DISCUSSION ON "THE DETERMINATION OF THE ECONOMIC LOCATION OF SUB-STATIONS IN ELECTRIC RAILWAYS." AT ATLANTIC CITY, N. J., JULY 1, 1908.

C. J. Hopkins: On December 15, 1905, a paper was read before this Institute on the most economical location of sub-stations for direct-current systems.* Mr. Werner's paper only differs from that, as far as I understand it, in its particular reference to single-phase systems.

Of course, we are all familiar with the form of curves given in Fig. 1. I would not criticise the accuracy of the formulas presented by Mr. Werner, but I question their general usefulness. As simple as it may sound, it appears to me that the most important feature in working out an electrification proposition is the proper consideration and formation of a train diagram, to represent what the service will be when the electrification is completed.

In the last paragraph Mr. Werner refers to the use of his formulas as obviating the necessity of solution by trial. This seems to imply that there might be a large number of solutions by trial necessary if that were the method resorted to, but in general there are only two or three practical solutions, and as a rule, they have to be worked out in detail and carefully considered.

The specific purpose of this paper is to develop an equation for the number of sub-stations, but I do not believe that such a determination is simplified by resorting to any formula of a general nature, but rather is the result of practical consideration and sound judgment.

Gerard B. Werner: The paper to which Mr. Hopkins refers was typical of the method of solution by trial, by evaluating the annual charges for a different number of sub-stations. Now the adjustment of the cost of sub-stations and the cost of copper, considered as an economical problem, is quite definite, and my paper is an attempt to develop some formula to obviate the trial method.

The economic condition of the secondary distribution, whether it can be executed in the actual layout of the road or not, should be determined as a basis of reference. This consideration is the primary intent of the paper, and not the substitution of a formula for judgment, for the handling of engineering problems of this character.

To the best of my recollection, Mr. Lincoln made a contribution to the proceedings of the International Electrical Congress in St. Louis in 1904 on a similar subject, and I have no doubt that he has some comment to make on this topic.

* "Some Considerations Determining the Location of Electric Railway Sub-Stations," by C. W. Ricker, *Transactions A. I. E. E.*, Vol. XXIV p. 1097

P. M. Lincoln: I have not much to add to the discussion, although I have given this matter considerable thought. I am rather inclined to agree with Mr. Hopkins in his suggestion, that after having worked over this matter with a whole lot of formulas, the actual locating of sub-stations is not so much a matter of manipulation by formulas as it is a matter of judgment. It is safe to use the location obtained by formulas only when no other location is dictated by common sense.