Jan. 30, 1934 F. K. ROUGE ET AL 1,944,952

HOMOPOLAR GENERATOR

Filed Jan. 29, 1932 3 Sheets-Sheet 1

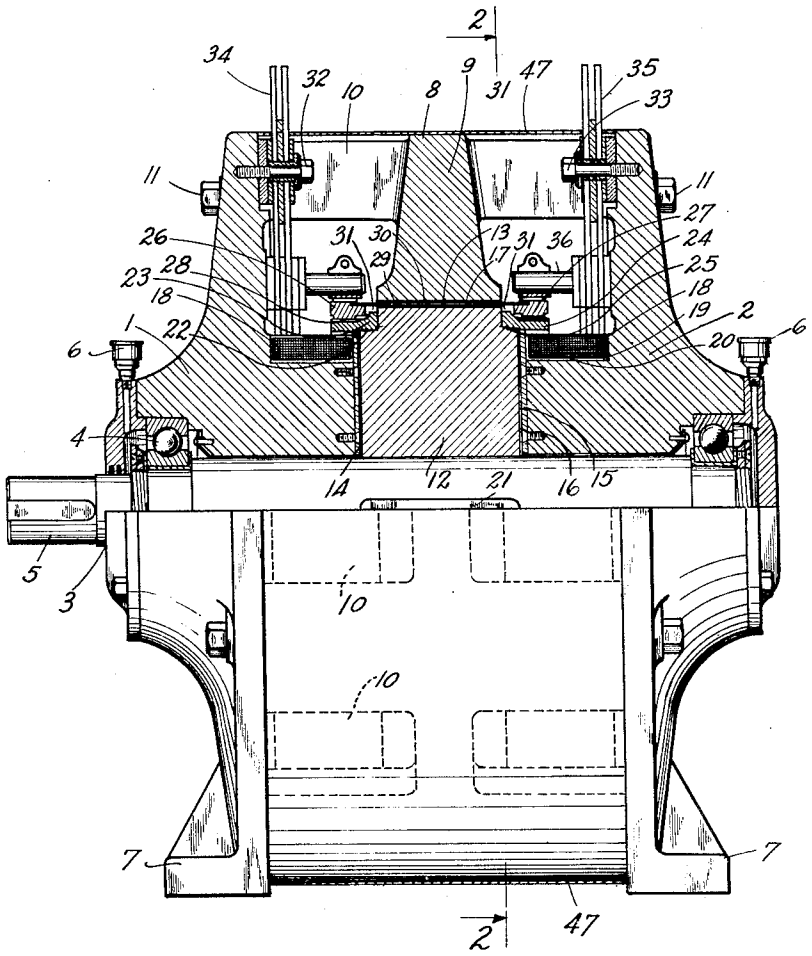


Fig. 1

Inventors
FRANK K. ROUGE
MABBOTT B. STEELE
ERASMUS D. SMITH

By Richey & Watts

Attorneys

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HOMOPOLAR GENERATOR

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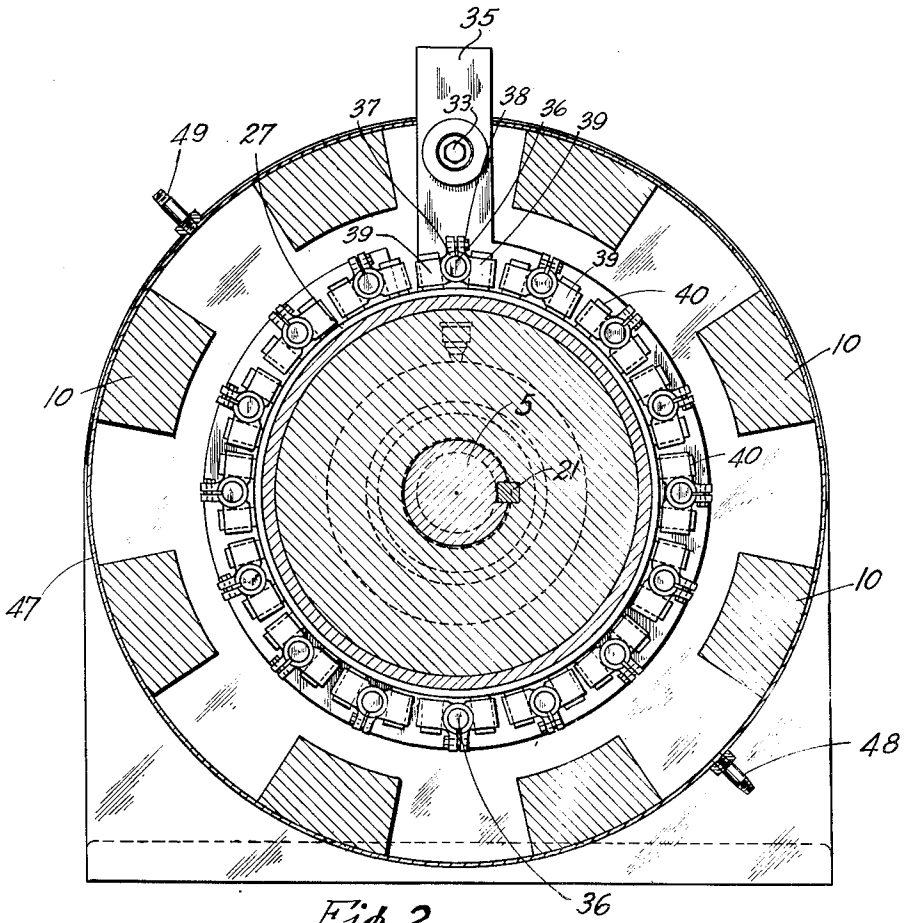


Fig. 2

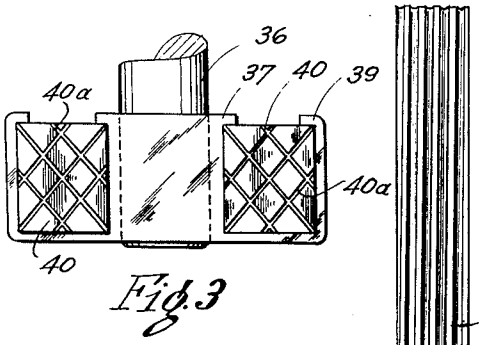


Fig. 3

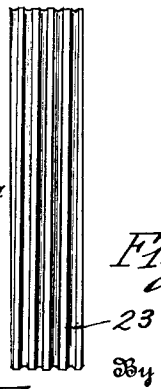


Fig. 6

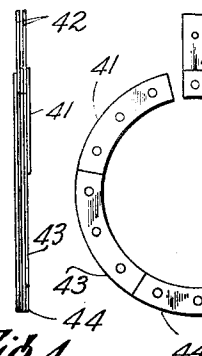


Fig. 4

Fig. 4a

Inventors
FRANK K ROUGE
MABBOTT B. STEELE
ERASMUS D SMITH

By Richey & Watts

Attorneys

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HOMOPOLAR GENERATOR

Filed Jan. 29, 1932 3 Sheets-Sheet 3

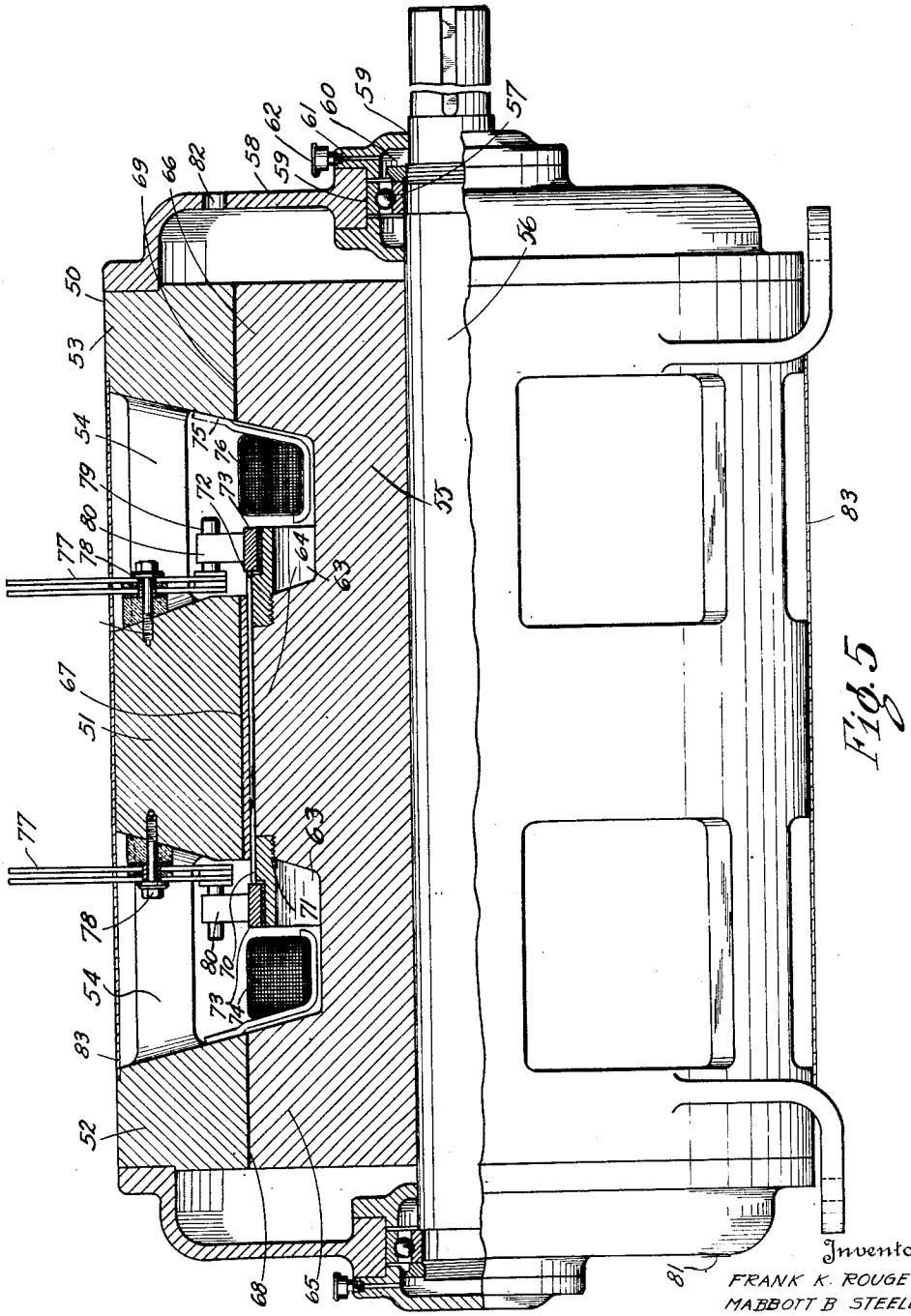


Fig. 5

Inventors
FRANK K. ROUGE
MABBOTT B STEELE
ERASMUS D SMITH

By Richey & Watts

Attorneys

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HOMOPOLAR GENERATOR

Frank K. Rouge, Mabbott B. Steele, and Erasmus D. Smith, Cleveland, Ohio, assignors to Steel and Tubes, Inc., Cleveland, Ohio, a corporation of Ohio

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16 Claims. (Cl. 171—212)

This invention relates to dynamo electric machines of the homopolar type and is particularly concerned with the provision of a new and improved homopolar generator having increased capacity with given physical dimensions, having positive and efficient means for conducting current from movable to stationary parts without arcing and its attendant disadvantages, and having new and novel means for collecting and leading off the current in such a manner that the current has the effect of creating an additional magnetic flux supplementing the main magnetic flux.

Referring now to the accompanying drawings in which preferred and modified forms of the invention are shown:

Figure 1 is a side elevation partly in section of an improved homopolar generator constructed in accordance with the principles of the invention.

Figure 2 is a sectional view taken substantially along the lines 2—2 of Figure 1.

Figure 3 is a plan view of a pair of brushes employed in carrying out the present invention.

Figures 4 and 4*a* are end and side elevational views respectively of an improved collector bus for use with present invention.

Figure 5 is a side elevation, partly in section, of a modified form of generator constructed in accordance with the principles of the invention.

Figure 6 is a view of a collector ring used in connection with this invention.

In all of the above described views like characters of reference are employed to designate like parts throughout.

The device involves in its general organization two end or core pieces 1 and 2. These core pieces are substantially identical having the like portions thereof facing each other and provided with central openings 3 in which bearings 4 are mounted in the hub portions of the core pieces. These bearings are adapted to receive an armature shaft 5 thereacross. The bearings 4 are provided with lubricating devices 6 in the form of grease cups which occupy an exposed position on the outside of the machine. The core pieces 1 and 2 are substantially of annular form but are provided with integrally formed feet 7 which provide a base for the entire machine.

The core pieces 1 and 2 are spaced from each other by means of a casting 8 in the form of an annular pole piece 9 located centrally of the machine and surrounding the shaft 5, from which pole piece there projects a plurality of axially extending, relatively heavy cross bars 10. These bars are spaced around the periphery of the machine and the inner faces of the core pieces 1 and 2 and are secured to these bars 10 at their ends by means of securing bolts 11. The core pieces 1 and 2 are in effect pole pieces which pole pieces in conjunction with the pole piece 9 and the annular extending arms or cross bars 10 form a portion of the path of flow of magnetic flux. The remainder of the path is completed through an armature 12 in the form of an annular body of magnetic material of high permeability mounted on the shaft 5 between the core pieces 1 and 2. This armature is provided with a peripheral surface 13 slightly spaced from the inner annular surface of the pole piece 9 by an air gap which gap is of substantially constant width around the periphery of the armature. Radial air gaps 14 are likewise provided between the vertical sides of the armature and the core pieces 1 and 2. In order to reduce the size of these air gaps 14 to a minimum a pair of steel plates 15 of ring-like formation are secured to the opposed faces of the pole pieces 1 and 2. These steel plates are secured in position by means of counter sunk screws 16. The plates 15 are accurately machined as are the opposite radial faces of the armature, and care should be taken to insure that the radial air gaps 14 shall be of equal thickness within very close limits to prevent slight endwise or axial movement of some of the parts due to magnetic forces, with resultant seizure of the parts or breakage of the bearings. In order to reduce the air gap 17 between the peripheral surface 13 of the armature and the inner surfaces of the pole piece 9 these surfaces are also accurately machined. The steel plates 15 perform a dual function in that their outer peripheries project beyond the hubs of the core pieces 1 and 2 and serve to retain a pair of magnetizing coils 18 in position on the core pieces.

The magnetizing coils 18 which serve to magnetize both the field magnet and the armature 12 are set in cut-away portions 19 formed in the hubs of the pole pieces 1 and 2. These coils are held in position by the steel retaining plates 15 as above described. The coils are insulated from the field magnet by means of suitable insulation 20. This insulation is of waterproof nature and extends completely around the coils to protect the same from the deleterious effect of cooling fluid circulated within the machine. The coils are disposed on opposite sides of the armature adjacent its outer periphery.

The armature 12 is keyed to the shaft 5 as at 21. The periphery of the armature is threaded on opposite sides of the armature as at 22 and these

threaded portions of the armature receive thereon metallic ring members 23 and 24, which have their inner ends threaded as at 25, by means of which they are threadedly received on the threaded portion of the armature.

The ring members 23 and 24 telescopically receive collector rings 26 and 27 respectively thereon which collector rings may be insulated from the ring members 23 and 24 by means of suitable insulation 28. The surface of these rings may be suitably grooved either circumferentially or spirally as shown in Figure 6. This provision will break up the film of cooling liquid which collects on the ring and causes unsatisfactory contact between the brushes and the ring. A plurality of axially extending armature conductors 29 may be insulated by suitable insulation 30 from the walls of holes passing through the armature near the periphery surface of the latter. The ends of the armature conductors project from the ends of the armature at opposite ends thereof and are secured to the collector rings 26 and 27 in any suitable manner as for example by welding or the like. The collector rings 26 and 27 are slightly spaced from the sides of the armature and provide annular troughs or grooves 31 which troughs or grooves are spanned by the armature conductors. In view of the fact that cooling fluid circulates within the space between the pole pieces 1 and 2, in a manner and for a purpose to be described more fully hereinafter, these annular troughs 31 are filled with any suitable filler material to prevent churning of the cooling fluid.

Insulated from but secured to the inner faces of the pole pieces 1 and 2 by means of securing bolts 32 and 33 are a pair of collector busses 34 and 35. Each of these busses consists of a split ring having a narrow gap between the ends and an extension projecting radially outwardly from one end. They are mounted coaxially with and radially outside of the field coils.

A plurality of brush holder studs or pins 36 extends into the ring-like portion of the collector busses 34 and 35. These brush holders are in the form of inwardly extending pins having mounted thereon split collars 37 which are secured in position on the pin 36 by means of bolts 38. The collar 37 carries brush sockets 39 on opposite sides in which the brushes 40 are mounted. The surfaces of the brushes 40 have suitable grooves 40*a* formed on the contacting surface thereof. These grooves are effective in breaking up any film of cooling liquid which might form between the brushes and the collector rings in a liquid cooled device. When grooved collector rings are used, brushes 40 may be plain surfaced, and when grooved brushes are used the collector rings may be plain or smooth surfaced. In other words, only one of these two members need be grooved. The brushes bear on the collector rings 26 and 27 held by brush pressure fingers (not shown) to conduct current generated in the armature conductors 29 to the collector busses 34 and 35.

Referring now to Figures 4 and 4*a* one of the improved collector busses 35 is shown as being in the form of a split ring terminating in a radially extending lead off portion 42. This ring 41 is comprised of a plurality of arcuate copper strips secured together to form a built up structure. These strips are designated at 41, 43, 44, 45 and 46, and are of progressive decreased circumferential lengths so that the ring portion of the bus-bar becomes progressively thicker around its periphery toward the lead off portion 42. The brush holder studs 36 extend into the ring shaped portion of the collector bus and are equi-distantly spaced around the same. As shown in the drawings three brush holder studs are connected to each segment of the ring portion of the collector bus and inasmuch as each of the segments of the ring portion is of increased cross sectional area the current discharged into the collector bus by means of the studs 36 is conducted to the terminal connection 42 at substantially uniform densities. The terminal connections 42 which project radially outward from the pole pieces 1 and 2 consist in a pair of copper strips whose combined cross sectional area is equal to the cross sectional area of the strips making up the split ring adjacent the end of the latter. To accommodate the terminal connections 42, two of the strips for example the strips 44 and 46 project beyond the ends of the strips 43 and 45. One strip forming a half of the terminal connection 42 is sandwiched, so to speak, between the ends of the strips 44 and 46 the other strip forming a half of the terminal connection 42 is bolted to the strip 46 on the outside thereof. By the use of a built up bus-bar such as has been disclosed, a conducting path is provided which is ample to accommodate a high current flow and which results in a saving of metal.

The improved generator embodies in its general organization a novel means by which the machine may be cooled. Towards this end means is provided for introducing a cooling fluid into the interior of the machine between the pole pieces 1 and 2. The pole pieces 1 and 2 project a slight distance beyond the outer surfaces of the cross bars 10 and a flexible metal cover plate for the machine fits closely around the outside of the members 10, being centered by the projecting portions of the pole pieces 1 and 2. This flexible cover is designated at 47.

At diametrically opposed points on the cover there is provided an inlet 48 and an outlet 49 for the passage of cooling fluid. The height of the outlet 49 determines the level of cooling fluid in the machine. While this cooling fluid may be any suitable liquid it is preferable that water be employed on account of the accessibility of the same for use and on account of its abundancy and comparatively small cost.

In actual operation as the armature 12 is rotated the conductors 29 cut the lines of magnetic force provided by the field magnet in its substantially uniform magnetic field in the same direction irrespective of their position in space. In order to maintain a uniform magnetic field the air gaps 14 and 15 are reduced to a minimum in the manner previously described. In addition to this the pole pieces 1, 2 and 9 taper radially outwardly and are accurately designed so that a sectional area around the pole pieces offers a cross sectional area that is uniform. In other words the path of the magnetic flux through the metallic portion of the machine is a constant cross sectional area. As the conductors cut the magnetic lines of force a constant and uniform current is induced into these conductors and is discharged into the collector rings 26 and 27. This current is picked up by the brushes 40 and is conducted through the brush holder studs 36 to the busses 34 and 35.

Inasmuch as the busses 34 and 35 surround the hubs of the pole pieces 1 and 2 and are concentric with the field coils 18 these busses have the effect of creating a series field supplementing the field maintained by the usual field coils 18. Thus when a relatively large current is flowing through the busses, an additional flux supple-

menting the flux created by the field coils 18 is caused to flow around the flux path.

It will be understood by those skilled in the art from the preceding description that a homopolar generator has been provided which is well adapted for the purposes intended. The provision of a grooved contact surface between each collector ring and its brushes insures good electrical contact between these members even in the presence of cooling liquid, which might have a tendency otherwise to form a film between the opposed members and thus makes possible the operation of the device in the presence of a cooling liquid at increased current densities without arcing and its attendant advantages. Moreover, the novel and efficient cooling means increases the capacity of the machine as contrasted with previous cooling methods. Furthermore, the collector busses, due to their form and arrangement with respect to other parts of the device, create a magnetic flux which is additional to and which supplements that of the field coils. This additional flux counterbalances the usual demagnetizing effect and its consequent decreases of terminal voltage with increases of load.

Referring now to Figure 5, a modified form of generator is disclosed. In this form in the magnetic circuit all radial air gaps have been eliminated. The machine involves in its general organization a core piece 50 in the form of a casting providing a central pole piece 51 and outer pole pieces 52 and 53. The outer pole pieces are connected to the central pole piece by means of relatively heavy bars 54. These bars are spaced uniformly around the periphery of the machine. The pole piece 51 and the pole pieces 52 and 53 form a portion of the path of magnetic flux and the remainder of the path is completed through an armature 55. This armature is in the form of a cylindrical mass of magnetizable material mounted on a central shaft 56 journalled in anti-friction bearings 57 carried by end plates 58 which form a part of the casing of the machine.

The end plates 58 are in the form of annular disc-like members having their peripheries connected to the pole pieces 52 and 53 respectively. These end plates are provided with central openings 59 through which the shaft 56 extends. The anti-friction bearings 57 are carried within a lubricant chamber 60 to the interior of which chamber a lubricant is conducted through a bore 61 having a grease cup 62 or similar connection associated therewith.

The armature which is keyed to the shaft 56 is of substantially cylindrical formation and is provided with a pair of annular troughs 63. The armature 55 is provided with a central projecting portion 64 of substantially the same width as the width of the pole piece 51 at its inner surface. A pair of annular projecting portions 65 and 66 are also provided on the armature 55 and these latter projecting portions are of substantially the same width as the width of the pole pieces 52 and 53 respectively. A relatively narrow air gap 67 of uniform thickness exists between the projecting portion 64 of the armature and the pole piece 51 and relatively narrow air gaps 68 and 69 exist between the projecting portion 65 and 66 and the pole pieces 52 and 53 respectively.

A plurality of armature conductors 70 extend longitudinally through the projecting portion 64 of the armature 55 just inwardly of the periphery thereof. The opposite ends, so to speak, of the projecting portions 64 are threaded as at 71 and telescopically received on these threaded portions 71 of the armature are a pair of ring members 72. These ring members each serve to carry a collector ring 73 into which rings the ends of the armature conductors 70 extend. The arrangement of armature conductors and collector rings in this modification of the invention is similar to the arrangement of armature conductors and collector rings shown in the form of the invention disclosed in Figures 1 and 2, and the type of grooved brushes and collector rings may be used as advantageously.

The field coils are designated at 74. These field coils are mounted upon spaced brackets 75 carried by the end pole pieces 52 and 53. The field coils 74 are annular in form and extend around the armature structure. A suitable insulation material 76 of liquid proof character covers these coils to protect the same from the cooling fluid circulated through the machine.

A pair of collector busses 77 substantially identical in construction to the busses 34 and 35 in the form of the invention shown in Figures 1 and 2 are secured to the pole piece 51 on opposite sides thereof by means of securing bolts 78. These busses are of a built-up structure and carry brush holder studs 79 similar to the brush holder studs 36. These brush holders carry brushes 80 which bear upon the collector rings 73 to collect and transmit current generated by the armature conductors 70.

The generator disclosed in this form of the invention as well as in the other form disclosed is designed to accommodate the novel water cooling feature embodied in this invention. Toward this end an inlet 81 is provided in one of the end plates 58 adjacent the bottom of the machine and an outlet 82 is provided in the other end plate adjacent the top of the machine. A suitable flexible cover 83 closes the central portion of the machine and this cover rests upon the pole piece 51 and has its opposite edges sealed against the pole pieces 52 and 53. Any suitable clamping means (not shown) may be employed for maintaining this cover in position. A cooling medium is circulated through the machine through the inlet 81 around the air gaps 68, 67 and 69 and is carried away from the machine through the outlet 82.

It is to be particularly noted that in this form of the invention there are no radial air gaps and consequently the danger of end thrust of the armature shaft is substantially eliminated.

The invention is not to be limited to the exact arrangement of parts shown in the accompanying drawings or described in this specification as various changes in the details of construction may be resorted to without departing from the spirit of the invention. Only insofar as the invention has been particularly pointed out in the accompanying claims is the same to be limited.

I claim:

1. In a dynamo-electric machine an annular armature having a plurality of armature conductors mounted thereon, a pair of collector rings spaced from said armature on opposite sides of the same and adapted to rotate therewith, the opposite ends of said armature conductors projecting from the armature and being secured to said collector rings, said collector rings and armature defining spaces for the reception of filler material and filler material disposed in the said spaces between said armature and collector rings.

2. In a dynamo-electric machine a rotatable armature having armature conductors mounted

thereon, a field structure for said armature having field coils covered by a liquid proof material, a pair of collector rings connected to the ends of said armature conductors, brushes bearing on said collector rings, collector busses electrically connected to said brushes and a cooling liquid disposed within said field structure and in contact with said armature, collector rings and brushes.

3. In a dynamo-electric machine, the combination with an annular pole piece providing a portion of the path of magnetic flux, said pole piece being surrounded by field coils, of a collector bus surrounding said pole pieces and supplementing the field maintained by the field coils.

4. In a dynamo-electric machine, the combination with a pole piece having field coils, of a collector bus supplementing the field maintained by said field coils.

5. In a dynamo-electric machine, a central pole piece, a pair of end pole pieces said pole pieces having projections thereon defining a chamber, a rotatable armature disposed within said chamber integrally formed of a mass of magnetizable material and having annular projecting portions extending toward said pole pieces respectively and forming relatively narrow axial air gaps therewith.

6. In a dynamo-electric machine, a plurality of ring shaped pole pieces having projections thereon defining a chamber, a substantially cylindrical armature disposed within and substantially filling said chamber presenting axial air gaps with respect to said pole pieces, said armature, throughout its entire length, projecting no further than the outer limits of said pole pieces.

7. In dyanmo-electric machine having a rotatable armature and armature conductors mounted thereon, a field structure for said armature, field coils, collector busses supplementing the flux maintained by said field coils, a pair of collector rings connected to said armature conductors, brushes bearing on said collector rings, said brushes having grooves formed in their bearing surfaces, and a liquid cooling medium disposed within said field structure in cooling contact with said armature, collector rings and brushes.

8. The combination with a collector ring for liquid cooled dynamo-electric machines having field coils, of brushes bearing on said collector rings, said brushes having a plurality of grooves formed in their bearing surfaces and collector busses of ring-like configurations positioned to supplement the field of the field coils.

9. In a dynamo-electric machine, an annular armature having a plurality of axial armature conductors mounted thereon, and a pair of collector rings mounted on said armature, grooves formed on the contacting surfaces of said collector rings, the opposite ends of said armature conductors extending into said collector rings.

10. In a dynamo electric machine, an annular armature having a plurality of armature conductors mounted thereon, a pair of collector rings mounted on said armature and insulated therefrom, grooves formed on the contacting surfaces of said collector rings, the opposite ends of each armature conductor extending into said collector rings.

11. In a dynamo-electric machine, a central pole piece, a pair of end pole pieces, said pole pieces defining a chamber, a rotatable armature substantially filling said chamber and rotatable therein, said pole pieces substantially confining said armature on all sides thereof in such a manner as to form relatively narrow air gaps therebetween.

12. In a dynamo electric machine, an annular armature having a plurality of axial armature conductors mounted thereon, a pair of collector rings mounted on said armature and adapted to receive the ends of said armature conductors, brushes bearing on said collector rings, a collector bus adapted to support said brushes comprising a split ring member positioned to supplement the flux of the field coils.

13. In a dynamo electric machine, an annular armature having a plurality of armature conductors mounted thereon, a pair of collector rings mounted on said armature and adapted to receive the ends of said armature conductors, brushes bearing on said collector rings, pole pieces being surrounded by field coils, a collector bus surrounding said pole pieces and adapted to support said brushes, said collector bus adapted to supplement the field maintained by said field coils.

14. In a dynamo electric machine, a shaft, a central pole piece, a pair of end pole pieces, said shaft and pole pieces defining an annular chamber, a rotatable armature consisting of a mass of magnetizable matter and substantially filling said chamber, said armature being spaced apart from the said pole pieces by relatively narrow air gaps, the air gaps between the said armature and the end pole pieces being of equal thickness within very close limits.

15. In a dynamo electric machine, a rotatable armature having a plurality of armature conductors mounted thereon, a pair of collector rings mounted on said armature and connected to said armature conductors; brushes bearing on said collector rings, one of the opposed surfaces of each set of collector rings and brushes being provided with a plurality of grooves, and collector busses connected to said brushes.

16. In a dynamo electric machine, a pole piece having a field coils, a rotatable armature having conductors mounted thereon, collector rings connected to said armature conductors, brushes bearing on said collector rings, one of the opposed surfaces of each set of collector rings and brushes being provided with grooves, split ring-like collector busses connected to the brushes and positioned to supplement the flux maintained by the field coils, and housing means for maintaining a liquid cooling medium in contact with the armature, collector rings and busses.

FRANK K. ROUGE.
MABBOTT B. STEELE.
ERASMUS D. SMITH.