

DISCUSSION ON "CALCULATION OF IRON LOSSES IN DYNAMO ELECTRIC MACHINERY." FRONTENAC, N. Y., JUNE 30, 1909.

R. E. Hellmund: Mr. Hanssen says that the teeth of dynamo electric machines are subject to a rotary magnetization by reason of leakage. Though some of the leakage fluxes actually pass the teeth crosswise, the leakages are so small compared with the main flux that the statement does not seem quite justified. This, of course, is not of great importance. In designing induction motors I have found Mr. Hanssen's method to be most useful. Other methods given for calculating surface losses are either too complicated to be of practical use or the results obtained by them are too inexact. Mr. Hanssen's method represents a very good compromise between exact theory and purely empirical formulas. It is, of course, not to be expected that any method for calculating core losses will always give correct results, it being well known that machines of the same type manufactured at the same time show core losses differing from each other as much as 20 per cent, sometimes even more. I have found, however, that the results obtained by Mr. Hanssen's method have always come close to the average value of the tests on a number of machines of the same type.

A. E. Averett: There are certain features of this paper which seems to me to be more of a specific than a general feature. In one part of the paper certain corrections should I think be applied to a specific type of machine. As soon as the type is changed, or the proportion of the iron in the teeth and in the yokes, the corrections will have to be changed.

Near the end of the paper it is said that a slight cut in the lathe will increase the core-loss about 50 per cent. I think that point is open to question. I have seen machines in which the rotors have been turned and in which the core-losses have not been increased appreciably; that is, with any commercial test the difference could not be detected. Again, I have seen machines where the core-loss has been nearly doubled. I think if the rotor is properly turned it will very seldom increase the core-loss appreciably.

In the high-frequency machines, silicon steel decreases the core-loss very much; for this reason I think it advisable to use it in spite of its increased cost.

V. Karapetoff: In estimating iron losses in revolving machinery it is not safe to rely upon the results obtained with stationary samples, because the distribution of the flux is far too irregular in space as well as in time. The safest procedure is to determine the actual iron loss from tests on a large number of actually built machines, at various densities and frequencies, and then use these data. In doing so, it will be found that the expression: total iron loss = $aB + bB^2 + cB^3$ comes much closer to the experimental curves than the formula ηB^n . Here B is flux density, and a, b, c , are empirical coefficients.

In regard to Figs. 1 to 9 given in Mr. Hanssen's paper: These are not photographs of actual lines of force, but of some fluid flowing between two plates of glass. Into this fluid some coloring matter is injected, and then the apparatus is projected by means of a lantern or photographed. To my knowledge, the method was first used by Professor Hele-Shaw. The only difference between the assumed distribution of magnetism and the flow of the water between two parallel plates of glass is that water has inertia while the magnetic lines are devoid of inertia. By making the water flow very slowly the effect of inertia is practically eliminated, and in order to make the analogy complete paths are provided whose mechanical resistances to flow are in the same ratio as the magnetic reluctances of the air-gap and the iron teeth.

The streaks seen in Figs. 1 to 9 represent the actual directions of the streams of water. The light streaks between the poles are not assumed or anticipated, but show that, while the reluctance there is high, nevertheless some water prefers to flow into the narrow space between the poles, instead of going around through the armature. This illustrates magnetic leakage between the poles.

I. E. Hanssen (by letter): It is true, as stated by Mr. Hellmund, that the leakage flux is small compared with the main flux; for this reason the paper states that the teeth are subjected to an elliptical field, not to a rotary field as Mr. Hellmund says. However, as the path of the leakage flux is limited to a relatively small section the resulting density may become quite high, and consequently should be considered.

Mr. Averett states that as soon as the type of machine or the proportions of the iron in the teeth and yoke are changed the corrections will have to be changed. Such is the case when the older methods are used; however it is not so with the proposed method, as here the principal losses are estimated individually and it is equally good for all proportions of iron in teeth and iron in yoke. Mr. Averett has evidently misread the statement referring to the increase in the losses due to machining the air-gap surface. The paper says that a slight cut in the lathe increases the surface losses, (the losses due to the slot openings) some 50 per cent while Mr. Averett seems to think that reference is made to the total iron loss.

In a machine having narrow slot openings and relatively large air-gap the losses due to the slot openings are small; consequently, increasing them 50 per cent may not appreciably affect the total iron loss; if, on the other hand, the slot openings are large compared with the air-gap, then the increase in the total losses will be quite important, in most cases.

When comparing the losses before and after turning the rotor, it must be remembered that the turning process increases the length of the air-gap, which tends to reduce the surface

losses; this must of course be taken into account, otherwise the results will be altogether misleading. If a heavy cut were made on the rotor of a machine, with say an air-gap of 0.020 in., we would probably find that the core loss would be decreased.

The writer cannot agree with Professor Karapetoff in what he says about the manner of estimating iron losses. The method outlined by the writer has been applied to several hundred machines with widely differing characteristics, and it has always given excellent results. Estimating core losses by comparison is, on the other hand, a very uncertain proposition particularly when, as is often the case, it becomes necessary to use very large slot openings or proportions out of the ordinary.
