „ „ „

Taking these in conjunction with the load hauled, it is found

that at 40 miles per hour the power required to haul 60 tons of paying load is,

for 10-ton wagons of 9 feet wheel-base	. . .	164·3 HP.
„ 10-ton „ 12 „ „ „	. . .	135·5 „
„ 20-ton „	. . .	130·3 „
and „ 30-ton „	. . .	117·4 „

Or, the power required per ton of paying load at 40 miles per hour is,

for 10-ton wagons of 9 feet wheel-base	. . .	2·74 HP. per ton
„ 10-ton „ 12 „ „ „	. . .	2·26 „ „ „
„ 20-ton „	. . .	2·17 „ „ „
and „ 30-ton „	. . .	1·96 „ „ „

It is obvious, therefore, that for a given load the 30-ton wagons can be hauled with less power than those of any other class, and although the 20-ton wagons have a resistance 1·6 lb. per ton greater than that of the 10-ton wagons of 12 feet wheel-base they can be hauled with less power. It will be noticed that there is a very considerable difference between the power required for the 10-ton wagons of 9 feet wheel-base and that for those of 12 feet wheel-base, the former being nearly $\frac{1}{2}$ HP. per ton greater than the latter.

In plotting the results it was found that they varied considerably for the same speed, owing to the wind-pressure on the vehicles. It was observed, however, that if they were plotted to a base representing the speed of the train relative to the air, the results were more comparable. The chart (*Fig. 2*) is therefore made out in this manner, the velocity of the wind against the train being taken as the speed of the train. It will be noticed that length on the diagram represents the actual speed of the train if there is no wind.

The diagrams (*Figs. 3*) showing the resistances on the curve represent the mean of three experiments; height on the diagram representing loss of speed in a given time. The resistances have been calculated from the loss of energy due to this reduction of speed.

The Paper is accompanied by three diagrams, from which the Figures in the text have been prepared.