(1) Maintenance of equipment, which consumes about 20% of total operating expenses.

"Railroad repair shops throughout the country do not show 50% efficiency on an average as regards either materials or labor."—Emerson.

(2) Maintenance of way, consuming about 20% of total operating expenses.

"Standards of maintenance of way vary, but innumerable assays of actual work show a maintenance-of-way labor efficiency of scarcely more than 30%."—Emerson.

(3) Transportation, consuming about 50% of total operating expenses.

"Fuel.—On the Santa Fe average fuel used per 1,000 freight train ton miles was reduced from 261 lbs. to ²³⁹ lbs. On the Chicago, Milwaukee & St. Paul, 175 lbs. Dynamometer Car, 80 lbs."—Emerson.

"It has been demonstrated that by proper instruction, fuel consumption could be reduced at least one-half."— Brandeis.

Terminal expense, particularly the handling of less than car load lots, should be improved by the use of mechanical conveyers.

Maintenance of Equipment.—A fair comparison cannot be made between industrial shops with uniform output and railway repair shops with little uniform work, particularly as such repair work is incidental to the main purpose of producing transportation, and while low cost is desired, expedition is primarily which is required.

Maintenance of Way.—The fact that maintenance-ofway forces may be scattered over thousands of miles of line makes adequate supervision difficult, and that the labor requirements vary with the season makes it impossible to always have the force as efficient as could be desired. The force required to man a thousand miles of line could be concentrated on one acre in a textile mill, so that comparisons of efficiency made under such conditions would be unsatisfactory.

Transportation.—Transportation forces are strongly organized and militant, largely increasing the difficulty of reducing labor charges, but by betterment of roadway and the use of heavier power the railways are effecting such economies as are possible. In this connection Mr. Emerson said: "The efficiency of the traffic by my standards is very high; that is, the efficiency of expense in the traffic departments."

As regards economy in fuel and in its use, this has ever been a subject of investigation on the part of the railways, as also that of mechanical conveyance.

It may also be said that railway development has been proceeding along logical lines. First, the period of railway building, then one of traffic organization and consolidation, followed by one of betterments, embracing perfecting of machinery; strengthening roadbed and bridges, cutting down grades and increasing the motive power and weight of trains. Now the human factor is coming in for increased attention and systems of organization are being studied to the end that the machine as a whole may be brought to the highest efficiency.

In this connection it will be interesting to examine the fundamental principles of scientific management as given by Mr. Frederick W. Taylor, its originator:

"Ist.—Each man in the establishment, high or low, should daily have a clearly defined task laid out before him. This task should not in the least degree be vague or indefinite, but should be circumscribed carefully and completely, and should not be easy to accomplish. "2nd.—Each man's task should call for a full day's work, and, at the same time, the workman should be given such conditions and such appliances as will enable him to accomplish his task with certainty.

"3rd.—He should be sure of large pay when he accomplishes his task. '

"4th.—When he fails he should be sure that sooner or later he will be the loser by it.

"When an establishment has reached an advanced state of organization, in many cases a fifth element should be added, namely, the task should be made so difficult that it can only be accomplished by a first-class man."

The railway as a proposition is characterized by its great extent requiring unusual specialization in every branch and this has in the earlier days led to undue centralization and the creation of departments whose heads endeavored to perform both "staff" and "line" duties. A departmental organization of this kind, projected over large areas with distant headquarters, has proved cumbersome in operation, a breeder of departmental jealousies, and unsatisfactory to both the public and employees. This type of organization is now being superseded by one in which the "staff" and "line" functions are being separated. "Staff" functions, consisting largely of the theoretical side of the work, studying the underlying principles, whether physical or psychological, which make for efficiency in construction and operation; systematizing and standardizing every operation; providing instruction as to application and formulating means by inspection and otherwise for unerringly recording attainment, is necessarily the work of specialists.

Line functions, consisting of the more practical side of the active conducting and directing of the work is none the less the work of specialists and experts, but of execution rather than design.

Line officers are in charge of stated districts, representing the railway in general and not any particular department. Under this arrangement the different departmental activities are co-ordinated and all the advantages of the public and employees being brought into close touch with a responsible representative of the railway gained.

In line with this, the accounting for each district is done on that district, to the end that greater accuracy may be attained by first-hand knowledge and the officer in charge of the district be in possession of all the figures pertaining to the work for which he is responsible, thus enabling him to supervise more intelligently.

A further development follows—that is a common office and file. While merely a detail, this has proved of great value in reducing the volume of correspondence and locating upon one file everything that pertains to any given subject. The use of this system on the railways recently known as the Harriman lines saved half a million letters a year.

Since material as well as labor enters into the work of a district, it is logical that this, both as regards purchase and supply, should be as far as possible in the hands of the local man, in order that he may be informed on every point. In the larger matters, blanket contracts would be let and districts would simply order under these, while in minor matters, standard prices would be fixed and when goods could be purchased locally as cheaply, preference would be given to the district, thus decreasing handling and increasing the good-will of the local public.

The distribution of the prime functions of railway building and operation would be: