

SPECIFICATION

Rotor Shaft Assembly

5 Description

This invention relates to electrical machinery and, more particularly, to an improved rotor assembly for AC generators.

AC generators are often used for various applications. For example, a generator may be mechanically coupled to and driven by a constant speed drive unit which provides rotational energy to the rotor of the generator at a constant speed. Alternatively, the generator may be coupled to an auxiliary power unit. When an AC generator is coupled to a selected constant speed drive or auxiliary power unit to form a power system, it is typical in such a system to circulate oil through the generator for lubricating and cooling. Generally, oil enters the generator through one end of a hollow rotor shaft from an oil supply. The oil flows through the shaft and out its other end. The oil pressure at each end of the hollow rotor shaft should be substantially the same.

The hollow rotor shaft carries the field winding structure and the rectifier assembly for rectifying the voltage from the exciter windings. The shaft is provided with holes through which oil flows for lubricating and cooling portions of the generator. For example, holes may be located near the field winding structure so that an oil spray from the holes impinges upon end turns of the field winding structure for cooling. Also, holes may be provided near the rectifier assembly for cooling the diodes in the assembly. Moreover, holes through which oil flows may be placed along the shaft for lubricating selected portions, as for example, a splined end of the shaft of the generator which receives the constant speed drive or the auxiliary power unit. The volume of oil flow through the holes in the hollow rotor shaft should be maintained at a selected level for optimum operation. Furthermore, the velocity of the oil spray from the holes should be controlled to minimize erosion of the insulation on end turn windings of the field winding structure.

Different constant speed drives and auxiliary power units have different oil inlet pressures and oil flow requirements which must be maintained. Therefore, before an AC generator is coupled to a particular constant speed drive or auxiliary power unit, the rotor must often be disassembled and the diameter and number of the holes in the hollow rotor shaft must be changed to assure that the oil inlet pressures and oil flow requirements are matched so that the constant speed drive or auxiliary power unit and the AC generator cooperate effectively with each other. Rotor disassembly and replacement is time-consuming and expensive.

The invention provides a rotor shaft assembly for an electrical machine, comprising a hollow rotor shaft having internal sealing surfaces at its ends and a number of radial oil holes through the shaft intermediate the sealing surfaces, a hollow tube within the rotor shaft extending from one of the sealing surfaces to the other and defining an annular cavity between the hollow tube and the hollow shaft,

a number of radial holes through the hollow tube for delivering oil to the annular cavity, and means for retaining the tube in the hollow shaft. In use, the hollow tube, which is removable, is disposed within the hollow rotor shaft and extends from substantially one end of the hollow rotor shaft to the other. Cooling oil flows from an oil supply through the hollow tube into a constant speed drive or auxiliary power unit coupled to the generator. The outer surface of the hollow tube and the inner surface of the hollow rotor shaft define the annular cavity extending axially along the shaft. The tube is provided with holes so that oil flows into the cavity and out through the holes in the hollow rotor shaft for cooling and lubricating portions of the generator. The diameter and number of holes in the hollow tube are selected in accordance with the inlet pressure provided by the selected auxiliary power unit or constant speed drive connected to the generator or in accordance with a desired flow volume of the oil through the holes.

The configurations of the hollow rotor shaft and the hollow tube facilitate removal of the tube from the shaft without complete disassembly of the AC generator so that a tube having a selected hole configuration can be inserted within the shaft for accommodating a particular oil inlet pressure and oil flow requirement.

It is a feature of the present invention to provide an improved rotor structure having an interchangeable tube for AC generator so that the AC generator may readily be modified for use with various constant speed drives or auxiliary power units having different oil inlet pressures and oil flow requirements.

Another feature of the invention is to provide an improved rotor structure of an AC generator having a configuration which facilitates removal of the tube without extensive disassembly of the generator.

The invention is hereinafter further described and illustrated, by way of example only, with reference to the drawing of which:

Figure 1 is a cross-sectional view of a generator rotor having a hollow rotor shaft with a removal tube therein, coupled to a constant speed drive;

Figure 2 is a longitudinal sectional view of another tube in accordance with the present invention; and

Figure 3 is a cross-sectional view taken along line 3-3 of Figure 2, showing a set of holes in the tube.

Referring to Figure 1, generator 10 is coupled to a constant speed drive 12 having housing 14. Although the description herein will be limited to the combination of the AC generator 10 and the constant speed drive 12, it is apparent that generator 10 could be coupled to other equipment as, for example, an auxiliary power unit.

Generator 10 includes a housing 16, a hollow rotor shaft 18 carrying field winding structure 20, and rectifier assembly 22. The hollow rotor shaft 18 may be of a two-piece construction including a hollow elongated member 24 and a hollow coupling member 26 secured to hollow elongated member 24 by screws 28. The shaft is mounted for rotation within generator 10 by bearings 30 at the left end, as shown in Figure 1, and by the constant speed drive 12 at the right end, as will be explained in detail below.

Generator 10 includes an oil inlet 32 through which oil enters from an oil supply (not shown). Oil flows through hollow rotor shaft 18 and into constant speed drive 12 and returns to the oil supply.

5 Hollow rotor shaft 18 is provided with a splined end 34 which is adapted to be received by the constant speed drive 12.

Holes or sets of holes are provided along the hollow rotor shaft 18 to direct oil onto parts of the generator 10 which require cooling. Hole 36 extends through hollow rotor shaft 18. Oil from hole 36 cools diode 38 in rectifier assembly 22. Similarly, spaced-apart sets of holes 40 and 42 extend through hollow rotor shaft 18. Oil from holes 40 and 42 cool exposed end turns 44 and 46 of field winding structure 20.

15 Additional holes may be provided in hollow rotor shaft 18 for lubrication purposes. Hole 48 provides oil flow to splined end 34.

Inner surface 50 of hollow rotor shaft 18 has sealing surfaces 52 and 54 of a reduced diameter at ends 56 and 58, respectively. End 56 is provided with a shoulder 60 adjacent sealing surface 52 for positioning hollow tube 62.

When generator 10 is removed from the constant speed drive 12, splined end 34 is exposed, and hollow tube 62 can be inserted into or removed from hollow rotor shaft 18. Ends 56 and 58 are of reduced diameter. The larger diameter of the hollow rotor shaft 18 between the ends 56 and 58 facilitates insertion and removal of hollow tube 62. The length of the hollow tube 62 is sufficient to extend from sealing surface 52 to sealing surface 54, and has a center portion 63 through which oil can flow. The hollow tube 62 is captured within the hollow rotor shaft 18 between shoulder 60 and a removable snap ring 64. The tube has channels 66 and 68 at ends 56 and 58, respectively, which extend circumferentially about tube 62. O-rings 70 and 72 disposed in channels 66 and 68 engage sealing surfaces 52 and 54, respectively.

An annular cavity 74, defined by inner surface 50 of hollow rotor shaft 18 and outer surface 76 of hollow tube 62, extends along the axis of hollow rotor shaft 18. Hollow tube 62 is provided with holes or sets of holes 78 which extend from center portion 63 of hollow tube 62 into cavity 74 for oil flow into cavity 74. The number of holes and the diameter of the holes control the oil pressure in cavity 74.

The oil pressure in cavity 74 is reduced from the oil pressure at inlet 32. When compared to a hollow rotor shaft 18 not having a hollow tube 62, the holes in hollow rotor shaft 18, as holes 36, 40, 42 and 48, may be increased without significantly further reducing the oil pressure at inlet 32. The holes in hollow rotor shaft 18, being larger, are less sensitive to clogging from dirt and other contaminants.

Constant speed drive 12 has a hollow shaft 80 mounted for rotation in housing 14 by bearing 82. A hollow connector 84 is retained within hollow drive shaft 80 by a snap ring 86, and is sealed with the hollow shaft 80 by O-ring 88. Hollow connector 84 is of sufficient length to be removed by hollow tube 62 at end 58 of hollow rotor shaft 18 when the generator 10 is coupled to the constant speed drive 12. End 90 of hollow connector 84 has a configuration which

conforms to the hollow tube 62.

If it is desired to remove or interchange hollow tube 62 from generator 10, generator 10 and constant speed drive 12 are separated at the splined end 34, thereby exposing the hollow tube 62. Snap ring 64 is removed and hollow tube 62 may be slid axially outwardly from hollow rotor shaft 18. The hollow tube 62 may be replaced with a similar tube having a different configuration of holes.

Referring to Figures 2 and 3, tube 92 is shown perforated with a plurality of holes 78. The holes may be in sets (as seen in Figure 3) equally spaced from each other, and extend along substantially the entire length of hollow tube 92. The holes in a set may be evenly spaced about the tube to minimize deflection during rotation. In all other respects, tube 92 is identical to tube 62, and may be interchanged with it.

A wide range of oil flow velocities and pressures can be achieved by the selection of the hole configurations in the hollow tubes. The flow requirements of generator 10 can remain constant when coupled to different constant speed drives or auxiliary power units having different inlet pressures of oil by the appropriate selection of the hole configuration in the hollow tube. Also, the oil flow rate through the generator can be changed to provide more or less flow therethrough by simply interchanging tubes having different hole configurations.

CLAIMS

1. A rotor shaft assembly for an electrical machine, comprising a hollow rotor shaft having internal sealing surfaces at its ends and a number of radial oil holes through the shaft intermediate the sealing surfaces, a hollow tube within the rotor shaft extending from one of the sealing surfaces to the other and defining an annular cavity between the hollow tube and the hollow shaft, a number of radial holes through the hollow tube for delivering oil to the annular cavity, and means for retaining the tube in the hollow shaft.

2. A rotor shaft assembly according to claim 1, wherein the means for retaining the tube in the hollow shaft comprises an internal shoulder at one end of the shaft and a removable ring providing an internal shoulder at the other end, the tube being retained between the two shoulders.

3. A rotor shaft assembly according to either preceding claim, wherein the radial holes in the hollow tube form an array extending substantially from one end to the other of the tube.

4. A rotor shaft assembly according to any preceding claim wherein the radial holes in the hollow tube are equally angularly spaced to achieve a rotational balance of the tube.

5. A rotor shaft according to any preceding claim, wherein the hollow tube is provided with sealing means for cooperation with the sealing surfaces of the hollow shaft.

6. A rotor shaft assembly according to claim 5, wherein the sealing means comprise an O-ring in an annular groove at each end portion of the hollow tube.



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- 15 Additional holes may be provided in hollow rotor shaft 18 for lubrication purposes. Hole 48 provides oil flow to splined end 34.

- Inner surface 50 of hollow rotor shaft 18 has 20 sealing surfaces 52 and 54 of a reduced diameter at ends 56 and 58, respectively. End 56 is provided with a shoulder 60 adjacent sealing surface 52 for positioning hollow tube 62.

- When generator 10 is removed from the constant speed drive 12, splined end 34 is exposed, and hollow tube 62 can be inserted into or removed from hollow rotor shaft 18. Ends 56 and 58 are of reduced diameter. The larger diameter of the hollow rotor shaft 18 between the ends 56 and 58 facilitates 25 insertion and removal of hollow tube 62. The length of the hollow tube 62 is sufficient to extend from sealing surface 52 to sealing surface 54, and has a center portion 63 through which oil can flow. The hollow tube 62 is captured within the hollow rotor shaft 18 between shoulder 60 and a removable snap ring 64. The tube has channels 66 and 68 at ends 56 and 58, respectively, which extend circumferentially about tube 62. O-rings 70 and 72 disposed in channels 66 and 68 engage sealing surfaces 52 and 30 54, respectively.

- An annular cavity 74, defined by inner surface 50 of hollow rotor shaft 18 and outer surface 76 of hollow tube 62, extends along the axis of hollow rotor shaft 18. Hollow tube 62 is provided with holes or sets of holes 78 which extend from center portion 63 of hollow tube 62 into cavity 74 for oil flow into cavity 74. The number of holes and the diameter of the holes control the oil pressure in cavity 74.

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- If it is desired to remove or interchange hollow tube 62 from generator 10, generator 10 and constant speed drive 12 are separated at the splined end 34, thereby exposing the hollow tube 62. Snap ring 64 is removed and hollow tube 62 may be slid axially outwardly from hollow rotor shaft 18. The hollow tube 62 may be replaced with a similar tube having a different configuration of holes.

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2. A rotor shaft assembly according to claim 1, wherein the means for retaining the tube in the hollow shaft comprises an internal shoulder at one end of the shaft and a removable ring providing an internal shoulder at the other end, the tube being retained between the two shoulders.

3. A rotor shaft assembly according to either preceding claim, wherein the radial holes in the hollow tube form an array extending substantially from one end to the other of the tube.

4. A rotor shaft assembly according to any preceding claim wherein the radial holes in the hollow tube are equally angularly spaced to achieve a rotational balance of the tube.

5. A rotor shaft according to any preceding claim, wherein the hollow tube is provided with sealing means for cooperation with the sealing surfaces of the hollow shaft.

6. A rotor shaft assembly according to claim 5, wherein the sealing means comprise an O-ring in an annular groove at each end portion of the hollow tube.



7. A rotor shaft assembly according to any preceding claim, wherein the internal sealing surfaces at the ends of the hollow shaft have an internal diameter smaller than that of the hollow shaft
- 5 intermediate the sealing surfaces.
8. A rotor shaft assembly according to any preceding claim, wherein the hollow rotor shaft has a hollow drive shaft portion releasably securable to the remainder of the hollow rotor shaft to form one
- 10 end portion thereof.
9. A rotor shaft assembly according to any preceding claim, further comprising means for delivering cooling and lubricating oil from one end of the hollow shaft axially through the hollow tube to a
- 15 drive unit at the other end of the hollow shaft.
10. A rotor shaft assembly for an electrical machine, substantially as described herein with reference to the drawings.

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