TRAIN RESISTANCE.

Train resistance varies with speed, length of train, weather conditions, wind, etc., and also if train has been standing or has been in motion for some time. The starting resistance may be considered at 15 lbs. per ton for long trains, and 20 lbs. for single cars. For speed of ten miles per hour and over, use the following formulæ, for ordinary train resistance in lbs. per ton. Trains loaded two contents to one tare, engines with tractive power about 30,000 lbs. or 1,000 H.P.

Grades 0.3 or 0.4. $R = 4.0 + \frac{V^{5}/_{3}}{100}$

Grades 0.5 to 0.7. $R = 4.0 + \frac{V^{5}/_{3}}{80}$

Grades 0.8 and over. $R = 4.0 + \frac{V^{5}/_{3}}{60}$

If train is all tare, use 9.0 lbs. as constant. The H.P. required to move train at any given speed will be found by the formula,

$$H.P. = \frac{R \times S}{375}$$

in which R = train resistance at given speed; S = speed in miles per hour.

GRADES.

The essential feature in a location for freight traffic is the ruling grade. Passenger trains are limited by speed requirements rather than tractive effort of the locomotive. This is also true for freight trains on long sections of continuous rise, the H.P. of the locomotive being the limiting factor.

Where low ruling grades of from 0.3 to 0.5 are being worked to and can only be obtained by long sections, about ten miles in length of continuous rise, and supporting ground for same is not obtainable except by very long cuts and fills, it would be economical to insert steeper grades, not to exceed ruling grade more than 0.1, provided adverse grades are not inserted and engine can be worked to full capacity over slack grades.