

on the line of railway only dealt with, with a view of arriving at the quantity consumed in moving 1 ton weight 1 mile. The result arrived at is as follows:—Canada Southern, 2·30 ozs.; Lake Shore, 2·38 ozs.; Michigan Central, 3·52 ozs.; and Hannibal and St. Joseph, 5·76 ozs.

Though it will surprise most people who have not paid particular attention to these questions, to learn that there is sufficient energy in a piece of coal weighing only 2·3 ozs. to move 1 ton weight 1 mile; yet the investigations would not be complete if it were not ascertained what is the total energy of the fuel; what portion of it is used, and what lost.

The units of heat (Fahrenheit) developed in the combustion of 1 lb. of coal are 14133,¹ and as the mechanical equivalent is 772 foot-pounds per unit, the combustion of 1 lb. of coal is equal to 10,910,676 foot-pounds, or 5455·3 foot-tons (American).

On the Canada Southern Railway, the average of the whole line is equal to a gradient of 5 feet to the mile; this will make the resistance to haulage equal to 11 lbs. per ton, taking the resistance on the level at 9 lbs. per ton; therefore as much energy will be expended in hauling 1 ton 1 mile, as in lifting 11 lbs. 1 mile vertically. In other words, hauling 1 ton 1 mile requires an expenditure of energy equivalent to $5,280 \times 11 = 58,080$ foot-pounds, or 29·04 foot-tons.

But on the Canada Southern Railway, 1 ton is hauled 1 mile by the combustion of 0·15 lb. of coal, which quantity of coal therefore does work equivalent to raising 29·04 tons 1 foot. At the same rate 1 lb. of coal would raise 193·6 tons 1 foot vertically. But as shown above, the full energy of 1 lb. of coal is 5,455·3 foot-tons; therefore the full energy is to the work effected on the Canada Southern Railway as 100 is to 3·5, and consequently there is a loss of 96·5 per cent. of the energy of the fuel. Though the quantity, 2·3 ozs. of coal, seems extremely small to do the work of hauling 1 ton 1 mile, yet, if all the energy contained in the coal could be utilized and applied to doing work, it would haul 1 ton $28\frac{1}{2}$ miles; while the quantity, 1·86 lb., consumed in moving a passenger 1 mile would, if fully utilized and applied to the transportation of freight, convey 1 ton 353 miles. Few passengers are aware of how much energy is required to make "fast time."

The speed of passenger trains on the Canada Southern Railway was from 35 to 40 miles per hour; on the Michigan Central and

¹ "A Manual of Rules, Tables, and Data, &c.," by D. K. Clark, M. Inst. C.E., p. 405.