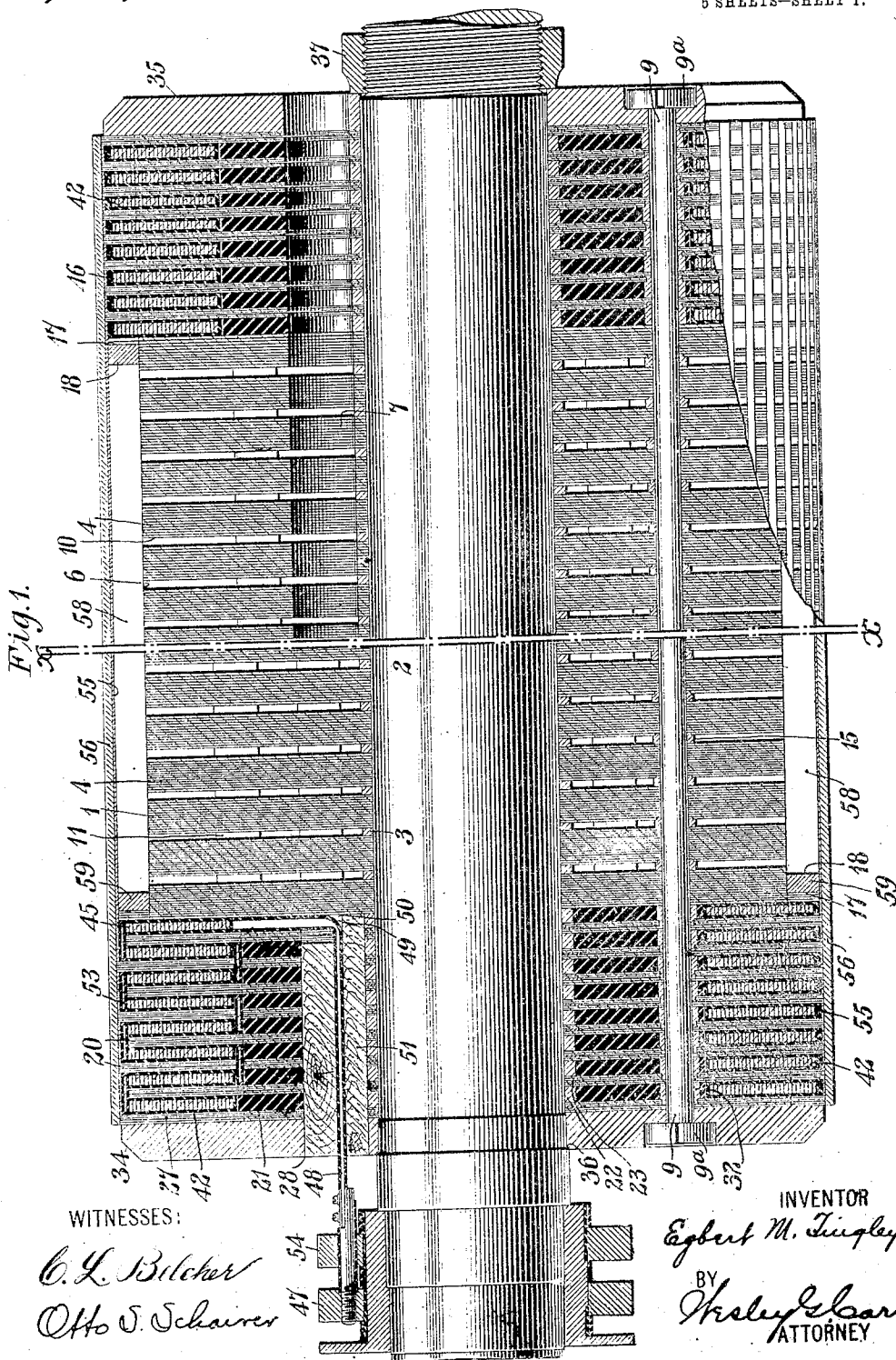


E. M. TINGLEY.
DYNAMO ELECTRIC MACHINE.
APPLICATION FILED APR. 10, 1905

Patented Feb. 27, 1912.

5 SHEETS—SHEET 1.

1,018,531.



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5 SHEETS—SHEET 2.

Fig. 2.

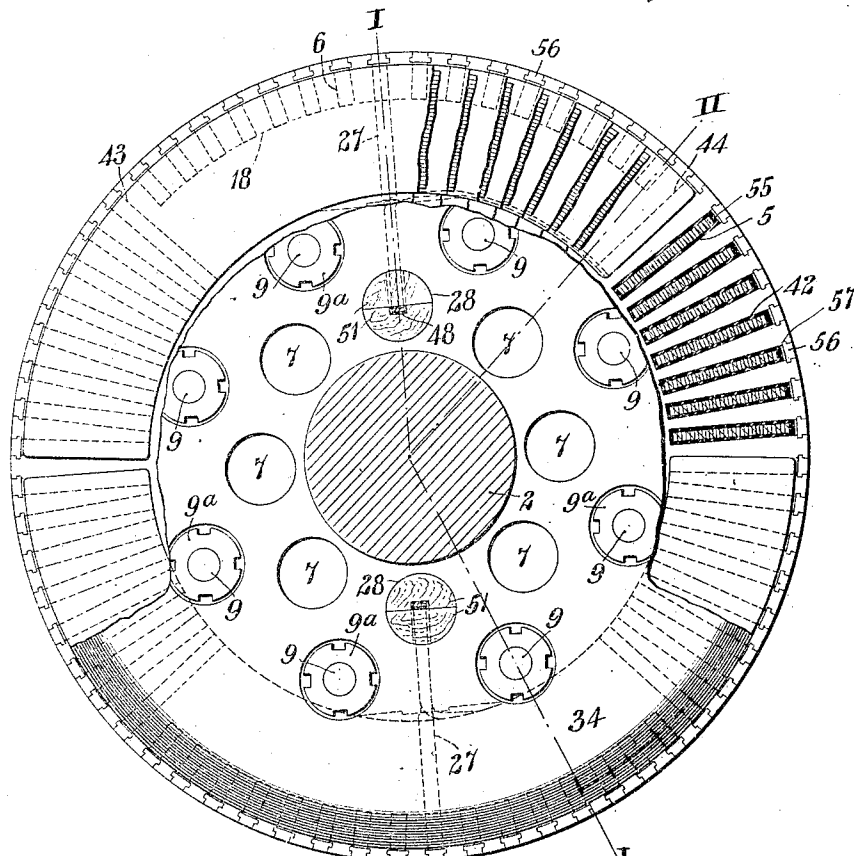


Fig. 3.

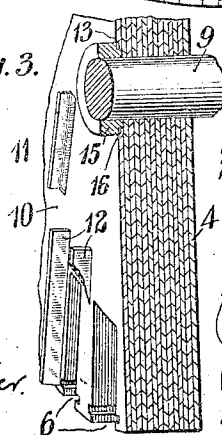
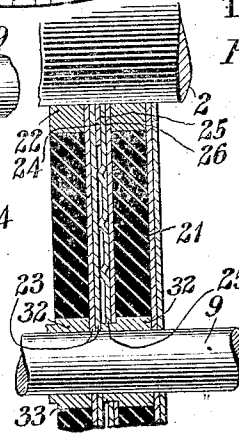


Fig. 4.



WITNESSES:

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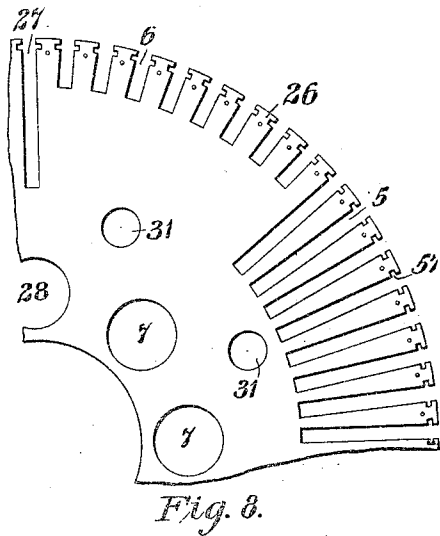
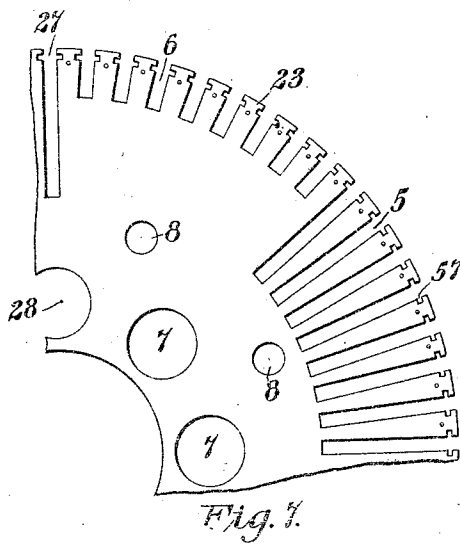
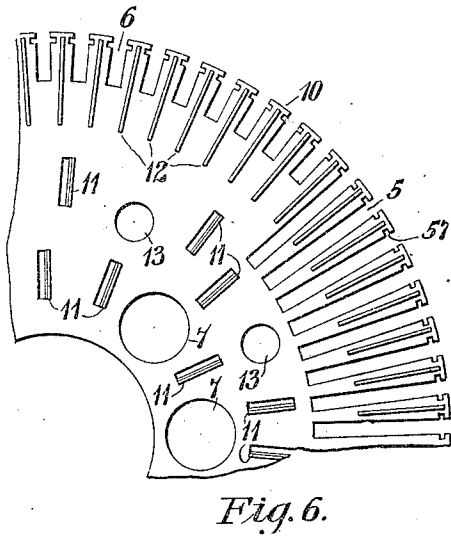
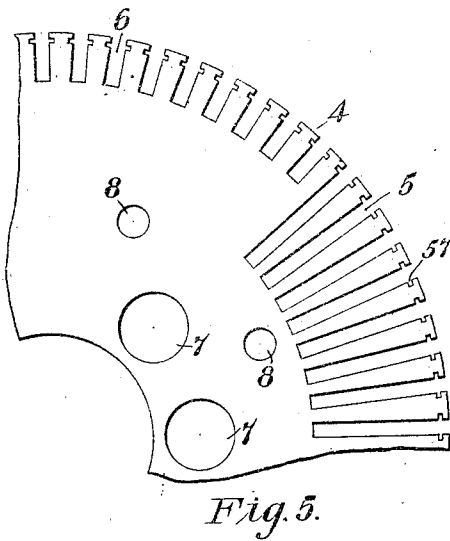
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E. M. TINGLEY.
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1,018,531.

Patented Feb. 27, 1912.
 5 SHEETS—SHEET 3.



WITNESSES:

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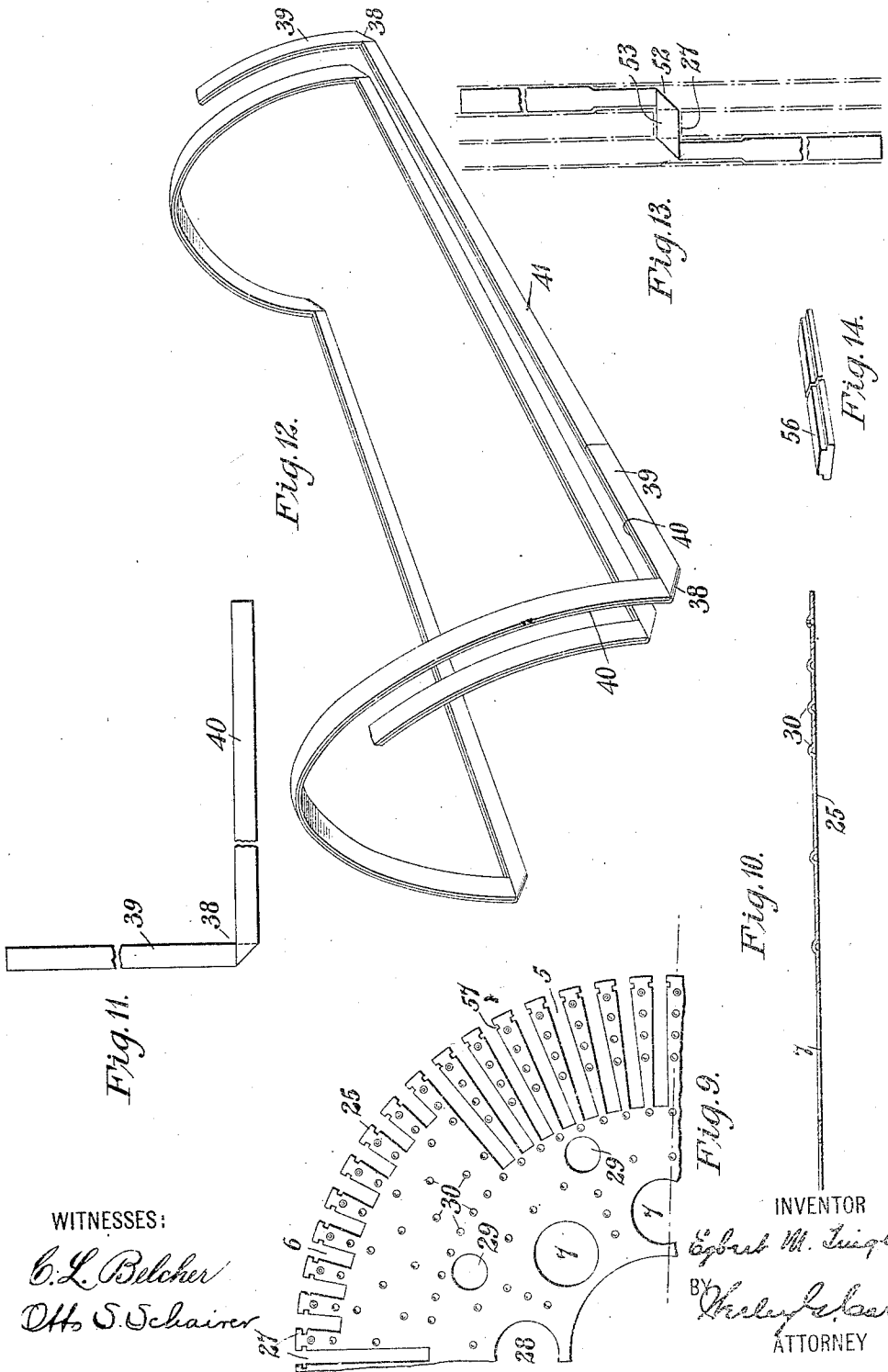
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1,018,531.

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5 SHEETS—SHEET 4.



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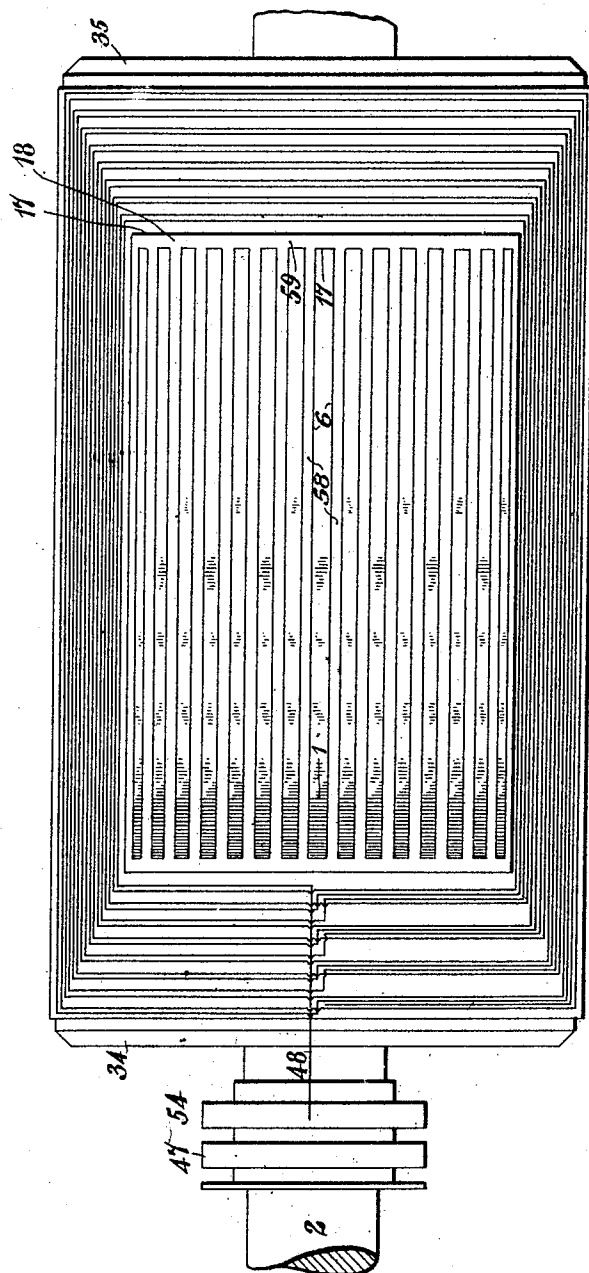
E. M. TINGLEY.
DYNAMO ELECTRIC MACHINE.
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1,018,531.

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5 SHEETS—SHEET 5.

Fig. 15.



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UNITED STATES PATENT OFFICE.

EGBERT M. TINGLEY, OF PITTSBURGH, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE
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DYNAMO-ELECTRIC MACHINE.

1,018,531.

Specification of Letters Patent.

Patented Feb. 27, 1912.

Application filed April 10, 1905. Serial No. 254,775.

To all whom it may concern:

Be it known that I, EGBERT M. TINGLEY, a citizen of the United States, and a resident of Pittsburgh, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Dynamo-Electric Machines, of which the following is a specification.

My invention relates to dynamo-electric machines, and particularly to the structure of the rotatable members of machines that are operated at high speeds.

The object of my invention is to provide an improved laminated core structure for dynamo-electric machines that is provided with specially arranged slots for the reception of the winding and that may be adequately ventilated for the purpose of getting rid of large amounts of heat due to electrical losses in the member.

A further object is to provide a winding that may be readily applied to the core and which shall be well adapted to withstand high centrifugal forces without displacement or rupture.

In the accompanying drawing, Figure 1 is a longitudinal, sectional view of the rotating member of a dynamo-electric machine constructed in accordance with my invention, the section at the left of the broken and dotted lines X—X being taken on line I—I and that at the right of the said lines on line I—II of Fig. 2. Fig. 2 is a view, partially in section and partially in end elevation of the rotating member shown in Fig. 1. Fig. 3 is a perspective, sectional view of a group of core laminae employed in the rotating member shown in Fig. 1. Fig. 4 is an enlarged, sectional view of another group of core laminae. Figs. 5, 6, 7, 8 and 9 are partial face views of core laminae. Fig. 10 is a sectional view, on line X—X of Fig. 9, of one of the core laminae. Fig. 11 is a view of one of the conductors. Figs. 12 and 13 represent the manner in which the conductors are applied to certain portions of the magnetizable core. Fig. 14 is a view, in perspective, of one of the wedges for retaining the winding in position, and Fig. 15 is a diagrammatic view of the windings as applied to the core structure.

The main portion of the rotatable member comprises groups 1 of magnetizable core laminae that are mounted upon a shaft 2, and spacing rings 3 that are also mounted upon

the shaft and interposed between the groups of laminae. Each group 1 comprises a plurality of disks 4, as shown in Fig. 5, that are provided with alternate sets of deep radial slots 5, and shallow radial slots 6 that are diametrically opposite each other, with ventilating apertures 7 and with apertures 8 for the reception of bolts 9. One of the ends disks 10 of each set or group 1 is of substantially the same form as the disks 4, (see Fig. 6) but is provided with bent-up portions 11 and with strips 12 secured perpendicularly thereto that serve as additional spacing pieces between the groups. The ventilating laminae 10 also differ from the laminae 4 in that the apertures 13 are larger in diameter than the corresponding apertures 8 in the laminae 4. The laminae comprising each group may, if desired, be secured together by rivets or by any other suitable means.

Surrounding the bolts 9 and located between adjacent groups, are bushings 15, the smaller ends 16 of which are inserted in the apertures 13 of the ventilating disks 10, the remaining portions of the bushings being of greater diameter than the apertures. The bushings are provided for the purpose of preventing the crushing of the bent-up portions 11 of the laminae 10 when the laminae are drawn together by means of the bolts 9 and their nuts 9^a.

One or more of the outer groups of laminae that comprise the main portion of the core may be provided with either one or a plurality of circumferential slots 17 formed by cutting away the teeth between the slots 6 of some of the disks 4, these slots in combination with the slots 6, being adapted to contain damping coils 18 which will be hereinafter more fully described.

Circumferential slots are provided in the end portions of the rotatable member between groups 20 of core laminae that are separated by means of disks 21 preferably composed of non-magnetizable material, the outer peripheries of the disks forming the bottoms of the slots. The disks 21 are mounted upon rings 22 that are in turn mounted upon the shaft 2, and are preferably composed of non-magnetizable metal which may be more conveniently and accurately fitted to the shaft than insulating disks.

The groups 20 comprise, as shown in Fig. 110

4, two disks 23, of the form shown in Fig. 7, a disk 24 that is mounted directly upon the shaft 2 and that is of smaller diameter than the other core laminae, a spacing disk 25 as shown in Figs. 9 and 10 and a disk 26 such as shown in Fig. 8, the disks being riveted or otherwise secured together.

The disks 23 (Fig. 7), are similar in form to those shown in Fig. 5, except that the middle slot 27 of one of the sets of slots 6 is of substantially the same depth as the slots 5. They are also provided with additional apertures 28 similar in dimensions and location to the apertures 7 in the disks 4. The spacing disks 25 are similar to the disks 23 but the apertures 29 are larger in diameter than the corresponding apertures 8 in the disks 23, and they are provided with suitably located raised portions 30 which serve as spacing devices between the groups. The disks 26 differ from the disks 23 only in having apertures 31 that are larger in diameter than are the corresponding apertures 8 in the disks 23. The disks 24 are placed between the laminae 23 and 25 in order to prevent crushing of the raised portions 30 of the laminae 25, and bushings 32 are provided, the smaller ends of which are located in the apertures 29 and 31 in the disks 25 and 26 and the large portions of which are located in corresponding apertures 33 in the insulating disks 21.

While I have shown specific forms of spacing and ventilating disks, it is to be understood that other suitable forms may be employed, and also that the compositions of the core groups and the forms of the individual disks may be modified considerably without altering the essential features of the structure.

The core groups are clamped between end plates 34 and 35, the former of which rests against a shoulder 36 on the shaft 2 and the latter of which rests against a collar 37 that is screw-threaded upon the shaft 2. The bolts 9 and nuts 9^a, above mentioned, provide additional means for clamping the groups of core laminae between the end plates.

It will be observed that spacing rings and bushings are provided for the purpose of preventing crushing of the spacing laminae at all points where the greatest pressures are applied. The apertures 7 provide longitudinal ventilating passages in the core and these communicate with the transverse passages that are provided by the spacing laminae, so that the structure may be easily and effectually ventilated.

One of the principal advantages of my invention lies in the fact that the winding may be readily applied to the core, the placing of the conductors in the core slots being facilitated by the character of the conductors employed. The winding is composed

of L-shaped pieces 38 of thin, pliable strips of conducting material which are placed in the slots one above the other with overlapping ends until conductors of the desired thickness have been composed, strips of insulating material being placed between the proper conducting strips in order to separate the turns of the conductor. The L-shaped pieces are made by folding the conducting strips upon themselves as shown in Fig. 11, with the straight end portions 39 and 40 at right angles to each other, the portions at the corners being of double thickness. In order to compensate for the double thicknesses at the corners the end portions 39 and 40 of consecutively applied conducting strips are caused to overlap, or else straight strips 41 are supplied to fill the spaces between the folded portions and the ends of the strips, as shown in Fig. 12, a conductor of uniform thickness being applied to the core in this manner. No solder or other connecting material or means is employed between the conducting strips, only the pressure of the strips upon one another due to centrifugal force being relied upon to effect good electrical connection between the strips.

Before the winding is applied to the core the slots are lined with suitable insulating material 42. The conductors are first placed in longitudinal slots 43 and 44 and in the circumferential slots 45 and 46, terminal connection being made with a collector ring 47, that is suitably mounted on the shaft by means of a conductor 48 that is carried through a radial passage 49 in insulating disk 50 and the apertures 28 in the core laminae 23, 25 and 26 and insulating disks 21 in which is located an insulating and supporting block 51 for the conductor 48. After the slots 43, 44, 45 and 46 have been filled, the winding is applied in like manner in the next adjacent slots and the process of forming concentric coils continued until all of the slots have been filled, the same method of winding being also employed on the opposite side of the core. Connections between the coils in adjacent circumferential slots are made by means of conducting strips 52 which are twice folded upon themselves, as shown in Fig. 13, the portions 53 between the folds being located in the slots 27 in the core laminae 23, 25 and 26. While, in order to insure balancing of the structure, I prefer to place the connections between concentric coils in the slots 27, they may, if desired, be placed in the slots 5 without materially unbalancing the member, in which case the slots 27 need only to be of the same depth as the slots 6. When all of the winding has been applied to the core terminal connection (not shown) is made with collector ring 54 in a manner similar to that shown and described for the first connection. Insulating

material and protecting metallic strips 55 therefor are then laid in the tops of the slots and wedges 56 (Fig. 14) are inserted in grooves 57 in the sides of the slots for retaining the winding in position.

Dynamo-electric machines which operate in synchronism with other machines in the same system, should, for most satisfactory operation, be provided with closed circuit damping coils surrounding portions of the field magnet polar extremities, and it is for the reception of such devices that the slots 6 and 17 have been provided in the core structure. The damping coils 18 may be composed of laminated conductors which are applied to the core in a manner very similar to that described for the exciting winding and they preferably comprise a plurality of straight, longitudinal portions 58 located in the radial slots 6 that are connected at their ends by means of transverse portions 59 located in the circumferential slots 17, in this manner forming grid-shaped structures. If desired, there may be more than one pair of the transverse portions 59, though I have shown only a single pair. The conductors of the damping coils may be placed in the core slots without insulation between them and the core. The damping coils are retained in position by means of the wedges 56 which also serve to retain the end portions of the exciting winding in the circumferential slots. Additional damping effect is provided by the metallic protecting strips, 55 which are located in the same slots as the exciting winding since they form closed circuit coils surrounding portions of the polar extremities.

While I have shown and described a structure having only two poles, I desire it to be understood that structures having more than two poles may be constructed in accordance with my invention, and many other of the details of construction and arrangement of the parts may be varied within wide limits from what is herein specifically shown and described without departing from the scope of my invention.

I claim as my invention:

50 1. A structure for dynamo-electric machines comprising slotted core laminae arranged in groups and having ventilating spaces between the middle groups, and spacing pieces between the end groups to form circumferential slots for the reception of coil ends.

2. A structure for dynamo-electric machines comprising slotted core laminae arranged in groups and having ventilating spaces between the middle groups, and non-magnetizable spacing disks between the end groups to form circumferential slots for the reception of coil ends.

3. A structure for dynamo-electric machines comprising slotted core laminae ar-

ranged in groups and having ventilating spaces between the middle groups and in the end groups and spacing pieces between the end groups.

4. A structure for dynamo-electric machines comprising slotted core laminae arranged in groups and having ventilating spaces between the middle groups, and spacing disks between the end groups to form circumferential slots for the reception of coil ends.

5. A structure for dynamo-electric machines comprising slotted core laminae arranged in groups and having ventilating spaces between the middle groups, spacing pieces between the end groups to form circumferential slots, and conductors located in the core slots.

6. A structure for dynamo-electric machines comprising slotted core laminae arranged in groups and having ventilating spaces between the middle groups, spacing pieces between the end groups to form circumferential slots, and laminated conductors located in the core slots.

7. A structure for dynamo-electric machines comprising slotted core laminae arranged in groups and having ventilating spaces between the middle groups and in the end groups, spacing pieces between the end groups and laminated conductors located in the core slots.

8. A structure for dynamo-electric machines comprising slotted core laminae arranged in groups and having ventilating spaces between the middle groups and in the end groups, spacing pieces between the end groups, and conductors located in the core slots.

9. A structure for dynamo-electric machines comprising core laminae having longitudinal slots, spacing pieces between certain of the end laminae forming circumferential slots, and conductors located in the said longitudinal and circumferential slots.

10. A structure for dynamo-electric machines comprising slotted core laminae, spacing disks located between certain of the end laminae and forming annular spaces, and conductors located in the core slots and in the annular spaces between the end laminae.

11. A structure for dynamo-electric machines comprising core laminae having radial slots, spacing pieces between certain of said laminae whereby circumferential slots are provided in said core, and conductors located in said core slots.

12. A structure for dynamo-electric machines comprising core laminae having radial slots, spacing pieces between certain of said laminae whereby circumferential slots are provided in said core, and laminated conductors located in said core slots.

13. A structure for dynamo-electric machines comprising core laminae having ra-

- dial slots, spacing pieces between certain of said laminae whereby circumferential slots are provided in said core, and radial slots of greater depth than the aforesaid radial slots connecting the circumferential slots.
14. A laminated core for dynamo-electric machines having longitudinal slots, spacing pieces between certain of the laminae to form circumferential slots, longitudinal slots of greater depth than the aforesaid longitudinal slots for connecting the circumferential slots, in combination with conductors located in said core slots.
15. A core structure for dynamo-electric machines having longitudinal and circumferential coil slots and longitudinal slots of greater depth than the first named longitudinal slots to connect the circumferential slots.
16. In a dynamo-electric machine, a core structure having longitudinal and circumferential slots, radial slots of greater depth than the longitudinal slots that connect the circumferential slots, and laminated conductors located in said slots.
17. In a dynamo-electric machine, a core structure having longitudinal and circumferential slots, radial slots of greater depth than the longitudinal slots that connect the slots, in combination with conductors located in said core slots.
18. A laminated core structure for dynamo-electric machines having longitudinal and circumferential slots, radial slots of greater depth than the longitudinal slots that connect the circumferential slots, and ventilating spaces located between certain of the core laminae.
19. A laminated core structure for dynamo-electric machines having longitudinal and circumferential slots, slots of greater depth than the longitudinal slots that connect the circumferential slots, ventilating spaces located between certain of the core laminae, and longitudinal apertures that communicate with the ventilating spaces.
20. A core structure for dynamo-electric machines having longitudinal slots, circumferential slots in proximity to its ends and radial slots of greater depth than the longitudinal slots that connect the circumferential slots.
21. A structure for dynamo-electric machines comprising slotted core laminae arranged in groups and having ventilating spaces between the middle groups and in the end groups.
22. A laminated core structure for dynamo-electric machines having longitudinal and circumferential slots, ventilating spaces located between certain of the core laminae, and longitudinal apertures that communicate with the ventilating spaces.
23. A core structure for dynamo-electric machines having longitudinal slots and lateral annular slots with which the ends of the longitudinal slots communicate.
24. In a dynamo-electric machine, a core structure having communicating longitudinal and circumferentially curved slots and conductors having straight sides and circumferentially curved ends to fit the corresponding portions of said slots.
25. In a dynamo-electric machine, a core structure having communicating longitudinal and circumferentially curved slots and laminated conductors having straight sides and circumferentially curved ends to fit the corresponding portions of said slots.
26. A core structure for dynamo-electric machines having longitudinal and circumferential slots and longitudinal ventilating apertures and communicating transverse ventilating spaces.
27. In a dynamo-electric machine, a core structure having alternate groups of relatively deep and shallow slots, an exciting winding located in the deep slots, and closed circuit coils located in the shallow slots.
28. A core structure for dynamo-electric machines having alternate groups of relatively deep and shallow radial slots and corresponding circumferentially curved slots.
29. A core structure for dynamo-electric machines having alternate groups of relatively deep and shallow radial slots and corresponding transverse slots.
30. A core structure for dynamo-electric machines having sets of concentric, deep slots and sets of relatively shallow slots surrounded by the deep slots.
31. In a dynamo-electric machine, a core structure having sets of concentric, deep slots, sets of relatively shallow slots surrounded by the deep slots, an exciting winding located in the deep slots, and closed circuit coils located in the shallow slots.
32. A core structure having deep longitudinal slots, relatively shallow longitudinal slots, and corresponding transverse slots.
33. A core structure having deep longitudinal slots, relatively shallow longitudinal slots, and corresponding transverse, circumferentially curved slots.
34. A rotor having longitudinal channels in its periphery to receive and retain the conductors of the winding and also having a series of transverse channels and teeth extending circumferentially around the periphery near the ends and connecting said longitudinal channels in pairs, to receive and retain the end-connecting portions of the winding, and retaining members outside said end portions of the winding united to said teeth.
35. A rotor having a series of longitudinal channels and transverse circumferential connecting grooves in its periphery, the active and end-connecting portions of a winding being embedded in said channels and

grooves, respectively, and keys interlocking with the transverse ribs between said circumferential grooves and overlying the end-connecting conductors therein to retain the same in place against centrifugal force.

36. A rotor having longitudinal channels in its periphery, a winding embedded in said channels, and retaining plates at the ends of the rotor extending radially between the end-connecting portions of said winding, and providing circumferential channels to receive and hold said end-connections, and retaining members outside said end portions of the winding united to said plates.

37. A rotor having longitudinal channels in its periphery, a winding embedded in said channels, transverse disks assembled at the ends of said rotor extending radially between the different end-connecting portions of the winding, and keys interlocking with said disks and overlying said end-connections to retain the same in place against centrifugal force.

38. A rotor having longitudinal channels and transverse disks assembled at the ends of the rotor, with circumferential grooves between said disks uniting said channels in pairs, and conductor-bars in said longitudinal channels, the end portions of said bars being bent to lie in said circumferential grooves, and united by a lap-joint, and retaining members outside said end portions of the conductor-bars and united to said disks.

39. A rotor having a winding with active end-connecting portions, a transverse retaining plate consisting of a central portion surrounding the shaft and having teeth passing radially between different end-connecting portions of the winding, notches or grooves in said teeth and keys interlocking with the said notches, whereby the windings are retained in place.

40. In a rotor for electric machines, a winding having end-connections, retaining plates extending radially between the different end connections and between the body of the core and the innermost set of end connections, and keys for interlocking said plates and windings, the plates located near the body of the core being made of magnetic material.

41. In a dynamo-electric machine, a core, coils thereon, an end plate at the extremities of the coils, and means for holding the end turns in place comprising a plurality of members extending from the end plate to the core.

42. In a dynamo-electric machine, a rotatable element comprising a laminated core having two or more poles, an end member at the end of the core, windings on the core having end turns or connections, an end member at the ends of the coils, and means for retaining said end-turns in place com-

prising a plurality of independently movable members extending between said end-members at the periphery of said rotatable element.

43. In a dynamo-electric machine, a slotted core, windings thereon having end turns or connections, an end cover or plate for said end turns, and means for retaining said end turns in place comprising binding elements secured to said end cover and to said core.

44. In a dynamo-electric machine, a rotatable member comprising a core, windings thereon, said windings having end turns or connections, an end cover for said end turns, said end cover having at its periphery a plurality of undercut grooves or notches, said core having corresponding grooves or notches, and wedges located therein and extending from said end cover to said core.

45. In a dynamo-electric machine, a core, windings thereon having end turns or connections, an end cover or plate for said end turns, and means for retaining the end turns in place comprising a plurality of binding elements secured to the end cover and core and extending across the end turns at intervals around the entire core.

46. In a dynamo-electric machine, a rotatable element comprising a core, windings thereon having end turns or connections, an end cover or plate for the end turns, said core and end plate having opposite corresponding slots or openings, and coil retaining elements extending across the end turns from the end plate to the core, said elements being secured in said slots or openings.

47. In a dynamo-electric machine, a rotatable element, comprising a slotted core, windings in the slots thereof having end turns or connections, and plates for said windings, undercut slots in the periphery of said plates and core, and coil retaining elements extending across the end turns and fitting in the slots of the end plates and core.

48. In a dynamo-electric machine, a rotatable member comprising a slotted core, windings in said slots having end turns or connections, and means located in the core slots for retaining the windings in place and extending beyond the core over the end turns.

49. In a dynamo-electric machine, a rotatable member comprising a slotted core, windings in said slots having end turns or connections, an end plate or cover for said end turns, said end plate having openings corresponding to said core slots, and means for retaining said windings in place located in said core slots and extending over said end turns into the openings in the end cover.

50. In a dynamo-electric machine, a rotatable member comprising a slotted core, the slots being undercut to receive wedges, coils in said slots having end-turns, an end-cover

for the end-turns located at the end of the rotatable member and having notches in its periphery, and coil retaining wedges in said undercut slots extending across the end-turns and engaging the notches in said cover.

51. In a dynamo-electric machine, a rotatable element comprising a slotted core, coils in said slots having end turns, end covers for said end turns on said shaft, wedges in the core slots for retaining the coils in place, and wedges extending from the end covers to the core for holding the end turns in place.

52. In a dynamo-electric machine, a shaft, a rotatable laminated slotted core thereon, coils in the slots having end turns, means for supporting the end turns comprising disks or collars, spacing plates between the end turns at each end of the rotatable element, end covers on the shaft, said end covers and spacing plates having openings at or near their peripheries, and binding elements extending across the end turns and located in said openings.

53. In a rotatable element of a dynamo-electric machine, a core, coils thereon, a separable end plate for the coils at the end of the element, means for retaining the end turns in place comprising a plurality of members extending over the end-turns from the core to the end plate, and means for providing a good ventilation around the end turns.

54. In a rotatable element of a dynamo-electric machine having axial ventilating passageways, a core, coils thereon, wedges for retaining the coils in place, said wedges extending over the end turns, said element having ventilating passageways communicating with the axial ventilating passageway and the spaces between the wedges.

In testimony whereof, I have hereunto subscribed my name this 31st day of March, 1905.

EGBERT M. TINGLEY.

Witnesses:

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BIRNEY HINES.