B. A. BEHREND & A. B. FIELD.
DYNAMO ELECTRIC MACHINE.
APPLICATION FILED OCT. 28, 1909.

982,784.

Patented Jan. 31, 1911.

Fig. 1

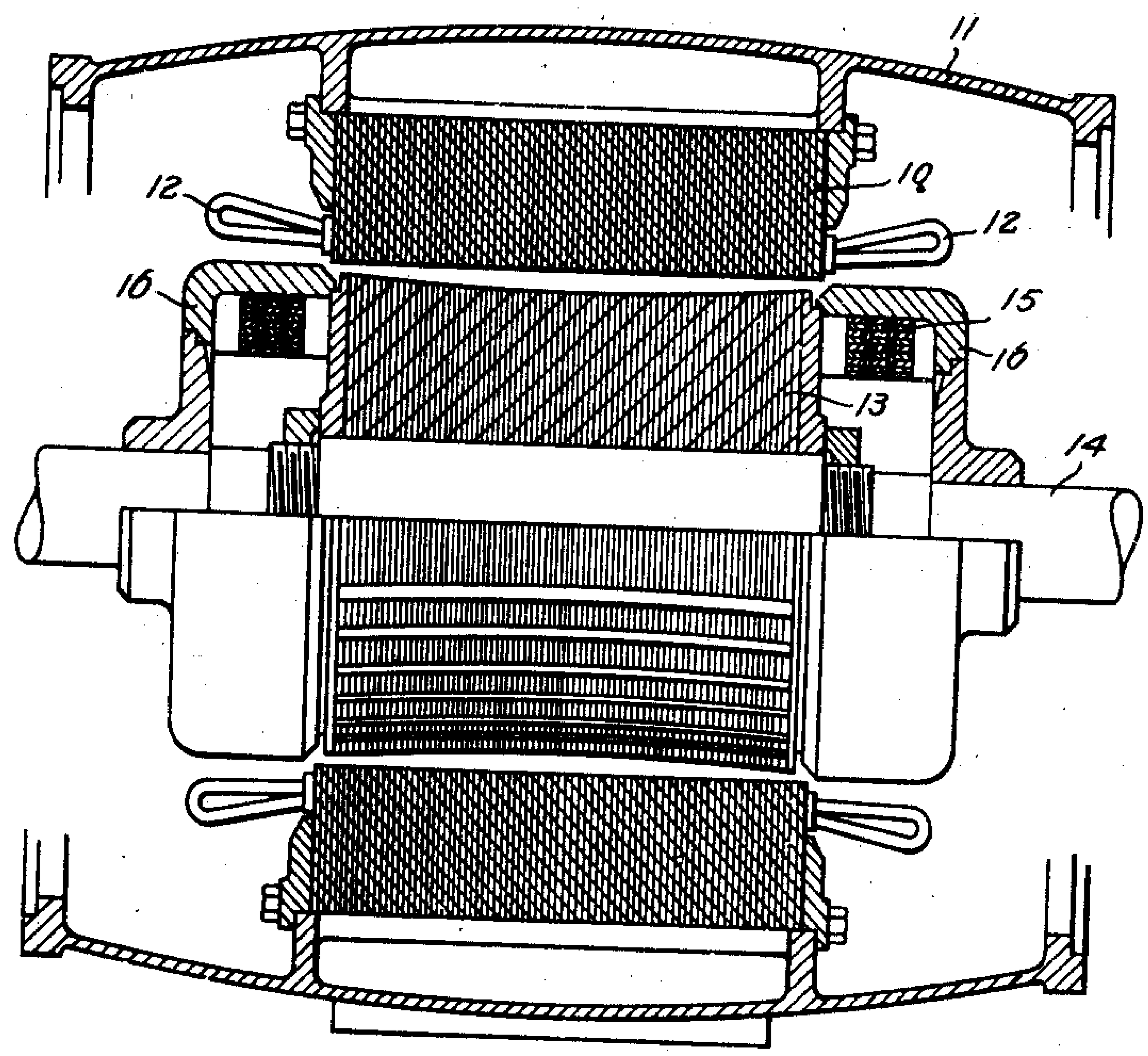
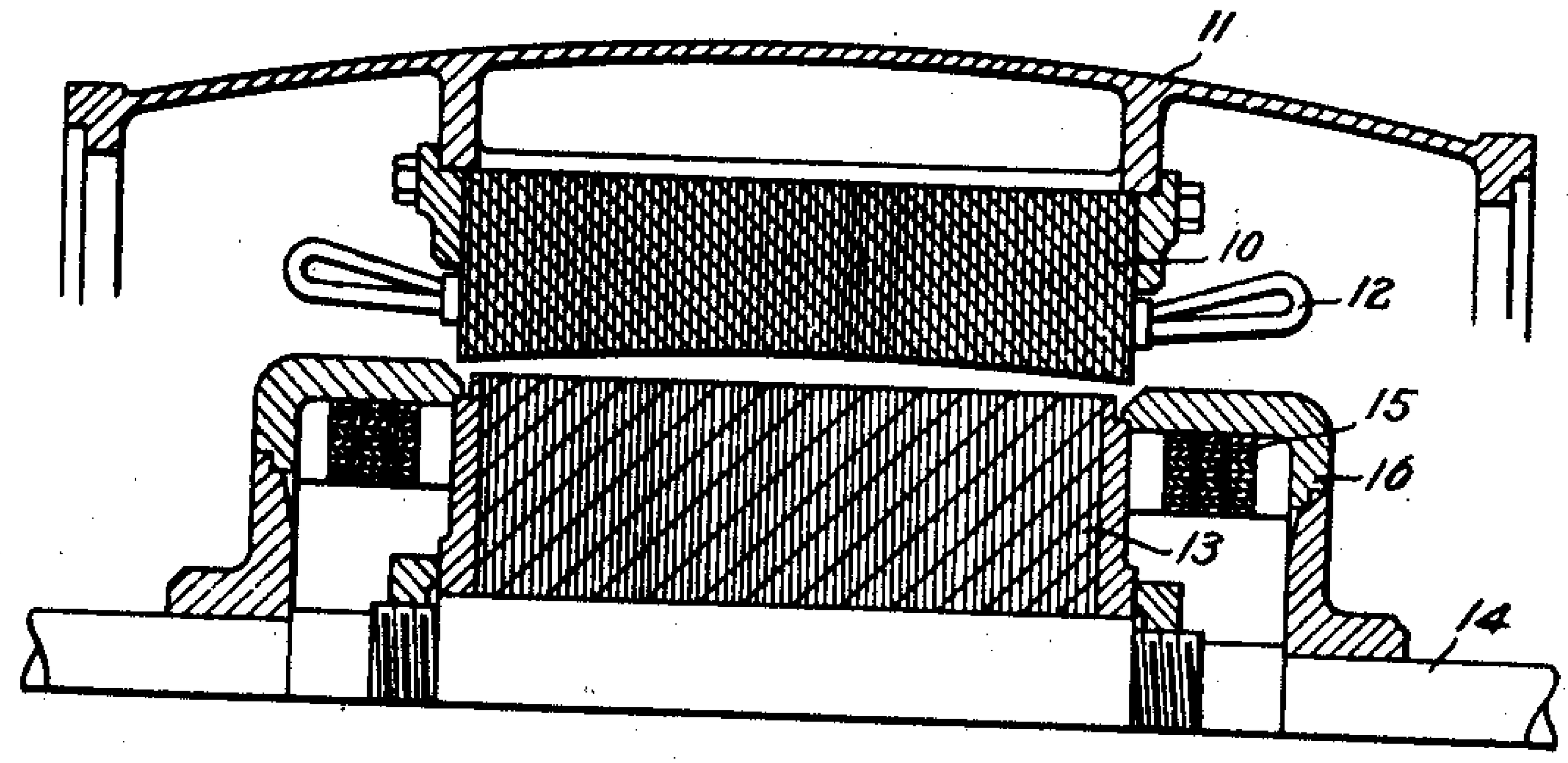


Fig. 2



Witnesses
Rob. E. Stoll.
Chas. L. Byron

Inventors
Bernard A. Behrend
Allan B. Field
By Chas. E. Lord
Attorney

UNITED STATES PATENT OFFICE.

BERNARD A. BEHREND AND ALLAN B. FIELD, OF PITTSBURG, PENNSYLVANIA, ASSIGNORS TO ALLIS-CHALMERS COMPANY, A CORPORATION OF NEW JERSEY, AND THE BULLOCK ELECTRIC MANUFACTURING COMPANY, A CORPORATION OF OHIO.

DYNAMO-ELECTRIC MACHINE.

982,784. Specification of Letters Patent. Patented Jan. 31, 1911.

Application filed October 28, 1909. Serial No. 525,097.

To all whom it may concern:

Be it known that we, BERNARD A. BEHREND, a citizen of the United States, and ALLAN B. FIELD, a subject of the King of England, residents of Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented certain new and useful Improvements in Dynamo-Electric Machines, of which the following is a full, clear, and exact specification.

Our invention relates to dynamo-electric machines.

In the operation of dynamo-electric machines, it is found that the density of the inducing magnetic flux, or that flux which cuts the active portions of the armature conductors, is less toward the ends of such active portions than toward the middle parts thereof. That is, in the ordinary types of machines, this inducing flux is less dense at and near the ends of the armature core than in the middle. This action is especially marked in rotating field machines and in machines in which covers of magnetic material are used for supporting against the action of centrifugal force the parts of the rotor winding which project beyond the ends of the rotor core. Perhaps it is most marked in alternating current turbo generators. It is probably due to magnetic leakage at the ends of the machine, this leakage being greatest in the types of machines above referred to. This non-uniform density of the inducing flux along the armature core is undesirable for several reasons, not the least among which is the fact that in consequence of it the core losses and the heating are greater at the middle of the armature than at the ends. This is particularly bad because it is more difficult to ventilate a machine at the middle than at the ends.

It is the object of this invention to obtain uniform density of the inducing magnetic flux in a dynamo-electric machine throughout the length of the active portions of the armature conductors. In attaining this object, the air gap of a dynamo-electric machine is made less at the points along the armature core where the density of the magnetic flux which cuts the active portions of the armature conductors tends to be less, and greater at points along such core where such flux density tends to be greater. In other words, in the ordinary types of machines the air gap is made wider at the middle, axially of the armature, than at the ends, and preferably gradually decreases in width as the ends are approached. In these ordinary types of machines, this difference in width of air gap may be obtained either by making the rotor core of less diameter at the middle than at the ends, or by making the internal diameter of the stator core greater at the middle than at the ends, or both.

The various novel features of our invention will appear from the description and drawing and will be particularly pointed out in the claims.

Figure 1 is a sectional view of a dynamo-electric machine embodying our invention; and Fig. 2 is a somewhat similar view showing a modification.

The figures of the drawing illustrate turbo generators which in the various details apart from our invention may be of any desired or usual construction. The stator core 10 is supported in a frame or housing 11, and is provided with armature coils 12. The active portions of the coils 12 are embedded in slots in the core 10, while the end turns thereof project beyond the core. The rotor core 13 is mounted on the shaft 14, and is provided with field coils 15 having parts 9 embedded in slots in the core 13 and projecting end turns which are supported against the action of centrifugal force by the end covers 16. In high speed machines such as here illustrated, these end covers 16 are made of steel of special composition in order to obtain the necessary strength, no suitable non-magnetic material having yet been discovered which has the requisite strength. As a result, a considerable part of the flux produced by the field winding 15 in the rotor core 13, is short-circuited by the end covers 16, and does not enter the stator core 10 and act upon the armature windings 12. This short-circuiting action would be present to some extent even if the end covers 16 were not used, as there would be some leakage through the air from pole to pole of the field member 13. As this leakage is most pronounced at the ends of the rotor core, the flux which cuts the armature coils 12 at the ends of the armature core 10 tends to be less dense than that which cuts said coils at the center of the core 10. To counteract this tendency, the width and consequently the reluctance of the air gap between the stator and the rotor is made less at the ends of the stator core than at the middle thereof, and preferedly decreases in width and reluctance from the middle to the ends. In the machine shown in Fig. 1, this is accomplished by making the rotor core 13 of larger diameter at the ends than at the middle, the diameter preferably gradually decreasing from the ends to the middle. In the machine shown in Fig. 2, it is accomplished by making the internal diameter of the stator core greater at the middle than at the ends, this internal diameter gradually decreasing as the ends of the core are approached. The action in the two cases is precisely the same.

In some cases it may be advantageous to combine the arrangements shown in Figs. 1 and 2 and to make both the external diameter of the rotor core less at the middle than at the ends and the internal diameter of the stator core greater at the middle than at the ends. By properly proportioning the air gap along the machine, the density of the flux cutting the armature conductors along the armature core 10 and the electromotive force generated in each unit of length of the active portions of the armature coils 12 may be made substantially uniform. In order to produce this uniformity, it is generally found best to make the change in the width of the air gap greater toward the ends of the core than toward the middle, as illustrated.

While both the stator and rotor cores in the arrangements illustrated are shown as laminated without any provision for ventilation, these features are not necessary. Either or both of these cores may be made solid or built up of disks of any desired thickness, and air ducts for ventilating purposes may be provided as desired. These changes, while they may affect quantitatively the distribution of the magnetic flux, do not affect qualitatively the general action of the machine. Practically uniform induction may be obtained in all cases by properly proportioning the width of the air gap at the various points along the core.

While we have shown our invention as applied to alternating current turbo generators, it is not limited to such application. Turbo generators were taken as a type for illustration, because the tendency to a non-uniform distribution of flux along the armature is perhaps more pronounced in this type of machine than in any other. The invention is applicable to any other form of machine, though in most other forms the difference in the air gap at the middle and ends need not be so great as in turbo generators.

Many modifications may be made in the precise arrangements here shown and described and all such which do not involve a departure from the spirit and scope of our invention we aim to cover in the following claims:

What we claim as new is:

1. In a dynamo-electric machine, a rotor, and a stator separated from said rotor by an air gap which is greater throughout the middle portion of the stator than at the end portions thereof.

2. In a dynamo-electric machine, a stator, a rotor within the stator, said rotor having coils which project beyond the ends of the rotor core and end covers of magnetic material for holding the projecting portions of the rotor coils against the action of centrifugal force, the air gap between the stator and the rotor being less at the ends of the rotor core than elsewhere.

3. In a dynamo-electric machine, a stator, a rotor core within the stator and separated from the latter by an air gap which is greater through the middle portion of the rotor core than at the end portions thereof, and coils embedded in slots in the rotor core.

4. In a dynamo-electric machine, a stator, and a rotor coöperating with said stator and separated therefrom by an air gap which gradually increases in width from the ends to the middle.

5. In a dynamo-electric machine, a stator, and a rotor within the stator, the air gap between the rotor and stator gradually decreasing in width as the ends of the stator are approached.

6. In a dynamo-electric machine, a stator, a rotor within said stator, coils located in slots in the rotor core and projecting beyond the ends of the rotor, and retaining rings of magnetic material for holding the projecting parts of the rotor coils against the action of centrifugal force, the air gap between the stator and the rotor being less near the retaining rings than at the middle and gradually increasing as the middle is approached.

7. In a dynamo-electric machine, a stationary member comprising a core, a rotary member comprising a core and coils which project beyond the ends thereof, means formed of magnetic material for protecting and holding in position the projecting portions of the coils, the clearance between the stationary and rotary cores being less at the ends of the machine than between the ends.

8. In a dynamo-electric machine, a stationary armature member comprising a core and coils, a rotary field member located within the stationary member and compris-

ing a core and coils which project beyond the ends of the core, end rings of magnetic material surrounding the projecting parts of the field coils and holding them against displacement, the clearance between the rotary and stationary cores being less near the end rings than at a distance therefrom.

In testimony whereof we affix our signatures, in the presence of two witnesses.

BERNARD A. BEHREND.
ALLAN B. FIELD.

Witnesses:
M. Cleve,
Henrietta Lucas.