DISCUSSION ON "A TRIGONOMETRIC METHOD FOR THE SOLUTION OF ALTERNATING-CURRENT PROBLEMS." ATLANTIC CITY, N. J., JULY 2, 1908

Comfort A. Adams: Eight or ten years ago I worked out, for the purpose of transmission line calculations, a method which, with tables and curves, was an almost exact equivalent of Mr. Pender's method. If one had frequent occasion to make transmission line calculations these tables and curves would be a great assistance, but for infrequent use it takes longer to become familiar with the method than to solve the problem by the long way.

Moreover, I cannot help viewing a matter of this sort from the standpoint of the teacher, and from that standpoint it seems to me that these short-cut methods are undesirable since they do not bring out step by step the physical meaning of the problem; they do not keep one reminded of exactly what one is doing, and an error is less likely to be detected. The natural method has proved more serviceable in my own work, where a given type of problem is considered occasionally, and I think it far more valuable for students. However, I do not wish to minimize the value of any such labor-saving device, as it has a legitimate field where it serves a most useful purpose.

W. A. Del Mar (by letter): The treatment of alternating-current problems has been subject to rapid evolution. When Dr. Steinmetz's method of imaginary quantities appeared it seemed that the summit of development in that line had been reached, but Mr. Pender's method is as much in advance of the Steinmetz method as the latter was of the plain vector method which preceded it. It is a more important advance than that due to Steinmetz's method, because it places the solution of alternating-current problems within the reach of those of very limited mathematical training.

To the teachers Mr. Pender's method should particularly commend itself, as it can be quickly acquired and students can be taught the solution of alternating-current problems before they reach the fairly advanced mathematics. One effect of this would be the possibility of inculcating elementary ideas about alternating currents before the professor of mathematics had propounded the theory of vectors and imaginary quantities.

A preliminary reading of the new method gave the impression that for didactic purposes it would suffer from the disadvantage of not offering a direct physical understanding of the various operations. This impression soon vanished, however, when the ease of working became apparent, for the observations of the writer have led him to believe that only a small portion of technical graduates understand the theory of alternating-current machinery so that they can apply it to the solution of practical problems. This condition arises either from indifference to mathematics, or from the ease with which the subject is for-

gotten in after years. The simplicity of Dr. Pender's method overcomes these two difficulties in an admirable way.

The writer has had occasion to try the new method to solve a number of problems, including the eddy-current brake and transmission problems, and has found the application extremely simple in every case.

L. W. Rosenthal (by letter): I should like to point out the character of the error resulting from the approximation for E_0 .

FIG. 1

between formulas (17) and (18). Denoting the power-factor angle of the load by ϕ and that of the line by θ , the error will depend on $(\theta + \phi)$ for leading currents and on $(\theta - \phi)$ for lagging currents. The error also depends on the per cent. voltage loss. The attached curves show the correction which must be applied to the approximate values of D , from which it is evident that for the range of 0 to 20 per cent. loss the approximation is sufficiently close only to about 45° . The values of $(\theta - \phi)$ for

various wires, frequencies, and lagging power-factors are shown in the table on Fig. 1.

As an extreme case of the possible error, suppose in the first numerical example that the frequency be taken at 125 cycles per second, the power-factor at 100 per cent., and the load reduced to 3500 kw. in order to obtain about the same voltage loss. The exact formula (17) will then give a voltage loss of 21.8 per cent., while the approximate formula (18) shows a loss of 12.8 per cent. In other words, the "approximate value" requires a correction of 70 per cent., as is also shown by the curves at 75° and a loss of 18 per cent. of the generated volts, corresponding to 21.8 of the received volts. In the example chosen by the author ($\theta - \phi$) equals 17° , and hence the error is small.

Although the author has drawn attention to the increasing error of the approximation by the letters a , b , and c in Table III, yet it would have been better to omit the values below c , which approximately correspond to $(\theta \pm \phi)$ equals 40° . It seems, therefore, that for high frequencies or power-factors, and for large wires or per cent. voltage losses, the approximate formulas (18) may give erroneous results. They should not be used in any case where the drop-factor M is below the c of its column.