RELATION OF LOAD FACTORS TO POWER COSTS.*

J. M. S. Waring.

I have so interpreted this title as to include in the power costs the fixed charges incident to the generating, transmission apparatus, etc., as well as the operating expenses, for there is a relation between the load factor and these fixed charges as well as between the load factor and the actual operating cost.

The fact that these relations exist (and that, other things being equal, the higher the load factor the less the fixed charges and operating expenses for any given energy output), is so well known that an attempt to prove these facts would result in a demonstration of a self-evident proposition, and I will, therefore, begin with the assumption that the fact is admitted, and will devote the major part of this paper to the description of a comparatively novel application of storage batteries where the ultimate benefit is an improvement in the load factor.

As a matter of fact, the installation of all storage batteries for railway and central station service has been made with a view of improving the load factor of the entire system or of some part of the system.

Most of these varied applications are well known to-day, and the time is too limited to make more than a passing reference to them. There is an application, however, that until recently has received comparatively little attention, but whose field is constantly enlarging, and will, I believe, result in more battery installations for railway, lighting and power service than any other single application. In order to obtain a comprehensive understanding of this application it will be necessary to lead up to it by a brief and necessarily academic discussion of power rates. This, I feel, will be justified in view of the facts that the value of the battery installation is here dependent on the nature of the rate, and that the result in this case, as in all the others cited, is the betterment of the load factor.

It is needless to say that for a power company to be on a paying basis, its total revenue must be more than sufficient

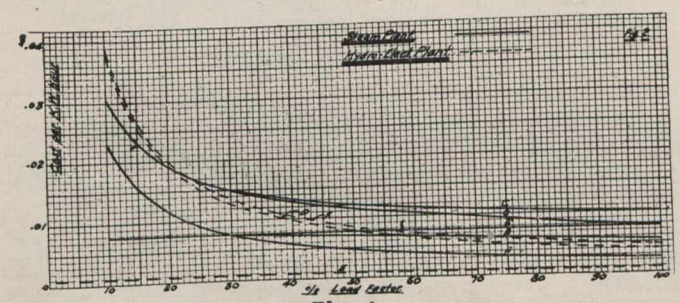

Fig. 1.

to cover all fixed charges and operating expenses. The total expenses of a power company may be divided as follows:—

(A) Fixed charges on equipment, including power house apparatus, transformers, transmission lines, etc., namely, interest, depreciation, taxes, insurance, etc.

(B) Operating expenses made up of such items as fuel and feed water, if it is a steam plant; oil, waste, incidentals, repairs and labor, including power house force, linemen, etc.

(C) Organization expenses, including salaries of officials, clerks, solicitors, etc., office rents and such expenses.

* Paper read before the Western Society of Engineers.

If each customer of a power company is paying annually an amount sufficient to cover the fixed charges, operating and organization expenses, incident to his demand only, plus a reasonable profit to the power company, his rate is a just one, and every well organized power company knows that an unfair discrimination in rates must finally be disastrous. Power companies are, therefore, realizing more and more the necessity of adopting a form of rate which will do justice to all of their customers as well as to themselves, and the tendency to-day is the adoption of a form of rate which will pro-rate the total expenses of the operating company as equitably as possible among its customers. In order to accomplish this: First—All fixed charges and fixed expenses, namely, those that are constant and irrespective of the

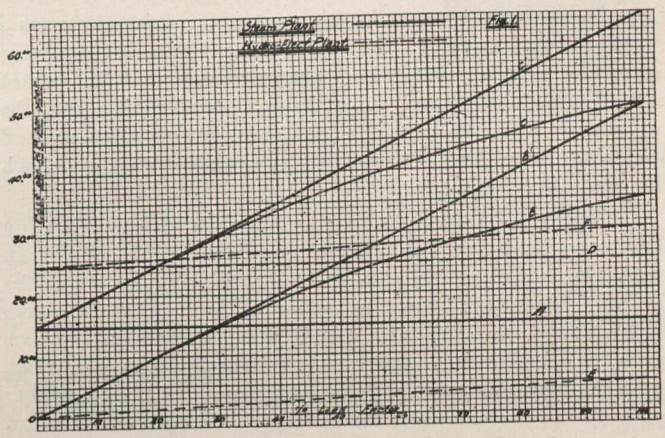

Fig. 2.

energy output of the plant should be divided among the customers in proportion to their maximum demand for power; then each customer pays the fixed charges and fixed expenses on the apparatus set aside for his use.

Second—All variable expenses, namely, those varying with the energy output of the plant should be divided among the customers in proportion to the energy they consume in a fixed time.

Of the various expenses under the headings, "A," "B" and "C," referred to above, the only variables in the case of a hydro-electric plant are the repairs, oil, waste, incidentals, and probably only a small part of the power house force, all the other expenses being practically fixed and independent of the load factor. In the case of a steam plant, however, the variables would include oil, waste, incidentals, fuel, feed water, repairs and a larger percentage of the power house force than would occur in the hydro-electric plant. Therefore, in general, the operating expenses, that is, the variable charges, are a greater percentage of the total operating cost in the hydro-electric than in the steam plants. Now, the total fixed charges of the plant divided by its kilowatt capacity will give the amount per kilowatt which each customer should be charged for each kilowatt of his maximum demand. By doing this, the total fixed charges are properly pro-rated among the customers in the manner outlined above. The total operating expense of the plant for a fixed period of time, divided by the kilowatt hours output for that period will give the cost per kilowatt hour of the actual operating expenses, exclusive of the fixed charges, and this amount plus the company's legitimate profit would be the kilowatt hour rate that the customers should pay for their energy consumption. In other words, an equitable basis of power rates is the one where a customer is billed annually a fixed amount per kilowatt of his maximum peak, which we may call a primary charge, and