

HIGH SPEED GENERATOR
ROTOR OIL PATH AIR VENT

Technical Field

This invention relates to rotary electric machines,
5 and more specifically, rotary electric machines having
liquid cooled rotors and an air vent path for venting air
entrained in the liquid coolant.

Background Art

In order to maximize the capacity of various rotary
10 electric machines as, for example, generators, it is
desirable to provide liquid cooling for various
components such as windings. In many instances, this
does not pose a particular problem. However, in the case
of rotary electric machines having rotor windings
15 requiring cooling, a problem may occur in view of the
fact that the coolant, frequently oil, seldom is totally
free from entrained gases such as air, and the further
fact that the coolant passages are displaced from the
rotational axis of the rotor.

20 As a consequence, during operation of the machine,
the more dense oil tends to collect in the high
centrifugal force field spaced from the rotational axis
of the rotor while the less dense air collects in the low
centrifugal force area surrounding the rotational axis of
25 the rotor.

Since the coolant is typically introduced into the
rotor by a rotary coupling located coaxial with the axis
of rotation of the rotor, the air bubble located on the
axis of rotation may impede or halt proper flow of the
30 coolant to the coolant passages displaced therefrom with
the undesirable result of winding overheating.

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The present invention is directed to overcoming one or more of the above problems.

Summary of the Invention

5 The invention provides a rotary electric machine comprising a stator, a rotor journalled for rotation relative to the stator and carrying electrical windings, a fluid inlet and a fluid outlet both on the rotor, a cooling liquid flow path through the rotor interconnecting the inlet and the outlet, the cooling liquid flow path
10 being in heat exchange relation to the electrical windings with at least a part thereof displaced from the axis of rotation of the rotor, and a gas vent passage in the rotor interconnecting the inlet and the outlet, the connections of the gas vent passage to the inlet
15 and the outlet being located substantially on the axis of rotation of the rotor. The air vent prevents the build-up of an air bubble on the axis of rotation of the rotor that might impede the flow of coolant to coolant passages.

20 In a highly preferred embodiment, the vent passage is sized to prevent substantial flow of a liquid to thereby prevent bypassing of the liquid flow path due to undesirable coolant flow through the vent passage.

The invention contemplates that the inlet may
25 include a chamber with a filter disposed in the chamber along with generally radially oriented entrance and exit ports for the chamber, the exit ports connecting to both the gas vent passage and the liquid flow path.

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Brief Description of the Drawing

The Figure is a sectional view of a rotary electric machine, specifically a high speed alternator, made according to the invention with certain components shown in somewhat schematic form.

Best Mode for Carrying Out the Invention

An exemplary embodiment of a rotary electric machine made according to the invention is illustrated in the drawing in the form of a high speed alternator. However, it should be understood that the invention can be employed with efficacy in other types of rotary electric machines wherein rotor cooling by a liquid coolant which may entrain gases is employed. The rotary electric machine includes a stator armature, generally designated 10, having a steel core 12, windings 14, and a rotor/stator air gap 16. Bearings such as those shown at 18 mounted on a housing component 20 serve to journal a rotor, generally designated 22, for rotation relative to the stator 10 within the gap 16 for rotation about the rotor axis.

In the particular form of the machine illustrated, the alternator is of the so-called brushless variety and includes windings 24 extending from end to end of the rotor 22 as illustrated. The windings receive a direct current to generate a magnetic field which in turn rotates upon rotation of the rotor to induce current in the windings 14 of the stator 10.

The rotor includes a fluid inlet, generally designated 26, on one end and a fluid outlet, generally designated 28, on the opposite end. A fluid system

including a pump 30 and an air-oil separator 32 if desired recirculate the liquid coolant from the outlet 28 to the inlet 26. A heat exchanger (not shown) for cooling the coolant may also be employed.

5 The inlet 26 includes a chamber 34 within the rotor. A centrifugal filter 36 is disposed in the radially outer part of the chamber 34. Generally radially extending entrance ports 38 interconnect the chamber 34 and the exit end of a tube 40 connected to the pump 30 by means
10 including a rotary coupling.

Axially inwardly of the ports 38, the chamber 34 opens radially inwardly in exit ports 42 to a centrally apertured plate 44, the aperture in the plate 44 being concentric with the rotational axis of the rotor 22.

15 Radial passages 46 extend generally radially outwardly from the rotational axis to allow liquid to flow into heat exchange relationship with the end turns of the windings 24 and through passages 48 extending axially along the rotor to the opposite end turns whereat
20 the coolant may emerge in a central chamber 50 concentric about the rotational axis of the rotor 22. A flow path including an orifice 52 interconnects the chamber 50 with the outlet 28.

As noted previously, the difference in densities
25 between the coolant, usually oil, and gas, usually air entrained therein tends to cause the more dense oil to migrate to radially outer portions of the flow paths due to centrifugal force during operation of the machine whereas the air tends to collect on the rotational axis
30 of the rotor during such operation. As can be readily appreciated from a consideration of the Fig., if the air bubble becomes sufficiently large, it can impede the flow of the liquid coolant to the windings 24 and the coolant

passages 48. In order to prevent such an occurrence, an air vent passage 54 extends axially through the rotor 22 along the rotational axis thereof. The air vent passage 54 has an entrance 56 in fluid communication with the inlet 26, and specifically, at the radially inner extent of the passages 46 on the rotational axis of the rotor 22. Similarly, the vent passage 54 is provided with an outlet 58 to the chamber 50 and also located on the rotational axis of the rotor 22. As a consequence of this construction, the pressure of incoming coolant at the inlet 26 will drive any forming air bubble into the inlet 56 to the vent passage and along the same to exit into the chamber 50 and be removed therefrom via the outlet 28. At the same time, the incoming liquid coolant, due to centrifugal force and the difference in densities, will drive any air in the chamber 36 radially inwardly toward the rotational axis and will spill over through the aperture plate 44 into the passages 46 to then flow through the passages 48 for the coolant and perform the desired cooling action.

In order to prevent any bypassing of the coolant passages 48 via the vent passage 54, the same has a cross sectional dimension that is but a minor fraction of the cross sectional dimension of the flow paths 48.

In the usual case, of the total flow of fluid, no more than about 10% will be entrained air. By using conventional compressible fluid flow calculations, the cross sectional dimension of the vent passage 54 may be determined. As a general practice, it should be chosen so that it will always be able to convey the maximum expected amount of entrained gas in the fluid being circulated and no more.

From the foregoing, it will be appreciated that a rotary electric machine made according to the invention

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eliminates the difficulties heretofore encountered when attempts have been made to cool rotor components in rotary electric machines by the flow of a coolant through the rotor. The unique construction assures that small
5 contaminating particles in the coolant are adequately filtered so as to prevent ultimate clogging of coolant passages and yet assures adequate venting of air to prevent winding overheating.



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CLAIMS:

1. A rotary electric machine comprising a stator, a rotor journaled for rotation relative to the stator and carrying electrical windings, a fluid inlet and a fluid outlet both on the rotor, a cooling liquid flow path through the rotor interconnecting the inlet and the outlet, the cooling liquid flow path being in heat exchange relation to the electrical windings with at least a part thereof displaced from the axis of rotation of the rotor, and a gas vent passage in the rotor interconnecting the inlet and the outlet, the connections of the gas vent passage to the inlet and the outlet being located substantially on the axis of rotation of the rotor.
2. A rotary electric machine according to claim 1 wherein the gas vent passage is sized to prevent substantial flow of liquid therethrough, to prevent by-passing of the cooling liquid flow path.
3. A rotary electric machine according to claim 2, wherein the vent passage has a cross-sectional area that is a minor fraction of the cross-sectional area of the liquid flow path.
4. A rotary electric machine according to any preceding claim, wherein the fluid inlet includes a chamber, a filter disposed in the chamber and generally radially oriented entrance and exit ports for the chamber.
5. A rotary electric machine according to any preceding claim wherein the whole of the gas vent passage is located substantially on the axis of rotation of the rotor.



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6. A rotary electric machine according to any preceding claim, wherein the fluid inlet is spaced from the fluid outlet on the rotor.
 7. A rotary electric machine, substantially as described herein with reference to the drawings.
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