March 31, 1925. 1,531,724

A. ARUTÜNOFF

ELECTRIC MACHINE

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Fig. 1.

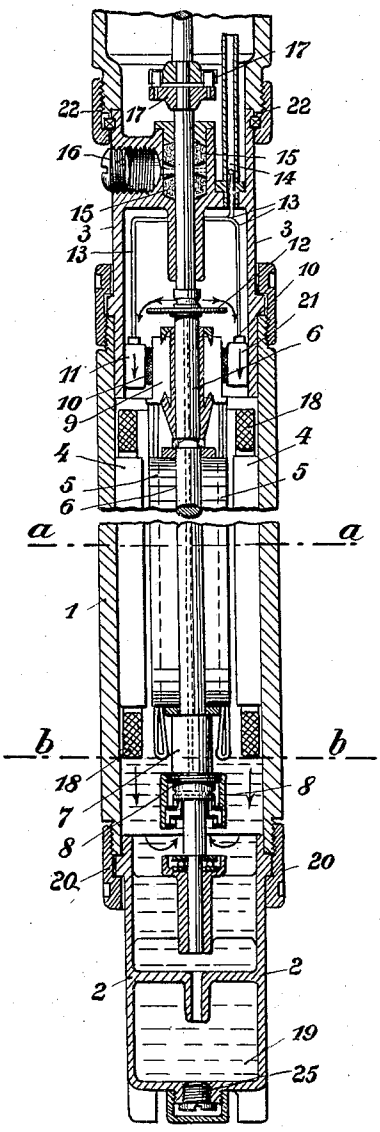


Fig. 4.

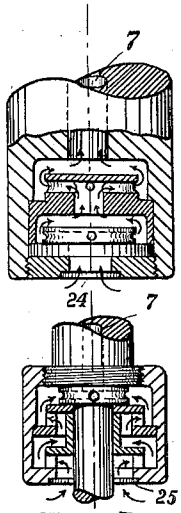


Fig. 5.

Fig. 2.

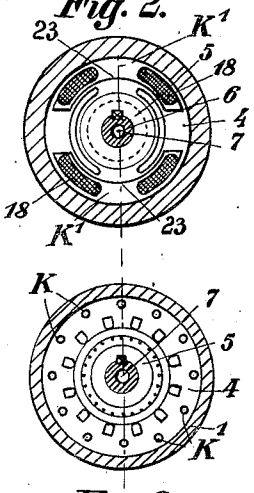


Fig. 3.

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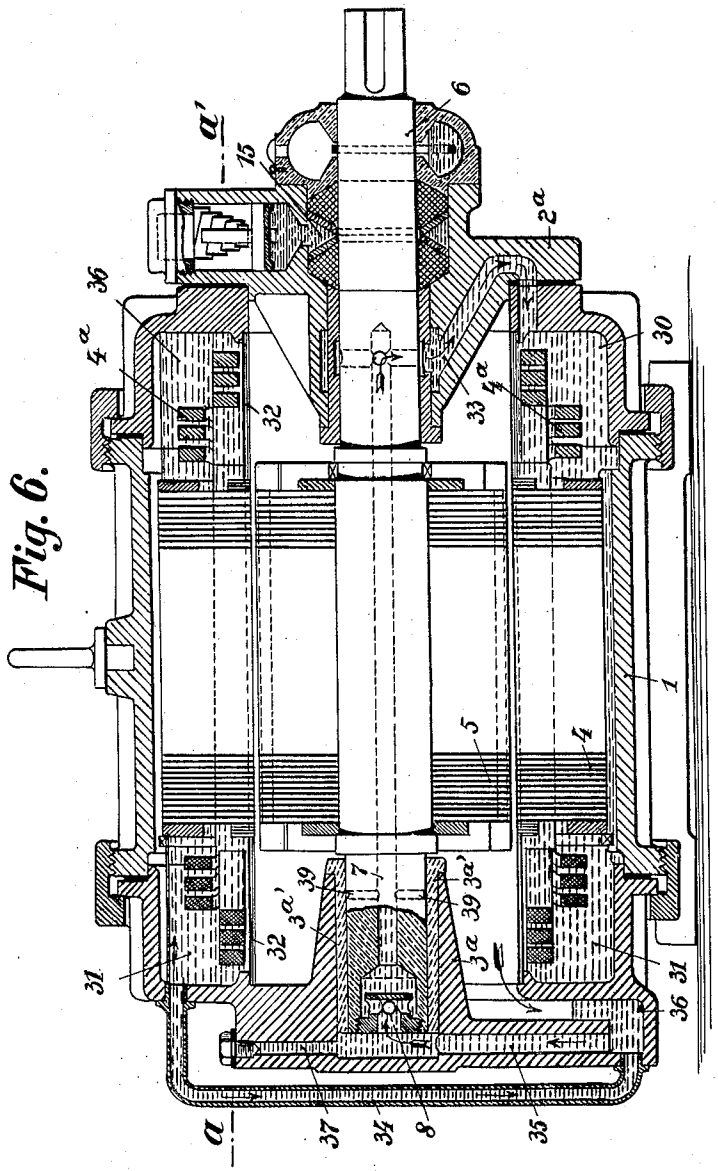
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Fig. 6.



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UNITED STATES PATENT OFFICE.

ARMAIS ARUTÜNOFF, OF BERLIN, GERMANY.

ELECTRIC MACHINE.

Application filed April 18, 1921. Serial No. 462,435.

To all whom it may concern:

Be it known that I, ARMAIS ARUTÜNOFF, residing at 6 Wilhelmstr., Berlin SW., Germany, have invented certain new and useful Improvements in Electric Machines, of which the following is a specification.

This invention relates to electric machines with internal liquid or oil chambers or passages. The object of the invention is to provide an improved method of cooling such machines. This is accomplished by continuously pumping the cooling liquid through a passage in the machine shaft during its operation and by causing the liquid to flow through the stator or stationary parts of the machine without touching external portions of the rotor or armature. Hence the external surfaces of the rotor remain free from liquid so that deleterious fluid friction is avoided.

If the above-described oil circulation principle is to be carried into effect with the aid of a hollow shaft in horizontal machines difficulties present themselves that can only be overcome by devising some special arrangements. In accordance with the invention this arrangement consists chiefly in providing an annular chamber at each end of the magnetic field or of the stator, and in completely closing these annular chambers against the central space in the machine whilst interconnecting them by a bore or passage extending through the machine shaft.

Other features of the invention will appear in the following description and claims.

The invention is illustrated in the drawing in which—

Fig. 1 is a longitudinal section of a vertical machine,

Fig. 2 a section on the line *a*—*a* of Fig. 1,

Fig. 3 is a similar section to Fig. 2 through a modified machine,

Fig. 4 a side elevation of the lower end of a vertical shaft, the greater part of this elevation being shown in section in order to disclose the rotary pump arranged in the foot of the shaft,

Fig. 5 is a sectional elevation of the bottom end of the vertical shaft of Fig. 1 disclosing the rotary pump arranged therein, and

Fig. 6 is a diametrical section of a horizontal type of machine to which the principle of the invention is applied.

The internal cavities of the machine (Fig. 1), excepting the central chamber in which the rotor 5 revolves, are filled with oil whose top surface, when the machine is at a standstill, is indicated by the line *a*—*a*, but which, when the machine is working, drops to the level *b*—*b*.

The machine shaft 6 has a central bore or longitudinal passage 7 and is equipped with a small rotary pump 8 (Fig. 1, 4, 5).

Whilst the machine is working, i. e. during the rotation of the rotor 5, the oil is driven by the pump 8 through the hollow shaft 6 and thus caused to wash against the inner part of the rotor and to cool the same. The upwardly driven oil passes through radial openings at the top of the shaft and then flows down again into the bottom chamber, either through passages *k* (Fig. 3) in the active iron of the stator, or, if it is a case of continuous current machine with a constant magnetic field, through spaces *k'* between the field coils. Thus during its upward passage the circulating oil cools the rotor and during its downward passage it cools the stator of the machine.

The pump that causes the oil to circulate is arranged inside the rotating shaft at the end or foot of the same, as shown in Fig. 4.

In cases in which the shaft is too thin to permit of the pump being arranged in its interior it is arranged around the shaft as shown in Fig. 5.

The constructional form illustrated in the drawing is that of a hermetically closed electrical machine whose diametrical section (Fig. 1) discloses the following parts:

The shell 1, the round foot piece 2, the round head piece 3, the electromagnets or stator 4, the armature or rotor 5, the rotary shaft 6 with its central bore 7, the rotary pump 8, the collector 9, the brushes 10, the brush-holders 11, the collector cover 12, the leads 13 to the brushes, the introduction tube 14 for the leads 13, a stuffing box 15 with a liquid seal, a pressure screw 16 which presses oil into the stuffing box, a shaft coupling 17, the coils 18 of the electromagnet or the stator, the settling chamber 19 for used oil, etc., the threaded connecting collars 20, 21, 22, the plates 23 which form separating walls between the rotor and the stator spaces, an oil filter 24 (Fig. 4), and an outlet for the impure oil with a screw stopper 25 (Fig. 1).

The oil, whose top surface is at the level

a'—a when the machine is at rest, sinks to the level b—b when the machine is running because it is then driven up through the bore in the shaft by the rotary pump 8 and a part of it will fill the entire borehole and the upper spaces between the coils of the stator.

In addition to cooling all parts of the machine whose temperature may be raised by electric currents the circulating oil also lubricates the bearings of the shaft. A filter 24 (Fig. 4) at the foot of the shaft cleans the oil before it rises in the borehole. Substances whose specific gravity is greater than that of pure oil settle in the settling chamber 19 (Fig. 1). The construction of this chamber 19 is such that substances that have sunk to the bottom of the same cannot mix with the pure oil again even if the machine should be turned upside down.

By removing the screw stopper 25 the entire dirty oil can be caused to flow out.

Fig. 2 is a cross section of a machine for continuous current. In this type of machine the plates 23 separate the central space in which the armature revolves from the space occupied by the field coils. The oil flows down through the channels K′ between the plates 23 and the inner wall of the shell 1 of the machine.

Fig. 3 is a cross section of an alternating current machine with a stator and rotor.

K are cooling channels in the stator through which the oil flows down and back into the bottom oil chamber.

The pump shown in Fig. 4 in the foot of the shaft 6 is a two-stage rotary pump that drives the oil upwards and thus maintains its circulation.

In the modification shown in Fig. 5 a two-stage pump is also employed, but in this case the pump surrounds a thin portion of the shaft instead of being arranged within the same. The thick portion of the shaft has a longitudinal bore as in the case of the shaft 6 which is thick throughout its whole length.

In the modification shown in Fig. 6 the frame 1 has two caps with bearings 2^a and 3^a attached to its two ends and envelops the stator or field magnets 4 and the armature or rotor 5. Journalled in the bearings 2^a and 3^a is the machine shaft 6 which has a central bore 7 extending from the left end to a point above the oil channel 33 at the right end of the machine. At the right and left ends of the stator or the field magnets chambers 30 and 31 are provided which are completely partitioned off from, and closed against, the interior of the machine by rings 32.

When the machine is at a standstill the oil in the same reaches up to the level of the line a—a', but when the machine is running the pump 8 rotated with the shaft drives the oil through the bore 7 of the hollow shaft in the direction of the arrow and it passes through the channel 33 in the bearing support into the chamber 30 and fills the same and then flows through the gaps in the laminæ of the stator, or, if it is a question of a continuous current machine, through the openings between the field magnets back into the chamber 31 and through the pipe 34 and the hole 35 in the bearing 3^a to the pump 8; a well 36 in the casing being filled with oil during this process of circulation. The hole 35 has an upwardly extending prolongation 37 which is closed by a screw 38. After this screw is removed fresh oil can be put into the hole 37. This hole remains filled with oil when the machine is at a standstill, so that the pump is always in readiness to act when the machine is started. Cross holes 39 lead from the longitudinal bore 7 to the bearing brasses $3^{a'}$ and through these the proper amount of oil passes for the purpose of lubrication, this oil also serving as a liquid seal of the chamber at the suction or intake end of the pump 8.

The machine, which may be a continuous current machine with the requisite commutator, or, as shown in the drawing, a machine for three-phase current, is hermetically sealed and, for this reason, provided with a stuffing box 15 of a special type.

When the machine is operating the whole stator space is filled with oil whilst the rotor space is kept free from oil and therefore unnecessary friction is avoided. The stator coils 4^a and also the stator laminæ are effectively cooled by the oil by the circulation of which a complete equalization of the temperatures is effected and all deleterious heating of the machine parts is avoided.

In the following claims the terms stator and rotor are intended to mean the stationary and rotary parts of either a continuous or an alternating current machine.

I claim:—

1. An electric machine comprising a stator, a rotor, a rotor shaft journalled in the said stator, oil passages in the stator and an oil channel in the rotor shaft, and means for continuously sending the oil through the said channel and the said passages, said channel having branches leading to the journals whereby the latter are positively lubricated.

2. An electric machine comprising a rotor, a stator enveloping the said rotor, a bearing cap attached to each end of the stator, an annular chamber in each of said caps, bearings in the said caps, a rotor shaft journalled in the said bearings, a rotor chamber, rings for isolating the annular chambers from the rotor chamber, a passage from one annular chamber to another consisting of a longitudinal bore in the rotor shaft and channels in the said caps, oil in

the said chambers, a pump at one end of the shaft for causing the oil to circulate through the said passage and means at the other end of the shaft to direct the oil outwardly to the stator passages.

3. An electric machine comprising a stator, a rotor, an annular chamber at either end of the stator, stator passages interconnecting the said chambers, a completely closed rotor chamber, a rotor shaft, a communicating passage extending from one said chamber through the rotor shaft to the other said chamber, and an oil well filled with oil during the stoppage of the machine and a pump at one end of the shaft for pumping oil therethrough.

4. An electric machine comprising a stator, a rotor, an annular chamber at either end of the stator, stator passages interconnecting the said chambers, a completely closed rotor chamber, a rotor shaft, a communicating passage extending from one said chamber through the rotor shaft to the other said chamber, bearings for the said shaft, transverse passages in the rotor shaft for conducting oil to the said bearings, and a pump at one end of the shaft for driving oil through the said communicating and transverse passages, the oil in the bearing at the pump end of the shaft being adapted to act as a hermetic seal in the space between the shaft and the bearing.

5. An electric machine comprising a stator, a rotor, an annular chamber at either end of the stator, stator passages interconnecting the said chambers, a completely closed rotor chamber, a rotor shaft, a communicating passage extending from one said chamber through the rotor shaft to the other said chamber, bearings for the said shaft, transverse passages in the rotor shaft for conducting oil to the said bearings, a pump at one end of the shaft for driving oil through the said communicating and transverse passages, the oil in the bearing at the pump end of the shaft being adapted to act as a hermetic seal in space between the shaft and the bearing, and an oil well reaching up to the pump, whereby the pump is always maintained in readiness for operation.

6. An electric machine comprising an enclosing casing frame, a rotor mounted in said frame, an enclosed stator in said frame, said frame having a chamber communicating with the space occupied by the rotor and by the stator, a pump operated with the rotor, and connections by which a fluid in said chamber will be circulated separately through the rotor and stator, the oil rising into the rotor space of the frame from said chamber when the rotor is idle and being drawn therefrom by the pump when the rotor is operating.

In testimony whereof I have signed this specification in the presence of two witnesses.

ARMAIS ARUTÜNOFF.

Witnesses:
RUDOLF ROHN,
THEOD. WILSON.