

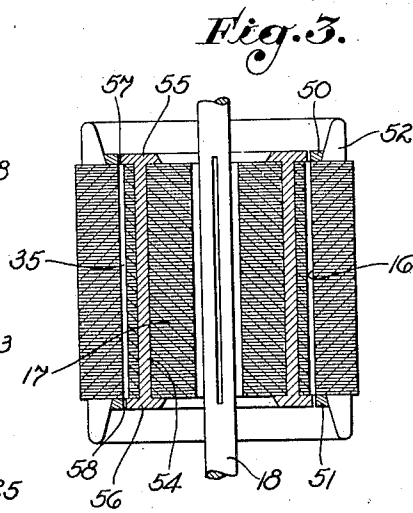
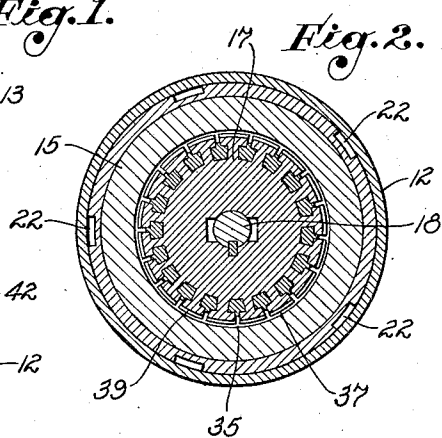
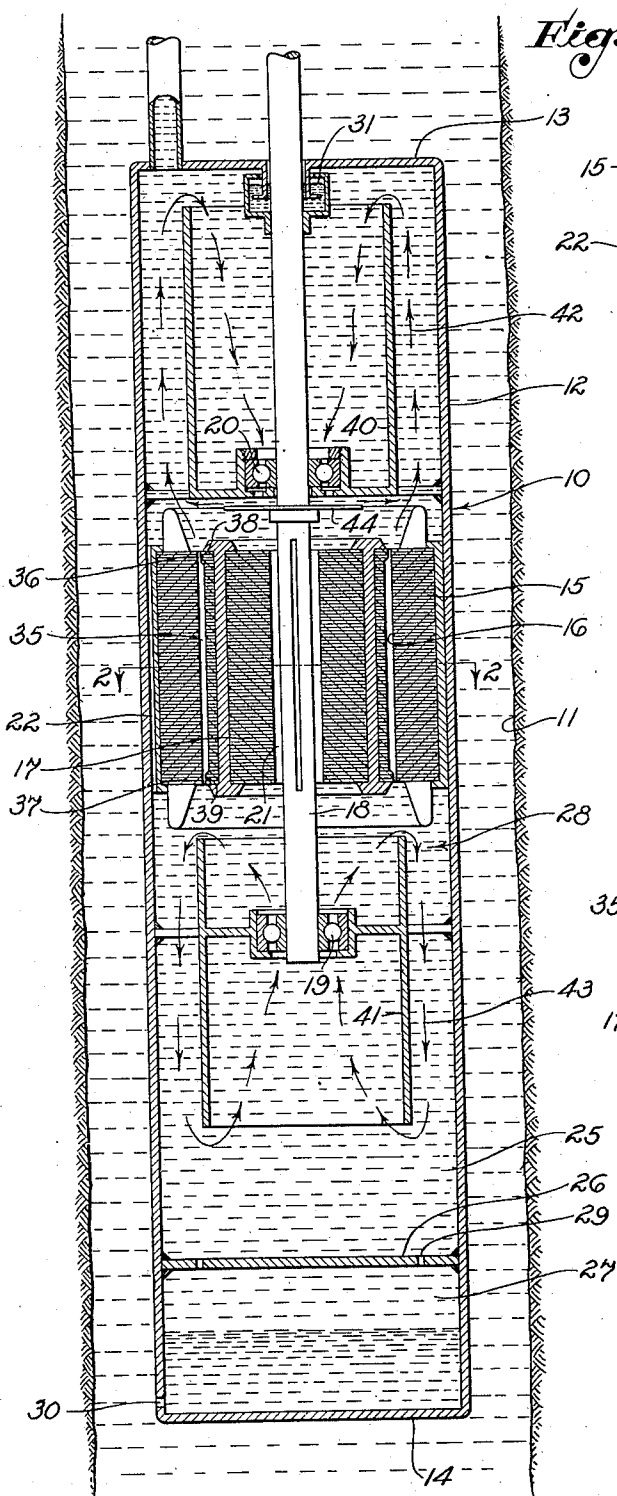
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C. J. COBERLY

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MOTOR CONSTRUCTION

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INVENTOR
CLARENCE J. COBERLY
By *Fad W. Lamer*
ATTORNEY.

UNITED STATES PATENT OFFICE

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MOTOR CONSTRUCTION

Clarence J. Coberly, Los Angeles, Calif., assignor
by mesne assignments, to Byron Jackson Co.,
Huntington Park, Calif., a corporation of Dela-
ware

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8 Claims. (Cl. 172-36)

My invention relates to dynamo-electric machines including rotatable and stationary elements cooperating in defining a gap. It is often desirable to be able to throttle the flow of whatever material fills this gap.

It is an object of the present invention to provide a novel throttle means for a gap of a dynamo-electric machine.

It is a further object of the present invention to provide such a throttle means in the form of a restricted passage at one or both ends of the gap.

Further objects of the invention lie in the novel structure of forming such a restricted passage.

Still a further object of the invention is to provide a restricted passage at each end of the gap and in some instances to make one of these restricted passages of smaller cross-sectional area than the other, the cross-sectional area of each restricted passage being smaller than the cross-sectional area of the gap.

Further objects and advantages of the invention will be made evident hereinafter.

Referring to the drawing,

Fig. 1 is a sectional view of one type of dynamo-electric machine, shown as being in the form of a submersible electric motor.

Fig. 2 is a sectional view taken on the line 2-2 of Fig. 1.

Fig. 3 illustrates an alternative form of gap construction.

The present application is a division of my application entitled "Method of and apparatus for reducing skin-friction losses", Serial 627,180 issued into Patent Number 1,985,887. In that application is disclosed a system wherein a vaporizable dielectric is used, this dielectric being formed of such material that it will expel a vaporous material if raised to the temperatures existing in the gap. The system therein disclosed includes the use of a heating means formed either by the windings of the dynamo-electric machine or by an auxiliary source.

In many installations it is desirable to cool the dynamo-electric machine by contacting at least a portion thereof with the dielectric liquid. If this dielectric liquid is permitted to fill the gap, skin-friction losses are unduly high, often amounting to several per cent of the output of the machine. Further, these losses increase materially with increased speed, skin-friction losses increasing approximately as a third power of the angular velocity. This will be apparent from the fact that the skin friction loss in such a machine is represented by the following equation:

$$\text{Loss} = \phi N^3 D^4$$

Where N=speed of rotation (R. P. M.)

D=diameter of rotor

ϕ =a constant

The horse-power delivered by an electric motor can be represented by the equation:

$$\text{Horse-power} = CND^2$$

Where C is a constant.

Thus to ascertain the percentage loss the first equation can be divided by the second, resulting in:

$$\text{Percentage loss} = KN^2 D^2$$

Where K is a constant.

Thus it will be apparent that the percentage loss not only increases as the square of the speed but also as the square of the diameter of the rotor. Thus the invention is also very desirable when used in installations requiring a large diameter of rotor and results in very marked savings in this capacity.

In my application supra the utilization of the vaporizable dielectric greatly decreases these losses, and the provision of one or more throttle means communicating with the gap greatly assists in this regard in so far as it tends to retain the vaporous material in the gap. The use of such restricted passages is not, however, limited to a system utilizing a vaporizable dielectric. The skin-friction losses existing in a gap are a function of the viscosity of any liquid which is therein. I have found that the gap construction or throttle means to be hereinafter described finds utility regardless of whether or not a vaporizable dielectric is utilized, for if the gap is filled with a dielectric liquid the throttle means retains this liquid in the gap, thereby permitting this liquid to be heated by the dynamo-electric machine to such a degree that the viscosity is materially reduced. If no such throttle means is utilized, any slight heating of the dielectric in this gap tends to set up a thermal circulation which quickly moves the dielectric therefrom. By use of the present invention this flow of the dielectric through the gap is materially retarded, thus permitting the dielectric to be increased in temperature to a degree heretofore impossible. This increased temperature to which a liquid dielectric in the gap is subjected reduces the viscosity and thus decreases the skin-friction losses.

In other instances dynamo-electric machines are provided with means for circulating such a dielectric liquid from one end of the stator to the other for cooling purposes. It is sometimes desirable to confine a major portion of this flow to those portions of the dynamo-electric machine in which maximum cooling efficiency will be obtained, and in this connection it is often desirable not to circulate the dielectric liquid through the gap but through one or more passages formed through the dynamo-electric machine and spaced from this gap. The present invention wherein the throttle means is used to restrict the

flow through the gap is very desirable in this regard inasmuch as it permits the major portion of the flow to take place through passages spaced from the gap.

5 For illustrative purposes I have illustrated the invention in the accompanying drawing as applied to a submersible electric motor, though it will be clear that the invention is not limited to this use.

10 Referring particularly to Fig. 1, I have illustrated a submersible motor 10 supported in a well 11 by means not shown, this submersible motor providing a shell 12 closed at its upper and lower ends by heads 13 and 14 and being positioned below the surface of the external liquid in the well. Inside the shell 12 is mounted a stationary element including a stator 15 which provides a rotor opening 16. A rotatable element including a rotor 17 is positioned to rotate in the rotor opening 16, this being accomplished by the use of a shaft 18 journaled in bearings 19 and 20. The rotor is shown as being provided with longitudinal passages 21, while one or more longitudinal passages 22 are formed between the stator 15 and the shell 12.

The interior of the shell 12 contains a dielectric liquid 25 which, if desired, may surround the working parts of the motor. In the system illustrated a baffle 26 extends across the shell 12 below the motor and cooperates with the head 14 in defining a balance chamber 27. The spaced baffle 26 also cooperates in defining a motor chamber 28, this motor chamber being in open communication with the balance chamber through one or more small openings 29. If desired, the lower end of the balance chamber 27 may contain a body of the external liquid which is in surface contact with the dielectric liquid, this external liquid entering the balance chamber through an opening 30. Such a system permits substantially pressure equalization between the dielectric liquid and the external liquid, this feature being desirable both from the standpoint of equalizing pressures inside and outside the shell 12 and also substantially equalizing pressures on a seal 31 which seals the junction of the shaft 18 and the head 13. Any suitable type of seal may be utilized, the seal illustrated being in the form of a fluid-packed seal containing mercury, for instance. The particular seal utilized is not per se a part of the present invention, it being possible to use any type of seal which effectively prevents admixture between the liquids inside and outside the shell.

55 The outer diameter of the rotor 17 is slightly smaller than the rotor opening 16 to provide a gap 35. Throttle means is provided at one or both ends of this gap, this throttle means being illustrated in Fig. 1 as comprising upper and lower restricting passages 36 and 37. In this embodiment of the invention the rotor opening 16 is of constant diameter throughout the laminated portion of the stator, but the ends of the laminated portion of the rotor 17 provide projections or beads 38 and 39 which extend outward toward the stator but terminate short thereof to define the restricted passages 36 and 37. In accomplishing this, the end laminations of the rotor are punched slightly larger than the intermediate laminations thereof to give this effect. It should be understood, however, that such projections or beads can be formed either on the rotor or on the stator or on both.

The restricted passages 36 and 37 are of smaller cross-sectional area than the gap 35, and it is

sometimes desirable to make one of these passages of smaller cross-sectional area than the other. With a vertically disposed motor, it is usually preferable to make the upper restricted passage 36 smaller than the lower restricted passage 37. Though in other instances this arrangement can be reversed, and in other instances it is entirely possible to make the cross-sectional areas of these passages equal. Nor is it always necessary to use restricted passages at both ends of the gap 35. Often entirely successful results can be obtained by using only one of these restricted passages. If the gap is to be filled with dielectric liquid, and if it is desired to maintain this liquid in the gap longer than would otherwise be the case so as to reduce the viscosity, the restricted passage is preferably formed at the upper end of the gap. If, however, merely a throttling action of the medium flowing in the gap is desired, this restricted passage can be placed at either end.

The shape of the gap 35 in Fig. 1 is greatly distorted for illustrative purposes. In actual practice the distance across the intermediate portion of this gap will be determined by the characteristic of the motor and will usually be in the neighborhood of from .02 to .05 inch, though this distance will vary with the desired electrical performance. The distance across the restricted passages 36 and 37 may be several thousandths of an inch less and may, for instance, range from .005 to .015 inch, varying with the viscosity of the dielectric, the speed of rotation of the shaft, the volume of the gap 35, etc. The distance across these restricted passages, is not, however, extremely critical and the best proportions can be readily obtained by empirical methods.

To further assist in the cooling of the motor, I have shown cylindrical baffles 40 and 41 spaced from the shell 12. The rotation of the rotor 17 tends to set up the circulating paths shown by the arrows 42 and 43. If desired this action can be increased by the provision of a pumping means in the form of a disc 44 secured to the shaft. This pumping means will not only assist the circulation indicated by the arrows 42, but will also tend to draw dielectric liquid upward through the passages 21, returning this liquid to the bottom of the rotor either through the passages 22 or through the gap 35.

It should not be understood, however, that it is essential to use the rotor construction illustrated in Fig. 1. An alternative mode of forming the restricted passages is shown in Fig. 3. Here annular rings 50 and 51 are positioned immediately inside a winding 52 formed on the stator. These rings may preferably be formed of an insulating material or other non-magnetic material, and, in the form shown, the inner diameter of these rings is substantially the same as the diameter of the rotor opening 16. The rotor 17 is here shown as being provided with bars 54 connected to end rings 55 and 56. These end rings are preferably positioned opposite the rings 50 and 51 and extend outward a distance across the gap 35 to define upper and lower restricted passages 57 and 58. This construction has the advantage that it does not change the magnetic characteristics of the motor. The distance between the magnetic portions of the rotor and stator may be made constant throughout the length of the gap, the restricted passages being formed by means other than the laminations themselves. In other instances it is possible to extend the rings 50 and 51 a slight distance inward from the rotor open-

ing 16 allowing the end rings 55 and 56 of the rotor to be of the same external diameter as the laminations forming the rotor.

Various other structures can be used for forming these restricted passages and it should be understood that the foregoing examples are illustrative only.

I claim as my invention:

1. A dynamo-electric machine including in combination: a stator forming a stationary element and providing a vertically-extending rotor opening therein; a rotor rotatable about a vertical axis and forming a rotatable element and positioned in said rotor opening and cooperating with said stator in defining a vertically-extending gap; and means on one of said elements and positioned near the upper end of said gap and extending toward the other of said elements but terminating short thereof to define a restricted passage opening on said gap and operative to throttle any material rising in said gap and flowing from the upper end of said gap.

2. A dynamo-electric machine including in combination: a stator forming a stationary element and providing a rotor opening therein; a rotor forming a rotatable element and positioned in said rotor opening and cooperating with said stator in defining a gap; a winding on at least one of said elements for heating said gap; and means forming a restricted passage at each end of said gap to confine a medium in said gap, each restricted passage having a smaller cross-sectional area than said gap, said means including projections on one of said elements extending toward but terminating short of the other of said elements to define said restricted passages.

3. A dynamo-electric machine including a combination: a stator forming a stationary element and providing a rotor opening therein; a rotor forming a rotatable element and positioned in said rotor opening and cooperating with said stator in defining a gap; and means forming a restricted passage at each end of said gap, each restricted passage having a smaller cross-sectional area than said gap, one of said restricted passages being of smaller cross-sectional area than the other, said means including projections on one of said elements extending toward but terminating short of the other of said elements to define said restricted passages.

4. A dynamo-electric machine surrounded by a fluid, including in combination: a stationary element including a stator providing a vertical rotor opening; a rotatable element including a rotor in said rotor opening and cooperating with said stator in defining a vertical gap; and means at each end of said gap for restricting any flow of said fluid in said gap.

5. A dynamo-electric machine including in combination: a stationary element including a

stator surrounded by a fluid, providing a rotor opening; a winding on said stator and extending from the ends thereof to form an extension portion having an internal diameter greater than the diameter of said rotor opening; an annular ring entirely inside said extension portion and positioned in the space between said extension portion and said rotor opening; a rotatable element including a rotor in said rotor space and cooperating with said stator in defining a gap, the distance between said annular ring and said rotor being less than the distance across the main portion of said gap whereby said ring cooperates with said rotor in defining a restricted passage communicating between said gap and the space exterior of said gap and to throttle any flow of said fluid through said gap; and said annular ring being formed of non-magnetic material so as not to change the magnetic characteristics of said dynamo-electric machine.

6. A dynamo-electric machine including in combination: a stationary element including a stator surrounded by a fluid, providing a rotor opening; a winding on said stator and extending from the ends thereof to form an extension portion having an internal diameter greater than the diameter of said rotor opening; an annular ring entirely inside said extension portion and positioned in the space between said extension portion and said rotor opening; a rotatable element including a rotor in said rotor space and cooperating with said stator in defining a gap, the distance between said annular ring and said rotor being less than the distance across the main portion of said gap whereby said ring cooperates with said rotor in defining a restricted passage communicating between said gap and the space exterior of said gap and to throttle any flow of said fluid through said gap; and said annular ring being formed of non-magnetic material and in which said rotor includes an end ring thereon cooperating with said non-magnetic ring of said stator in defining said restricted passage.

7. In a dynamo-electric machine, a shell containing a dielectric fluid, a stator provided with a rotor bore mounted in said shell, a rotor operatively mounted in the stator bore and cooperating therewith in defining a gap therebetween, and means located at each end of the gap for retaining dielectric fluid within said gap.

8. In a dynamo-electric machine, a shell containing a dielectric fluid, a stator provided with a rotor bore mounted in said shell, a rotor operatively mounted in the stator bore and cooperating therewith in defining a gap therebetween, and non-magnetic means located at each end of the gap for retaining dielectric fluid within said gap.

CLARENCE J. COBERLY.