DISCUSSION ON "ACYCLIC (HOMOPOLAR) DYNAMOS," AT BOSTON,
FEBRUARY 1, 1905.

A. E. KENNELLY: A curious feature about this machine is that although we have discarded smooth-core armatures for years, and thought they had been scrapped, here comes once more a smooth-core armature with the conductors lying on the top and tied on with a binding wire. This shows that one cannot be sure that when a piece of apparatus has been discarded and laid on the junk-heap, that it will not come to life again. Now the query arises; is the extra expense of drilling the solid armature core at sufficient depth to permit of the conductors going in without producing eddy currents in the pole pieces as they go round, such that the improved mechanism of a toothed-core armature would be not worth while? The speaker thinks that although a machine could be made solid and sound by binding the conductors on the surface, yet at high speeds one would feel less uneasy if the conductors were embedded in the solid metal.

As regards the question of stationary or rotating field, the speaker thinks that on any hypothesis—in this machine at least—the field should be looked upon as stationary, and the armature as cutting through that field. Most people who have entered this contest—it has been a theoretical contest for many years—would concede this case. There are other structures, however, different from this one, where there would be more discussion as to what takes place, although the speaker believes it is conceded now that flux-lines have in a certain sense a physical existence. The speaker does not know whether any conclusion has been reached in some cases as to whether the flux in particular types of unipolar machines remains stationary or is rotating.

J. E. NOEGGERATH: The wires were not embedded on account of reaction. As far as the size of the machine is concerned, the length of the armature conductors is somewhat over one foot, not much more than that.

A. E. KENNELLY: It is extremely interesting to note that out of a machine with 12 conductors one foot long one can get 300 kilowatts and 500 volts.

H. E. HEATH: The difficulty of compounding depends on the type of machine. Take for instance the same type, but with five volts and 15 000 amperes or something of that sort; it is readily seen that it would be rather difficult to put in series coils and get satisfactory compounding action. That would require large conductor and would be rather difficult to handle. There are also some other forms that are extremely similar.

W. H. PRATT: Further remarks on the matter of compounding are asked for: the speaker does not quite gather the arrangement of compounding by shifting the brush position in connection with the armature conductors.

J. E. NOEGGERATH: The field coils are wound cylindrically around the shaft. If there is circumferentially a space between the brushes and stationary conductors, a current flows, in the same or opposite direction as the current in the field coil, and therefore there is a compound reaction. Since there are 12 conductors in series, if all of them are shifted there is 12 times as much reaction; in other words the compounding is effected by the length of the brush leads.

H. E. HEATH: There is a bare possibility that one or two people may not quite understand what Mr. Noeggerath meant by compounding action. His armature is really a cylinder of iron carrying 12 conductors; these conductors cutting the magnetic circuit when the armature is revolved, with a consequent generation of electromotive force. The collector rings and leads embrace portions of the magnetic circuit. If the leads from collectors to conductors are straight and parallel to the lines of force, no addition to the magnetomotive force is produced when current flows in them, the magnetomotive force due to this current tending to produce distortion only. But if the leads are carried spirally around the armature (and therefore the magnetic flux) then, when a current passes between collectors and conductors, we get a magnetomotive force which either assists or opposes the main magnetomotive force, the strength of this magnetomotive force in ampere-turns being the fraction of a turn taken by the lead multiplied by the current.

Now speaking of a type about which there can be no doubt as to where the cutting takes place. Let us take a hollow iron cylinder as an armature, supported at one end and surrounding a cylindrical magnetic pole from which it is separated by the usual air-gap. The supporting shaft passes through the center of this pole, or is in line with it. A magnet pole in the form of a ring surrounds the cylinder and the magnetic circuit is completed through an exciting coil at any convenient point away from and outside of the armature, the material being assumed to be so distributed as to give uniform flux density in the air-gap. Then we have the magnetic circuit through the cylinder from one pole to the other and the electrical circuit lengthwise of the cylinder through the flux. We have then possibly as simple a form as you can conceive, and there is no doubt about the cutting. You do not imagine for a moment that the lines of force are going to cut out through the sides of the exciting coil, nor do you expect any coiling of them, so the action must take place in the cylinder.

Roughly, this is the type mentioned by the speaker as the heavier form that it might pay to use for very low pressures and comparatively low currents. Instead of the external-ring pole we may use another internal pole in the opposite end of the armature cylinder with the armature support between the two poles and the shaft running through their centers.

The magnetic path will then be through the cylinder from pole to pole, and the electrical path from outside of armature to shaft. In both of these forms we have the same maximum collector surface velocity for same pressure and speed. If we now make both the internal poles of the same magnetic pressure and use the ring for the opposite pole, we shall be able to get double the electromotive force for same collector surface velocity and revolutions per minute, as this electromotive force is determined by the polar section at the entrance of the cylinder and now the flux enters at both ends; that is, we have a double magnetic circuit type with series armature.

All the above refer to single elements; there is of course the possibility of much modification, but they are all accessible. There is no doubt that the less accessible forms will be considerably lighter than those which are more accessible.

One thing more with regard to these types—there is no doubt about where the action takes place; for if we could hold the armature still the cutting would take place just the same. There is a case where the flux actually revolves, because the reluctance revolves. It is the speaker's opinion that a revolution in a case of this kind is a purely relative matter in the machine itself; it makes little difference which part moves, the action would be just the same.

G. H. STICKNEY: Is there any possibility of reducing the collector velocity?

H. E. HEATH: Not in a machine of that kind, and for the reason that the collector rings have got to be outside the magnetic flux; it is merely a matter of how much density can be carried through there.

As to core loss, the speaker will not say there is none, but it will be so small that it will require considerable care to detect it. On one machine we had—we were driving the machine as a motor, and were unable to detect whether the field was on or not by the reading of the instrument—there was no variation at all in the motor readings when one excited the field or cut it out.

C. M. GREEN: That also enables you to run at a very high density?

H. E. HEATH: At high density, yes; but there is a limit to the density. The speaker would not hesitate to run at as high a density as 100 000 or 115 000 per square inch, but running at that density costs money.

As long as the armature is centred there will be no pull; if the machine is running at extremely high density there will be very little pull. Fairly large shafts are used, something that has no spring.

C. M. GREEN: There is no magnetism on that shaft?

J. E. NOEGGERATH: There is no or very little stray field in the shaft. There is considerable side pull to a machine of that construction, and it is not possible to increase the densities up above

a certain point, because the core loss will be detrimental. As pointed out in the paper, it is necessary to have a certain relation of density near the air-gap to the total flux and to the density in the remaining part, but there are certainly limitations as to the density. If the air-gap is uniform the machine could be run at very high density; but while this is true at the start it is not the case afterward. The machines now vary from 0.0625 in. up to 0.4375 in. air-gap.