

June 22, 1965

I. CSILLAG
DYNAMOELECTRIC MACHINE ELECTRIC CURRENT
TRANSFERRING ARRANGEMENTS

3,191,082

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4 Sheets-Sheet 1

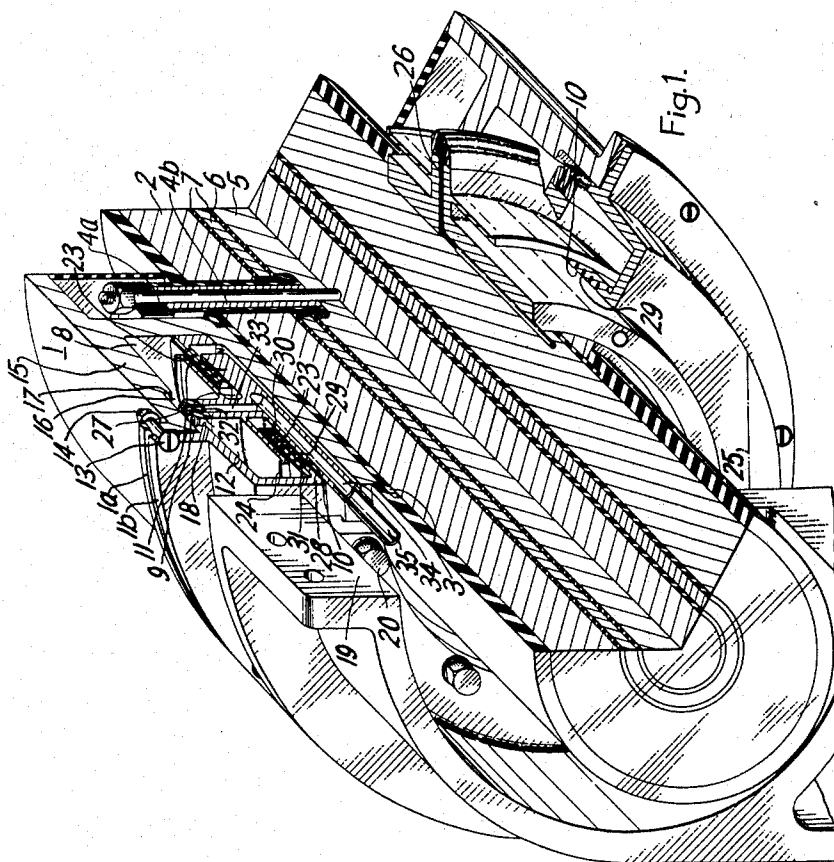


Fig. 1.

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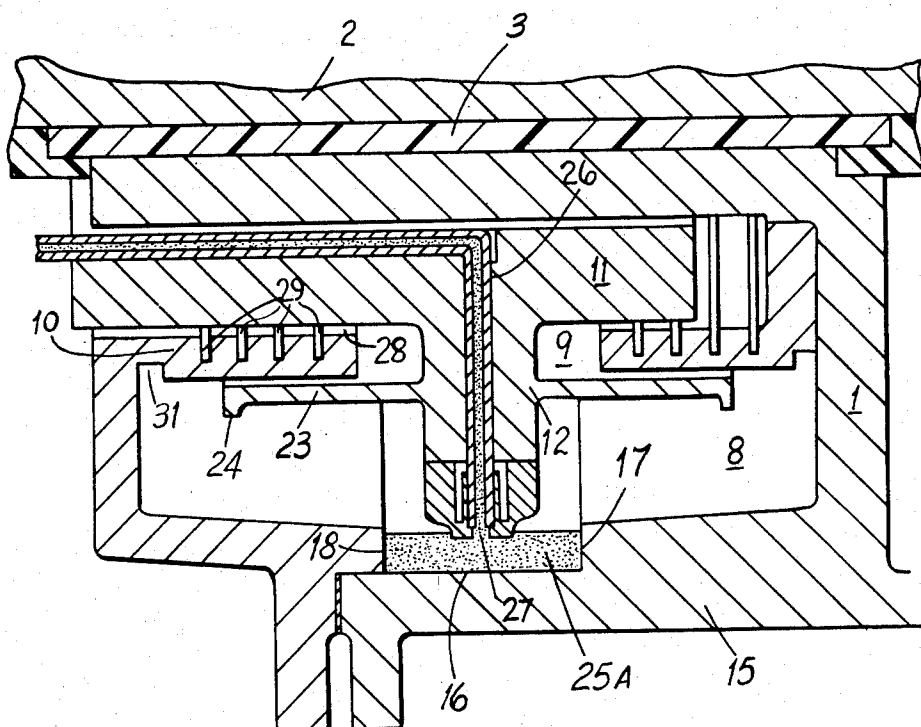


Fig. 1A.

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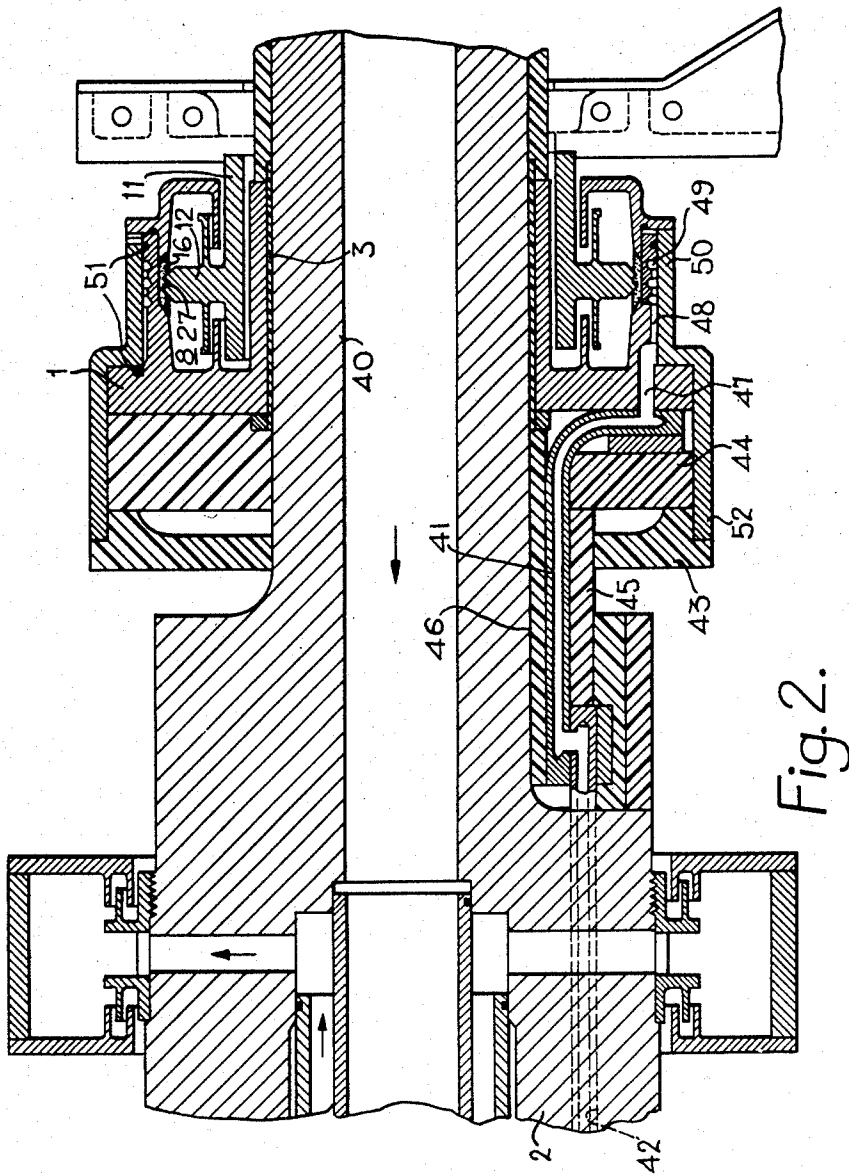
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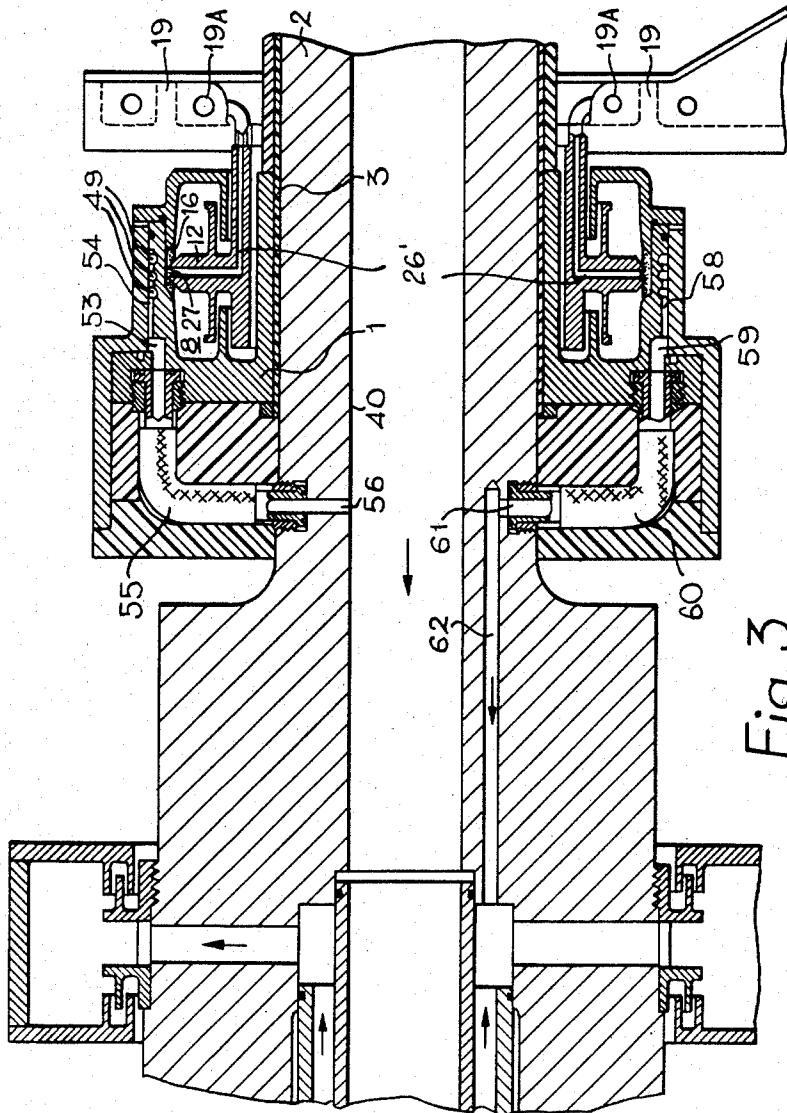
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DYNAMOELECTRIC MACHINE ELECTRIC CURRENT TRANSFERRING ARRANGEMENTS

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13 Claims. (Cl. 310—219)

This invention relates to an arrangement for providing an electric current path between a stationary member on the one hand and on the other hand a rotary member which is liable to be somewhat eccentric with respect to its nominal axis of rotation and may also be subject to transverse vibratory displacement. For example, the arrangement, which may be designed also to permit a certain extent of axial displacement between the members without affecting the electric current path, could be used between the rotor of an electric alternator and a stationary supply terminal.

Conductive liquid contacts for providing an electric current path between rotating and stationary parts are well known and present certain advantages, such as low contact resistances, over other forms such as sliprings with co-operating brushes. These liquid contacts, which commonly employ mercury as the conductive liquid, have the disadvantage, however, that the mercury or other liquid has to be contained by means of close fitting seals, which cannot allow significant transverse and axial movements of the rotating parts with respect to the stationary part. Their use has therefore been limited, and it has not been practicable, for instance, to use conductive liquid contacts for providing an electric current path between the rotor of a high speed alternator and a stationary terminal because of the difficulty in ensuring that the rotor shaft has no significant eccentricity and is not subject to axial displacement.

With a view to enabling a conductive liquid contact to be used in such circumstances the invention provides an arrangement for providing an electric current path between rotary and stationary members, comprising a rotatable part defining an annular chamber coaxial with the axis of rotation and having a radially inner wall formed with an annular entrance through which a stationary part extends into the chamber with sufficient clearance to accommodate the amount of play to be allowed for, said chamber being arranged to contain a quantity of conductive liquid sufficient to immerse a portion of the stationary part when the conductive liquid is compelled to form an annulus in said chamber by rotation of the rotatable part.

In carrying out the invention that portion of the stationary part within the chamber may be provided with annular projections which overlap the entrance to the chamber and serve to prevent the escape of any conductive liquid which is splashed during the short transitional period when the rotatable member is accelerated from rest to full speed.

In order to give a fuller understanding of the invention, and to explain its mode of operation, reference will now be made to the accompanying drawings in which:

FIG. 1 shows a perspective view, partly in section, of an arrangement in accordance with the invention; and

FIGURE 1A is a fragmentary detail cross-sectional enlarged plan view illustrating more clearly part of the arrangement shown in FIGURE 1.

FIGS. 2 and 3 show axial sections in angularly displaced planes of another arrangement in accordance with the invention.

Both arrangements could be used between the rotor

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winding of an electric alternator and a stationary supply terminal.

Referring to FIG. 1 and FIG. 1A of the drawings an annular member 1, coaxially mounted on a shaft 2 with intervening insulation 3, is electrically connected by way of a connecting link 4a and a conductor 4b to the inner one of two coaxial conductors 5 and 6 which pass axially through the shaft 2 and are connected to opposite ends of a rotor winding (not shown). The conductors 5 and 6 are insulated from each other and from the shaft 2 by insulation 7. The annular member 1, which is hollow, defines an annular chamber 8, of generally rectangular cross-section having an annular entrance 9 in one wall 10 through which a portion 12 of an annular stationary member 11 extends into the chamber 8. The portion 12 is of generally cruciform cross-section with its cross parts 23 overlapping the inside of the wall 10 on opposite sides of the entrance 9. To facilitate assembly the member 1 can conveniently be formed from two annular parts 1a and 1b secured together as by bolts 13 and nuts 14.

On the inside of the outer annular wall 15 of the chamber 8 is defined a circumferential groove 16 which, when the annular member 1 is formed by two parts 1a and 1b, as illustrated, can conveniently be formed by respective co-operating stepped portions 17 and 18. The portion 12 of the annular member 11, which is secured to a stationary supply terminal 19 as by bolts 20, extends through the entrance 9 into the chamber 8 with sufficient clearance to permit the axial movement of the annular member 1 that is to be catered for. The portion 12 at its inner end within the chamber projects into the circumferential groove 16, the depth and width of which is designed to accommodate the radial and axial movement of the member 1 which is to be catered for. The axially extending annular cross-parts 23 of the cruciform portion 12 of member 11 terminate short of the end walls of the chamber 8 by an amount sufficient to permit the axial movement of the member 1 to be catered for, these parts 23 being provided with lips 24 which extend away from the overlapped wall 10 of the chamber 8. In use the chamber 8 contains a quantity of conductive liquid such as mercury which, when the member 1 is stationary, occupies the chamber 8 to a level indicated by the broken line 25. The mercury can be introduced from an external container (not shown) through a tube 26 which passes through the member 11 in a plane passing substantially horizontally through the axis of rotation to a narrow circumferential groove 27 round the inner end of portion 12. A tube similar to that indicated at 26 communicating with the groove 27, but situated at a diametrically opposite position can be connected to discharge mercury into the container. The whole assembly may be surrounded by a protective cover (not shown), the interior of which, if necessary, could be ventilated to remove any mercury vapour which might escape from the chamber 8.

When the shaft 2 and member 1 are rotated at high speed, the mercury is compelled to form a shallow rotating annulus 25A (FIG. 1A) in the circumferential groove 16 in consequence of the centrifugal force generated by the rotation, so that the portion 12 has its periphery immersed in the mercury. The cross-parts 23 act as splash barriers to prevent mercury from escaping from the chamber 8 during the short transitional period when the member 1 accelerates from rest to its final speed. Some mercury may, however, find its way between the lips 24 and the adjacent end walls of the chamber 8 and it is desirable that this should be removed. To this end the exterior surface 28 of the wall 10 is provided with a plurality of circumferential grooves 29 in which is collected any mercury which falls between this wall 10 and the adjacent surface of the stationary member 11. These

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grooves 29 communicate with ducts such as 30 which pass axially through the wall 10 and in turn communicate with the chamber 8 by way of a circumferential groove 31 in the interior surface of wall 10. Thus mercury collecting in the groove 29 is compelled by centrifugal force to enter the ducts 30 from where it passes through the groove 31 to be discharged past the lips 24 into the chamber 8. The difference in the pressure between the mercury in the two tubes 26 caused by rotation will give rise to a self-pumping circulating action through the container which can be arranged to co-operate with a weir system to separate oxides and impurities from the mercury.

In using the described arrangement for connecting an alternator to stationary supply terminals such as 19, one end of the rotor winding carried by the shaft 2 would be connected to conductor 5 and a further assembly of annular members 1 and 11 (not shown) would be provided to establish a connection between a further stationary terminal and the outer conductor 6, to which the other end of the rotor winding would be connected. This second assembly would occupy a portion of the shaft 2 alongside the arrangement shown and need not occupy the extreme end of the shaft 2 which can be left free to be utilised for other purposes.

When the shaft 2 and member 1 are rotated at high speeds, considerable heat may be generated at the periphery of portions 12 and 17 and water cooling may be provided if required. To this end, circumferential cooling ducts 32 may be provided in the periphery of portion 12 and water conveyed to these ducts 32 by way of a duct 33 which passes radially through portion 12 and communicates with a further duct 34 which passes axially through the member 11 and is fed from an insulating hose 35. The water can be discharged through similar ducts 33 and 34 at a different angular position.

Referring now to FIGS. 2 and 3 of the accompanying drawings which illustrate an embodiment of the invention provided with water cooling of the rotating parts, the annular member 1 is coaxially mounted on the shaft 2 with intervening insulation 3 as before, but this time the shaft 2 is provided with a central bore 40 through which water is fed. This shaft 2 may for instance be the shaft, or an extension thereof, of an alternator with water cooled rotor and rotor winding to which cooling water is fed through the shaft 2. Electrical connection between the annular member 1 and, for example, an end of a rotor winding, is provided this time by a hollow conductor 41 (FIG. 2) which passes through a longitudinal hole 42 in the shaft 2, and is supported along the portion outside the hole 42 by insulating blocks 43, 44, 45 and 46 which are secured to the shaft 2. A cooling duct 47 which extends into the annular member 1 communicates with the hollow conductor 41 and with a groove 48 in the outer surface of the member 1. The groove 48 intersects a plurality of circumferential grooves 49 in the outer surface of the member 1, these grooves 49 and the groove 48 being effectively formed into ducts by an annular casing 50 which fits closely round the outer surface of the member 1. Sealing rings such as 51, between the casing 50 and the member 1, prevent the escape of water from the axially opposite ends of this part of the casing 50. An annular, axially extending portion 52 of the casing 50 serves to clamp the insulating blocks 43-46 to the shaft 2.

Referring now to FIG. 3 in particular, water enters the grooves 49 through a groove 54 which intersects them and communicates with a duct 53 passing through the member 1. An insulating hose 55 connected between the duct 53 and a duct 56 passing radially through the shaft 2 into the bore 40, conveys water from the bore 40 to the duct 53. Water is discharged through a similar arrangement of a groove 58, duct 59, insulating hose 60 and duct 61, situated at a diametrically opposite position, but communicating with a longitudinal hole 62 parallel with the bore 40. Water is fed into the hollow conductor 41

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(FIG. 1) through groove 48, and duct 47, which are at an angular position in the member 1 close to that of groove 53 and duct 54. In this way the water can flow through, and therefore cool, the whole length of the conductor 41 which affords electrical connection to one end of the rotor winding.

In a complementary arrangement such as would be used to afford electrical connection to (and to convey water from) the other end of the rotor winding, the duct 47 and groove 48 would be in a diametrically opposite position to that shown (that is an angular position in the member 1 close to duct 58 and groove 59) and would discharge water returning from the rotor winding into the grooves 49. Such a complementary arrangement would occupy a portion of the shaft 2 alongside the arrangement shown.

The arrangements for current conduction in the embodiment shown in FIGURES 2 and 3 are generally similar to those illustrated in FIGURE 1 and like reference numerals are applied to like parts. Since cooling takes place through the rotatable member 1, however, the stationary member 11 is not made hollow for cooling purposes. Ducts 26' are provided in the stationary member 11 for the supply and discharge of mercury to and from the groove 27 in the periphery 12 of that member. These ducts 26' which are, again, diametrically oppositely disposed in or near a horizontal plane through the axis of rotation, extend respectively to mercury inlet and discharge connectors 19A on the electric supply terminal 19.

In the case of large diameter arrangements which are rotated at high speeds, the annular member 1 would preferably be made of steel with the portion forming circumferential groove 16 plated with nickel and then with rhodium. The annular member 11 would preferably be made of high conductivity copper plated with nickel and would have at least the end of the cruciform portion 12 also plated with rhodium to give improved electrical conduct with the mercury. In the case of current collecting arrangements which rotate at relatively slow speeds and which would therefore generate less heat, both the member 1 and the member 11 may be made from stainless steel. In this latter case a small quantity of metal soluble in mercury such as copper, could be added in dust form to the mercury to reduce the potential drop at the contact surface of the stainless steel.

What I claim is:

1. An arrangement for providing an electric current path between a rotatable conductive member and a stationary conductive member comprising a rotatable part defining an annular chamber coaxial with the axis of rotation and having a radially inner wall formed with an annular entrance to said chamber, an annular stationary part which extends through said entrance into said chamber, the dimensions of the stationary part measured axially within the chamber and where it passes through the entrance being smaller than the corresponding dimensions of the chamber and of the entrance to an extent permitting substantial axial play between said parts, and a quantity of conductive liquid in said chamber sufficient to immerse a portion of the stationary part when the conductive liquid is compelled to form an annulus in said chamber by rotation of the rotatable part.

2. An arrangement for providing an electric current path between a rotatable conductive member and a stationary conductive member, comprising a rotatable part defining an annular chamber coaxial with the axis of rotation and having a radially inner wall formed with an annular entrance to said chamber, an annular stationary part which extends through said entrance into said chamber, annular projections on the stationary part disposed within the chamber and overlapping said entrance, the dimensions of the stationary part, including the annular projections thereon, measured axially within the chamber and where it passes through the entrance being smaller than the corresponding dimensions of the chamber and of

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the entrance to an extent permitting substantial axial play between said parts, and a quantity of conductive liquid in said chamber sufficient to immerse a portion of the stationary part when the conductive liquid is compelled to form an annulus in said chamber by rotation of the rotatable part.

3. An arrangement for providing an electric current path between a rotatable conductive member and a stationary conductive member, comprising a rotatable part defining an annular chamber of generally rectangular section having an inner annular wall, an outer annular wall and side walls, said chamber also having an annular entrance at said inner annular wall, an annular stationary part which extends through said entrance into said chamber, annular projections on the stationary part disposed within the chamber and overlapping said entrance, the dimensions of the stationary part, including the annular projections thereon, measured axially within the chamber and where it passes through the entrance being smaller than the corresponding dimensions of the chamber and of the entrance to an extent permitting substantial axial play between said parts, and a quantity of conductive liquid in said chamber sufficient to immerse a portion of the stationary part when the conductive liquid is compelled to form an annulus in said chamber by rotation of the rotatable part, the said annular projections being closely spaced from the said inner annular wall of the chamber so as to minimize escape of conductive liquid through the intervening space.

4. An arrangement for providing an electric current path between a rotatable conductive member and a stationary conductive member, comprising a rotatable part defining an annular chamber of generally rectangular section having an inner annular wall, an outer annular wall and side walls, said chamber also having an annular entrance at said inner annular wall, the interior surface of said outer annular wall having a circumferential groove therein, an annular stationary part which extends through said entrance into said circumferential groove, and a quantity of conductive liquid in said chamber sufficient to immerse a portion of the stationary part when the conductive liquid is compelled to form an annulus in said circumferential groove by rotation of the rotatable part.

5. An arrangement as claimed in claim 4, wherein the

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inner annular wall of said chamber is provided with circumferential grooves in its exterior surface and with ducts affording communication between said grooves and the interior of said chamber.

6. An arrangement as claimed in claim 1 wherein the stationary part includes a duct passing radially through it into the chamber for supplying conductive liquid to the chamber.

7. An arrangement as claimed in claim 6, wherein the stationary member includes a further duct passing radially through it from the chamber as an exit duct for the conductive liquid.

8. An arrangement as claimed in claim 7, wherein said radial ducts are at diametrically opposite positions in said stationary member in a plane passing substantially horizontally through the axis of rotation.

9. An arrangement as claimed in claim 1 including ducts in the stationary part for passing liquid coolant therethrough.

10. An arrangement as claimed in claim 1 including ducts in the rotatable part for passing liquid coolant therethrough.

11. An arrangement as claimed in claim 10 including, fast with the rotatable part, a shaft having a bore through which the liquid coolant is supplied and a radial duct extending from said bore for conveying liquid coolant therefrom into said rotatable part.

12. An arrangement as claimed in claim 11 wherein the shaft has a further bore for discharge of liquid coolant and a duct communicating with said further bore for conveying liquid coolant to it from said rotatable part.

13. An arrangement as claimed in claim 2, in which the said annular projections are closely spaced from the said inner annular wall of the chamber so as to minimize escape of conductive liquid through the intervening space.

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