man while in the service becomes incapacitated he may go on the pension list.

Pension lists have the effect of making the men feel interested in the concern which provides for them, and is a step towards co-operation, which is being tried out in so many industrial concerns.

EDITORIAL NOTES.

The fight of the recent eight-hour law in Vancouver on municipal work was ended recently when all the men on the contract left work as soon as the order was enforced. The men as well as the contractors find under many conditions the eight-hour labor law a hardship.

* * * *

One of the interesting balance sheets recently issued is that of the Hudson's Bay Company. The company's profits for the year ending May, 1909, amounted to over $800,000, and for the year ending May, 1910, nearly $600,000. Their export of fur and sale of land was as great as during any year in the last ten.

ELEMENTARY ELECTRICAL ENGINEERING.

L. W. Gill, M.Sc.

CHAPTER IV.

This series of articles will be continued for some months. They will be of particular interest to the student of electrical work and the civil engineer anxious to secure some knowledge of the simpler electrical problems.

The symbols used in the following represent the same quantities as in the case of the generator:—

The armature current is $Ia = I - Ie$.

Armature copper loss = Ia^2Ra.

Shunt copper loss = EIe.

If the motor is series wound the series copper loss is Is^2Rs.

The total copper loss is $W = I^2R + EI + I^2R$.

The efficiency of the motor is

$$F = \frac{\text{Output}}{\text{Intake}} = \frac{\text{Intake—Losses}}{\text{Intake}} = \frac{EI-(Wf+Wi+Wc)}{EI} \quad (20)$$

The efficiency of motors is sometimes determined by measuring the mechanical output directly by means of a brake or dynamometer and the electrical intake by means of meters. A brake is not always available, however, and in any case this method involves the use of an amount of power equal to the capacity of the motor. The determination of efficiency by measuring losses, known as the "indirect method," requires less time and only a small amount of power.

Rating of Direct Current Machines.—It has been previously noted that the heat generated in any conductor increases as the square of the current. From this it follows that if the current passing through the armature of any machine—motor or generator—is increased indefinitely, the temperature will rise until deterioration and subsequent destruction of the insulation takes place. To avoid this the current must be restricted to a definite limit. In other words, the current should not exceed that value which will cause a certain definite rise of temperature in the armature. The general practice is to allow a maximum temperature rise of 45° C. in the armature and exciting coils and 50° in the commutator. These values are always based on continuous running at full load for at least ten hours and a room temperature of 25° C. If the temperature of the room is higher or lower than 25° C., the observed temperature rise should be decreased or increased one-half per cent. for each degree the room temperature differs from 25°. Manufacturers of the higher grades of machinery usually guarantee a temperature rise not exceeding 40° C. in the armature and 45° C. in the commutator, except in the case of small machines. Measurements of temperature are usually taken after a ten hours' run by placing a thermometer on the various parts, a small pad of cotton waste or cotton wool being placed over the thermometer bulb to prevent radiation. Nearly all modern machines are rated so that they are able to carry an overload of 25 per cent. for two hours without destructive heating. The additional temperature rise caused by this overload, after the machine has reached a constant temperature with normal load, should not exceed 10° to 12° C. in any part.

From the above it follows that the capacity of a machine is practically fixed by its ability to carry current without destructive heating. In the case of a modern generator, the current which it can deliver continuously to the **external circuit** without excessive heating and the corresponding terminal voltage is always stamped on the

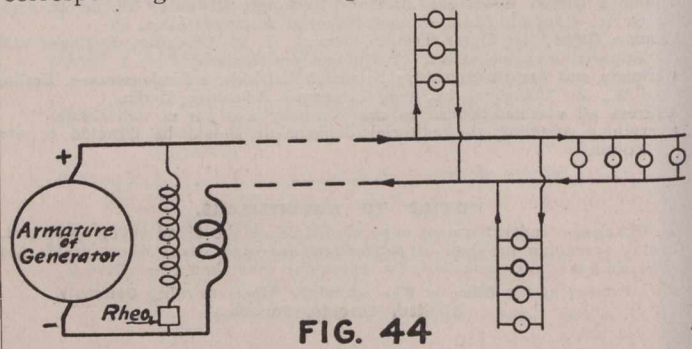

FIG. 44

name-plate. The capacity or rating of a generator is the product of these two, and is the power output which it can maintain continuously. In the case of the motor the rating is the mechanical power which it can deliver continuously without excessive heating. This is always stamped on the name-plate, as well as the voltage, speed, and current capacity.

In some cases the capacity of a machine is fixed by its ability to carry current without sparking at the brushes, but this is very rarely the case with machines manufactured at the present time. Sparking at the brushes is usually due to improper design, assuming that the connections are properly made and the brushes properly set.

Regulation of Direct Current Machines.—The "regulation" of a machine with respect to any characteristic quantity (such as voltage, speed, etc.) is the ratio of the maximum deviation of that quantity from its intended value to the full load value. Thus if a direct current generator is compounded with the object of maintaining a constant voltage at its terminals, and its voltage varies 2 per cent. from the full load value, the regulation is said to be 2 per cent. In the case of an over-compounded generator which is intended to give a gradual increase of terminal voltage from no load to full load, the regulation is the ratio of the maximum variation from the intended voltage at any load to the full load voltage.