Items 10 and 23 are chargeable directly to passenger.

Items 1, 2, 3, 4, 15, 17, 19 and 24 are divided in the proportion of the freight and passenger revenue.

Items 12, 13, 16, 26, 27, 28, 29, 30 and 31 in the proportion of the freight and passenger train mileage.

Item 9 in the proportion of the freight and passenger engine mileage.

Items 20, 21 and 22 are directly proportional to the train mileage, but the cost of these items per train mile varies from 50 to 70% more in freight than in passenger service. In the absence of more accurate data, therefore, we add 60% to the freight train mileage, and distribute the items in the proportion of the freight train mileage thus obtained, to the actual passenger train mileage.

Items 5, 6 and 7 vary directly with the engine mileage, but their cost per freight engine mile is from 60 to 100% greater than per passenger engine mile. To apportion these items, therefore, when more accurate data is not obtainable, we increase the freight engine mileage 80%, and adopt this and the passenger engine mileage as the basis of subdivision.

The item "Fuel for locomotives" 8 is one of the largest of railway expense, and should be very carefully distributed. If access is to be had to the company's accounts, the relative amounts chargeable to freight and passenger may usually be readily ascertained. Generally, this item may be apportioned arbitrarily with considerable accuracy. The cost of fuel per engine mile varies from 50 to 100% greater in freight than in passenger service. To the freight engine mileage, however, has been added the switching mileage, which reduces the increase to an average of about 50%. The item is therefore divided in the proportion of the freight engine mileage, increased 50%, to the actual passenger engine mileage. Having now apportioned the total expenses between freight and passenger, these divided respectively by the freight and passenger train mileage give the average cost per freight and passenger train mile. We may proceed further and divide these expenses respectively by the total number of revenue ton and passenger miles, and obtain the average cost per ton and per passenger mile—the main transportation units.

The cost of freight and passenger train mileage is found to vary from 75c. to $1.50, and from 65c. to $1.40 respectively, according to conditions, but a fair average for each may be taken as 85c. and 75c. Having obtained these results, we are in a position to estimate the yearly value of improvements by which the engine rating is increased. Proceeding upon the lines laid down by A. M. Wellington, it will be found that from 50 to 60% of the expense varies with increased train mileage. This percentage, multiplied by the cost per freight train mile, and by the number of train miles saved in a year, gives the yearly saving in operating expenses.

When the tonnage of a train is not governed by the speed or other limiting conditions, the haulage capacity of a locomotive on different grades may be determined from the following formula:

$$T = \frac{c}{4.5 + 20} r - E$$

in which

T = tonnage of train.
C = cylinder tractive power of engine at a minimum allowable speed of 7 or 10 miles per hour.
R = rate of grade.
E = weight of engine in tons.

The engine rating may be greater in one direction than the other, and at the same time the traffic may be of such a nature that the average train tonnage may be less in the former direction than in the latter, consequently although the rating may be considerably increased in one direction, it does not necessarily follow that the average train tonnage in that direction will be increased in a like proportion. In estimating, therefore, the number of train miles saved by an increase in the engine rating, care should be taken to ascertain the actual number of properly balanced trains necessary to operate on the new line to handle the given traffic.

The question of the most suitable grades to adopt is usually complicated by an unequal balancing of the grades to the traffic. If the tonnage is greater in one direction the return tonnage will consist partially or wholly of unloaded cars. It is usually estimated that 30% additional power is required to haul empty cars than a like tonnage of loaded cars, and the locomotive haulage sheets are compiled on that basis. The frequency with which trains of empty cars are stalled would indicate, however, that this is not a sufficiently large allowance. Wellington's experiments on loaded and empty cars tend to confirm this belief, giving 45% at 7 miles per hour as the additional power required, a percentage which decreases slightly as the speed increases. In reducing grades to balance the traffic, therefore, that portion of the return tonnage which consists of empty cars should be increased by at least 35 or 40%, and proportionately for partially loaded cars, and grades adopted which will suit this equivalent tonnage and the actual tonnage in the opposite direction.

On lines traversing a river valley with a low ruling gradient of a practically continuous rise, the scheduled speed may be such as