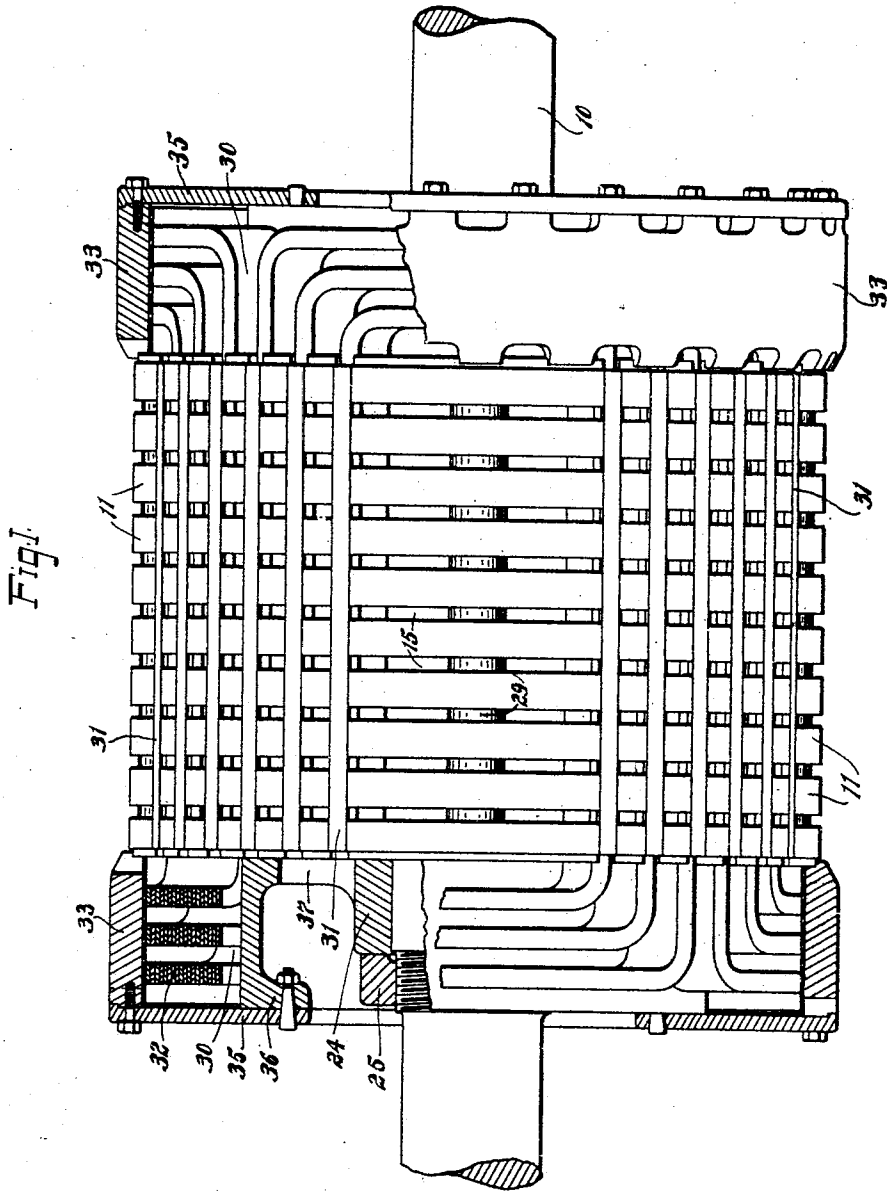


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 ROTOR CONSTRUCTION.  
 APPLICATION FILED DEC. 1, 1905.

932,097.

Patented Aug. 24, 1909.  
 2 SHEETS—SHEET 1.



WITNESSES:

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*Fred J. Kinsey*

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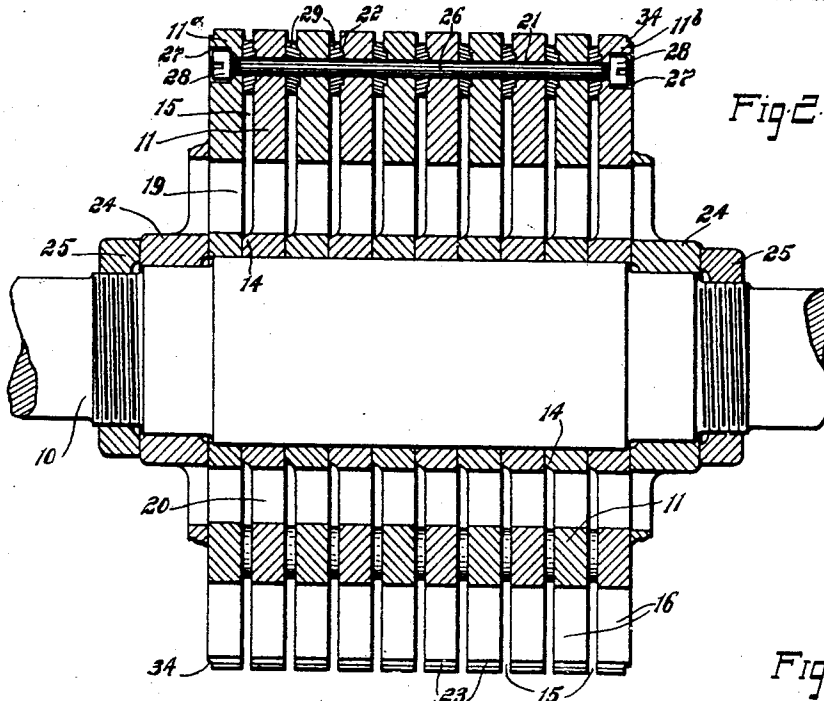


Fig. 2.

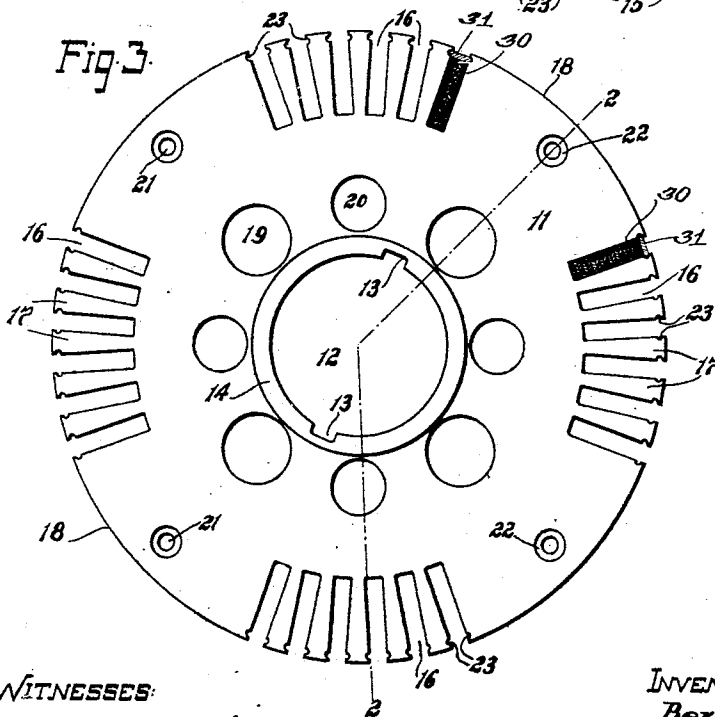
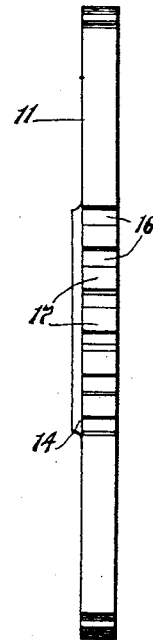


Fig. 3.

Fig. 4.



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# UNITED STATES PATENT OFFICE.

BERNARD ARTHUR BEHREND, OF NORWOOD, OHIO, ASSIGNOR TO ALLIS-CHALMERS COMPANY, A CORPORATION OF NEW JERSEY, AND THE BULLOCK ELECTRIC MANUFACTURING COMPANY, A CORPORATION OF OHIO.

## ROTOR CONSTRUCTION.

932,097.

Specification of Letters Patent.

Patented Aug. 24, 1909.

Application filed December 1, 1905. Serial No. 289,743.

*To all whom it may concern:*

Be it known that I, BERNARD ARTHUR BEHREND, citizen of the United States, residing at Norwood, in the county of Hamilton and State of Ohio, have invented certain new and useful Improvements in Rotor Construction, of which the following is a full, clear, and exact specification.

My invention relates to the rotary field members of dynamo-electric machines and particularly to the construction of field members of high speed turbo-generators.

The rotary field members of turbo-alternators, on account of the exceedingly high speeds to which they are subjected, must be well balanced and sufficiently strong to resist enormous centrifugal forces; the core and pole pieces should be so constructed that the rotary member will have a smooth exterior to avoid the noise and air resistance which would otherwise result, the field poles and coils should be so constructed and arranged, that the latter will not be disarranged nor displaced at the highest speeds; and also the core should be so constructed that the core and coils will be ventilated and that sufficient air currents will be forced through the stator to prevent an undesirable or dangerous rise of temperature therein.

A rotary field member possessing most of the above requirements is shown in U. S. Patent No. 780,085 granted Jan. 17, 1905, to W. D. Pomeroy and myself. The rotor, shown in this patent, is cylindrical in form and has a smooth exterior. Thus the disagreeable noise and air resistance is lessened, since there are no prominent pole pieces nor projections of any kind on its outer cylindrical surface. The core is provided with radial slots in which the concentric field coils are located. In this machine, the core is built up of groups of laminae spaced apart, so as to form ventilating slots or passageways. The laminae are provided with a number of holes or perforations, which, when the laminae are assembled, aline, forming axial air passageways, which communicate with the spaces between the groups of laminae, and extend from end to end of the core. When the field member is rotated in operation, air is drawn from the ends of the machine through the axial passageways and is forced outward through the passageways between the groups of laminae, and is forced over the face of, and through the core

of the stator. In the structure shown in this patent, the laminae are made from thin sheet metal. It is therefore necessary that, between contiguous groups of laminae, strong spacing members be employed entirely around the core, to hold the groups apart. It has been found that in large machines designed for very high currents and high voltage that these spacing members between the groups of laminae interfere seriously with the ventilation of the machine. It is therefore desirable to so construct the machine that these spacing members can be dispensed with. Furthermore, the field member of large machines designed for several thousand kilowatts, must be large in diameter.

It is not expedient for several reasons to provide circular steel punchings having a diameter greater than a certain length, one of the reasons being the great cost in providing large expensive dies and the difficulty and expense in obtaining sheet metal of sufficient size. Therefore, in laminated rotary field members having a diameter say of four feet or more, it would be necessary to build up the core of segments. It will be easily understood, that such a structure built up of a multiplicity of parts would be undesirable for the reason that it would not possess the necessary strength and rigidity required for the great peripheral speeds for which the structure is intended.

One of the objects of my invention is to so construct the rotary member that the large number of spacing blocks in the passageways of the core can be dispensed with, so that both the rotary field and the stationary armature will be well cooled by the fan-like action of the former.

A further object of my invention is to provide a core structure for large high speed rotary field members having the general design of the rotor shown in the patent referred to, which will be sufficiently strong and compact to resist the centrifugal forces at any speeds to which the rotor may be subjected.

With these ends in view, I employ instead of groups of laminae, strong rigid, solid steel disks, a definite number of which are arranged side by side on the shaft. These disks are so constructed and arranged that a ventilating space is provided between each pair of adjacent disks. The disks are sufficiently strong to withstand great centrifugal

gal stresses and have sufficient inherent stiffness and rigidity that few if any spacing members are required, whereby there will be an unobstructed circulation of air. The disks are provided with radial slots in which

are placed the field coils formed preferably of edgewise wound strap copper and having inclined or radial sides and parallel ends.

My invention consists in the details of construction and combinations of elements described in the specification and set forth in the appended claims.

For a better understanding of my invention, reference is had to the accompanying drawing, in which,

Figure 1 is an elevation of a rotor, parts being broken away for the sake of clearness; Fig. 2 is a sectional view of my improved rotor core, the section being taken through the core disks approximately along the line 2-2 of Fig. 3; Fig. 3 is an elevation of one of the core disks; and Fig. 4 is an edge view of the same, with one of the rotor coils shown in section.

As my invention relates to the rotor only of a turbo-generator, I have not considered it necessary to illustrate the stator. The core of the rotor is mounted on a shaft 10. This core is cylindrical in shape and has a comparatively smooth exterior and therefore the humming noise, and great frictional resistance incident to high speed rotors, are reduced to a minimum. It has been proposed to build up the core of punched laminae, which are arranged in groups spaced apart by ventilating spacing disks. This construction is satisfactory under some conditions, especially for machines designed for such loads and speeds that a rotor of comparatively small diameter can be employed. In large machines, however, the peripheral speed is so great that the laminated structure, especially if the laminae are segmental instead of circular, may not possess the requisite strength to resist the centrifugal stresses, and furthermore the necessary spacing blocks between the groups of laminae obstruct to a great extent the free circulation of air through the ventilating passageways in the rotor and stator. To avoid these difficulties and to improve in general the design of the rotary field member, I employ for the core, instead of the laminated units, heavy, rigid steel disks 11, of a thickness equal approximately to the thickness of a group of laminae. The thickness of the disks may be varied to suit the circumstances of each case. These disks are arranged side by side and as many are employed as is necessary to obtain the necessary length of core.

Each disk or core-unit is made from a circular plate or disk of steel, which is provided with a hole 12 to receive the shaft, and one or more keyways or keyslots 13. The disk is carefully machined on all sides and

turned to the proper diameter. An integral rim or flange 14 is preferably provided around the opening 12, on one side of each disk, in order that ventilating passageways 15 may be provided between the assembled disks. Groups of radial slots 16 are milled a sufficient distance into the body of each disk, the number of radial slots depending on the number of poles and the number of concentric coils per pole. Referring to Fig. 3, it is seen that twenty-four slots are provided, six in each group, the disk illustrated being intended for a four-pole rotor, having three concentric coils per pole. Between each pair of slots 16 are teeth 17 and between the groups of slots are comparatively large un-slotted pole faces 18. Transverse ventilating openings or passageways 19 and 20 are provided in each disk adjacent the flange 14. The openings 19 which are larger than the opening 20, are located opposite the pole faces, while the smaller openings 20 are located opposite the groups of slots 16. The disks are preferably provided with bolt holes 21, and as shown in Fig. 2 one side of each of the disks, except the outer disk at the left side of the figure, is provided with recesses 22 about the bolt holes 21. The purpose of these recesses will appear later. The slots 16 are preferably milled, and the ventilating openings are preferably drilled, in each disk separately. Slots 23 are milled in the outer end and on each side of each tooth for the reception of brass or bronze coil-holding wedges. These slots are preferably milled in all the disks at the same time.

The disks are assembled one at a time on the shaft and are held tightly together by end members 24 and holding nuts 25 screw threaded on the shaft. Although I prefer to use bolts to assist in drawing the disks tightly together, I do not consider this absolutely necessary. Tie bolts 26, one of which is shown in Fig. 2 pass through the holes 21 in all the disks. The outer disks 11<sup>a</sup> and 11<sup>b</sup> are provided with recesses 27 for the reception of nuts 28, on the ends of the bolts 26. Separating washers 29 which surround the bolts 26, are seated in the recesses 22 on the disks and hold the outer portions of the disks firmly together. I do not consider the use of the washers 29 as necessary, but prefer to employ the same as they interfere only to a slight extent to the circulation of air between the disks. It is seen that the flange 14 on the one side of each of the disks 11 and 11<sup>b</sup> rests against the unflanged or smooth side of the adjacent disk. I do not wish to be confined to the use of flanges integral with the disks as separate spacing rings may be employed if desired. I prefer however to employ the structure shown as it is desirable to reduce as much as possible the number of parts on the rotor. By means of keys which engage the slots 13 and the corre-

sponding slots on the shaft, the disks are prevented from turning relative to the shaft and by means of the nuts 25 and bolts 26 they are held tightly together. The holes 19 and 20 in the several disks aline when the latter are assembled and communicate with the spaces between the disks.

Concentric coils 30 are placed in the slots. These coils are preferably formed from strap copper edgewise wound and each coil has inclined sides, which are radial with respect to the axis, and parallel ends. As is clearly shown in Fig. 1, there are three coils per pole, one of these coils being shown in Fig. 3 in transverse section.

The radial sides of the coils are held in place in the slots by brass or bronze wedges 31, which are seated in the notches 23 in the outer ends of the teeth, and the parallel ends or end-turns 32, which project beyond the core are surrounded by rigid steel rings 33 which prevent the displacement of the ends of the coils by centrifugal action, said rings fitting in the grooves 34 provided in the disks 11<sup>a</sup> and 11<sup>b</sup>.

Brass or steel end rings or plates 35 are bolted to the end rings 33 and to extensions 36 of end members 24. These plates protect the end turns. The end members are provided with circular air passageways 37 which aline with the axial passageways of the core. I have shown no supports for the end-turns of the coils between the latter and the extensions 36 of the end members 24. If desired such supports may be employed.

While I have shown a specific embodiment of my invention, I do not wish to be confined to the same, as many minor changes may be made without affecting the main features of my invention, and I aim in my claims to cover all the changes and modifications which do not involve a departure from the spirit and scope of my invention.

Reference is here made to my co-pending application Serial No. 225,072, filed Sept. 19, 1904 for claims covering generically the specific invention of this application.

What I claim as new and desire to secure by Letters Patent is:—

1. In a rotary field member, a shaft, a plurality of rigid circular steel disks mounted side by side on said shaft, each of said disks having a definite predetermined thickness, and being provided with radial milled slots arranged in groups forming wedge shaped pole pieces, with a plurality of transverse ventilating openings adjacent the shaft, with a plurality of bolt holes near the periphery of the disk, and with an integral flange between the shaft and the transverse ventilating holes, tightening nuts on the shaft for forcing the flange of each disk in engagement with the next adjacent disk, tie bolts passing transversely through the disks

near the outer periphery, spacing washers on the bolts between adjacent disks, and wedge shaped field coils of edgewise wound strap copper in the slots, the whole structure having a smooth exterior.

2. In a rotary field member, a shaft, a core comprising a plurality of rigid, circular, steel, disks of definite thickness mounted side by side on the shaft in such a manner that there are ventilating spaces between adjacent disks, each of said disks being provided with groups of open radial slots and pole pieces between adjacent groups, wedge shaped field coils of edgewise wound strap copper located in said slots, there being a number of concentric coils per pole, said coils having radial sides, and parallel ends which are located beyond the ends of the core, rigid rings or bands surrounding the projecting portions of the coils, end members at the ends of the core and bearing against the two outermost disks, and circular plates or disks secured to the rings and to said end members so as to protect the ends of the coils.

3. In a rotary field member of a dynamo-electric machine, a shaft, a core comprising a plurality of rigid circular steel disks of definite thickness, located side by side on the shaft, said disks having radial slots and wedge shaped pole pieces, and a plurality of wedge shaped field coils located in the slots, said coils being formed of edgewise wound strap copper and having radial or outwardly diverging sides and parallel ends.

4. In a rotary field member of a dynamo-electric machine, a shaft, a core comprising a plurality of rigid circular steel disks of definite thickness, located side by side on the shaft, said disks having radial slots and wedge shaped pole pieces, and groups of concentrically arranged wedge shaped field coils of edgewise wound strap copper in the slots, said coils having radial sides and parallel ends.

5. In a rotary field member of a dynamo electric machine, a shaft, a core comprising a plurality of rigid circular disks of definite thickness located on said shaft, said disks having radial slots and wedge-shaped pole pieces, and a coil of edgewise wound strap copper surrounding each of said wedge-shaped pole pieces, said coil having radial sides and parallel ends.

6. In a rotary field member of a dynamo electric machine, a shaft, a core comprising a plurality of rigid circular disks, mounted on the shaft and spaced apart so as to form ventilating passageways, said disks having radial slots and wedge-shaped pole pieces, and field coils of edgewise wound strap copper located in said slots and surrounding said pole pieces, each of said coils having radial sides and parallel ends.

7. In a rotary field member of a dynamo

electric machine, a shaft, a core comprising  
a plurality of rigid circular steel disks, said  
disks having radial slots and wedge-shaped  
pole pieces, field coils of edgewise wound  
5 strap copper and having radial sides and  
parallel ends located in the slots and sur-  
rounding said pole pieces, the ends of said  
coils projecting beyond the ends of the core,  
means for retaining said coils in the slots,  
10 and rigid means surrounding the portions of  
the coils projecting beyond the core to pro-  
tect and retain the same in position.

8. In a rotary field member of a dynamo-  
electric machine, a shaft, a core comprising  
15 a definite number of rigid circular disks  
mounted on the shaft, said disks having  
wedge-shaped pole pieces, and coils of edge-  
wise-wound strap conducting material sur-  
rounding the polepieces, the sides of the coils

being radial and the individual turns or 20  
layers of the end portions of the coils lying  
in concentric cylindrical surfaces.

9. In a rotary field member of a dynamo-  
electric machine, a shaft, a core comprising 25  
a definite number of rigid circular disks  
mounted on the shaft, said disks having ra-  
dial slots and wedge-shaped pole pieces, and  
a plurality of coils of edgewise-wound strap  
conducting material surrounding each pole  
piece, the sides of the coils being radial and 30  
the individual turns of the ends of the coils  
being in concentric cylindrical surfaces.

In testimony whereof I affix my signature,  
in the presence of two witnesses.

BERNARD ARTHUR BEHREND

Witnesses:

ARTHUR F. KWIS,  
HARRIET SUTPHIN.