DESIGNS AND SPECIFICATIONS OF A UNI-POLAR DYNAMO

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THESIS

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THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

DAVID ARTHUR BAER and GEORGE GARRET VANHORNE

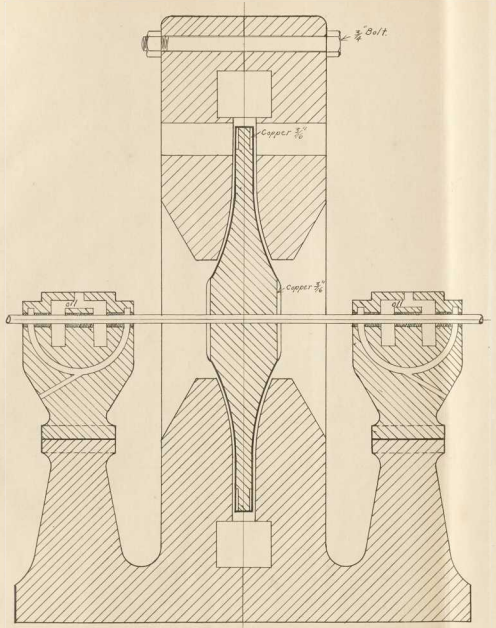
ENTITLED DESIGN AND SPECIFICATIONS OF A UNIPOLAR DYNAMO.

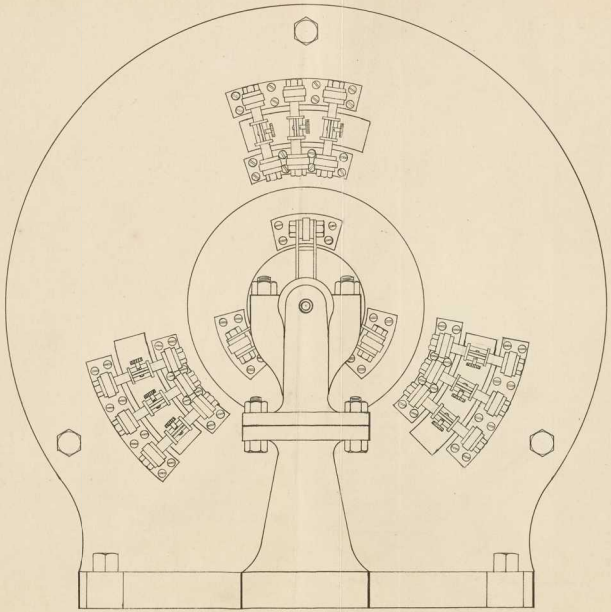
IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE

OF Bachelor of Science in Electrical Engineering.

Morgan Brooks

HEAD OF DEPARTMENT OF Electrical Engineering.





THESIS
E.E. DEPT.
UNIV. OF ILLINOIS.
DESIGN OF
5K.W. UNIPOLAR DYNAMO
SCALE 1"=4" JUNE 1904
Geo. F. Vanhorne, D. A. Baer

DESIGN OF A 5 K. W. - UNIPOLAR DYNAMO

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In the last few years the steam turbine has been so highly developed that two of the largest manufacturers of electric machinery in America are now furnishing generating sets connected to steam turbines.

The high speeds attainable with the turbines have had a tendency to reduce the number of poles on the generators used in connection with them, these generators being mostly of the alternating type.

One reason for the speedy adoption of alternating current machinery by the general public, is that machines of that type require no commutating devices. If it were possible for some form of machine, yielding a direct current without any commutating parts, to be designed and be the equal of any of our modern machines direct current apparatus would possibly stand on an equal footing with that of the alternating type.

This fact together with the desire to have such a machine in the laboratory of the University of Illinois lead the authors to undertake the design of a unipolar dynamo as their thesis.

The type of dynamo known as unipolar, or homopolar in England, is the only form of electro-magnetic device that will generate direct current without a commutator. It is restricted to low potentials, no practical machine having been produced except for electrolytic work where large currents are employed.

It is a type of machine quite apart from that of the usual commutator design and should be represented in every electrical laboratory.

The recent developement of the steam turbine furnishes an economical source of power with the very high speeds, better adapted to the unipolar than to the ordinary types of dynamos either for direct or alternating current.

The unipolar type of dynamo is so little known that it is not commercially built at all in this country and probably our turbine manufacturers have overlooked the possibilities of developing a turbine-unipolar unit.

The name "Unipolar" which is given to this particular form of generator is misleading in the fact that the machine is not "unipolar" but "uniconductor"; that is the generating part consists of one conductor.

The unipolar dynamo is a developement of the Farraday disc which consisted of a small circular plate rotated between the legs of a permanent magnet. In the unipolar machines,however, the fields may be compound wound and the rotating disc is made of steel, it being formerly believed that such a part should always be made of copper. This disc has some copper about it, however, used merely to give a smooth and good contact surface, it being put on electrolytically and then turned.

The rest of the machine is made of steel , the shaft being machine steel.

It will be seen that the shaft is small in comparison with that of machines of equal output or having equal weights

on the bearings. It has been found that at very high speeds the disc of the turbine rotates about a center of gravity which may not coincide precisely with its center of figure. For this reason some sort of flexible bearing or flexible shaft must be employed. In the machine designed by the authors the latter is used.

In any dynamo the electromotive force generated is proportional to the number of conductors which are connected in series. If in the disc of the unipolar dynamo we can imagine an infinite number of conductors radiating from the center and then imagine these to be joined side by side, it will be seen that the number of conductors in this disc or armature is equal to one. Since the number "in series" is only one it is evident that the voltage generated by this machine will be that of one conductor.

The unipolar dynamo though generating a very low voltage gives out exceedingly large currents. Due to the high speed at which these machines are run, considerable difficulty has been experienced in devising some piece of apparatus for the collection of the large currents. Copper rings are deposited on the disc and large carbon brushes are used but with such peripheral speed as three hundred feet per second there must necessarily be a large amount of heating. Roller bearings give very little friction but on account of their poor contact, it was decided to try nothing but a good quality of carbon brushes.

Due to the fact that the unipolar machine generates large currents at a low voltage this type of machine would be used

mainly in such places as metallurgical works. Another reason that this kind of machine would be in favor in such a works, is that its current curve is a straight line. The deposition of metals requires a fairly steady current and in the kind of machines used for that work, that is, those with a small number of commutator segments, the current curve presents a pulsating wave form. In the unipolar machine, due to the lack of all commutating devices, the wave takes the form of a straight line.

The greatest advantage of such machines as the unipolar dynamo is the extreme simplicity, the armature having no winding and as before mentioned, no commutator. The almost infinitesimal armature resistance not only gives increased efficiency and decreased heating but also causes the machine to regulate more closely as a generator or motor. Furthermore, there is very little hysteresis as the field is always magnetized in the same direction and to the same intensity. For similar reasons there can be no eddy currents sunce the electromotive force generated in any element of the armature is exactly equal to that induced in any other element, the magnetic field being perfectly uniform due to the symmetrical construction of the magnet frame.

Machines of the unipolar type are practically indestructible since they are so strong and so simple that they are not likely to be damaged mechanically, while it is almost impossible to conceive of an armature being burned out,as the engine would be stalled by the current before it reached the enormous strength necessary to fuse the armature.

The machine designed by the authors is a 5 K.W. dynamo of

500 amperes capacity generated at a pressure of 10 volts. The series winding consists of 27 percent of the ampere-turns of the shunt winding and it is expected by the authors that this will compound the machine at least 8 or 10 per cent. The frame is made of two parts firmly held together by bolts. On each part of the frame rests one of the bearings supporting the armature, these bearings being held in place by bolts. The brushes are of copper and carbon, those bearing on the periphery of the disc being of carbon while the remainder are of copper. All of the brushes are held in place by a brass rod which runs through a rubber bushing inserted in an iron plate. This plate surrounds the hole through which the brushes extend and is screwed directly to the frame of the machine. The machine is about 33 inches high and occupies a floor space of about 33 inches square.

Machines of this type possessing all of the advantages previously mentioned certainly deserve a more prominent place in the field of electrical engineering; whereas now they have no practical existence.

DATA FOR 5 K.W. UNIPOLAR DYNAMO

D.A.Baer and)
Geo. G.Vanhouse) (Designers.

Rated Output	5 K.W.
Volts	10
Amperes	500
Speed	3000
Number of poles	2
Number of conductors	1
Air gap - total	.25
Density in yoke	80,000
Density in air gap	40,000

Shunt Winding

Ampere turns	3670
Amperes	10
Turns	367
Resistance	1.01
Length	2200 ft.
Size of Wire	#7 B.&S.

Series Winding

Ampere turns	1000
Amperes	500
Turns	2
Resistance	.0052
Length	12.5 ft.
Size of wire (8 wires in parallel)	#4 B.&S.