

ELECTRICAL MACHINE

This invention relates to an electrical machine and, in particular, to an a.c. motor.

It is known that in operation electrical machines generate unwanted heat, for example from the resistance of windings, and from the friction in bearings. It is also known to provide cooling means e.g. a fan, to blow air through cooling ducts. For example GB-2115987 B discloses an a.c. motor having cooling ducts, some passing through the stator and others passing through the rotor.

It is an object of the present invention to provide for alternative or additional cooling.

In accordance with the invention an electrical machine comprises air direction means constructed and arranged to direct air current over the exterior of the machine.

The air direction means may cover at least part of the exterior of the machine and comprise a cowl, being either an extended part of or secured to a fan housing. The cowl may extend from the fan housing located at one end of the machine and over at least part of the exterior of the machine, a gap e.g. a channel being provided between the cowl and the exterior.

The cowl may be secured to any suitable part of the machine. For example if the machine comprises an a.c. motor having a stator and a rotor, each comprising laminations, the cowl may be secured to the stator laminations, to a pressure plate for holding the stator laminations together, or to a bracket, at one end of the motor.

The air direction means may comprise an air baffle situated within the fan housing and be of frusto conical or cylindrical shape. The baffle may be integrally formed within the housing or attached thereto.

The air direction means, particularly the cowl or the baffle, may also direct air through at least one hole in the machine e.g. in the stator laminations, in the rotor laminations and/or in between the stator and rotor.

The air direction means may comprise at least one projection secured to, or formed on or located immediately adjacent the exterior of the machine

causing the cooling air to 'scrub' the exterior surface. The projection may define one or more channels through which the air passes and may be formed integrally with the cowl, with an end bracket, with a pressure plate or with some or all of the laminations.

A stator winding protection cowl may be provided to cover the windings e.g. at each end of the stator. This cowl may be connected to an end bracket, to a pressure plate or to the stator itself.

A terminal board may be provided completely enclosed within one of two brackets. The terminal board may be secured to part of a bearing supported by the one of the two brackets and within which a shaft supporting the rotor rotates.

One embodiment of the invention, an a.c. induction motor, will now be described by way of example only with reference to the accompanying drawings of which:-

Figure 1 shows a longitudinal cross-section through an electrical machine; in this instance an a.c. induction motor, according to the invention;

Figure 2 shows a cross-section through the stator lamination pack on line II-II of Figure 1;

Figure 3 shows a perspective view of the stator lamination pack;

Figure 4 shows a perspective view of a pressure plate; and

Figure 5 shows a perspective view of a modified form of fan and cowl.

The a.c. induction motor shown in the drawings, particularly in Figure 1, comprises a rotor 10 mounted on a shaft 11 which is rotatable about an axis O-O in bearings 12, 13 located one in each of two end brackets 14, 15, and a laminated stator 16, sandwiched between two pressure plates 17, 18, each of which supports one of the two end brackets 14, 15.

The rotor 10 comprises a plurality of circular or salient pole laminations stamped from electrical steel plate and held between end rings 19, 20. Slots (not shown) are provided in the laminations and extend radially inwards from the lamination periphery. Conductor bars 21 are formed in the slots, the end rings 19, 20 and conductor bars 21 being formed of aluminium alloy by die-casting to form a known squirrel cage construction. The rotor laminations are also provided

with a plurality of circumferentially spaced-apart cooling ducts 22, one of which is shown on Figure 1. The laminated rotor 10 and rotor end rings 19, 20 are all fixed to the shaft 11 to rotate therewith.

The stator 16 has no enclosing shell and comprises a plurality of laminations, each one stamped from electrical steel plate and having the shape shown particularly in Figure 2. Each stator lamination is generally square, but with the four corners removed, so that in fact the overall shape is octagonal with four of the sides being much longer than the remaining four sides. The laminations are provided with eight cooling ducts 24, each of generally triangular outline. The cooling ducts are arranged in pairs, one pair being adjacent each short side. The laminations are sandwiched between pressure plates 17, 18, the assembly being securely held together by rods 25, passing through the cooling ducts 24 in the stator laminations and through corresponding ducts 29 in the pressure plates. The ends of the rods are screw-threaded and provided with nuts 28 for tightening against the pressure plates 17, 18, although one end of a rod may be headed and the other end provided with a tightening nut. Alternatively the stator laminations may be securely held between the pressure plates by cleats or welding. The pressure plates are also each provided with cooling ducts 29 which have substantially the same size and shape as, and are in alignment with, the cooling ducts 24 in the stator laminations.

As can be seen in Figure 2, the stator laminations comprise a central circular hole 33 within which the rotor rotates and a plurality of slots 34 radiating from the circular hole. These slots are filled with the stator windings 35 shown in Figure 1.

Secured one to each of the pressure plates are two end brackets 14 and 15 having the same generally square shape and size as the pressure plates 17 and 18 in the stator 10. Each end bracket 14, 15 has an end portion 30, 31 extending perpendicular to the shaft 11. Each end portion 30, 31 contains and supports a bearing 12, 13 for rotatably supporting the shaft. The end portion 30 on one end bracket 14, (on the left hand side of Figure 1) has a terminal board inside the chamber formed by the end bracket 14, the terminal board having terminals mounted on an adaptor plate which also acts as an end support for the

bearing 12. The connecting leads (not shown) from the stator windings 35 run directly to the board through an orifice 37 in a winding protection cowl 38 positioned within the end bracket, and also connected to the pressure plate 17. The shaft extends through a central aperture 39 in the protection cowl. Cables (not shown) bringing power from an external source to the terminal board pass through a gland (not shown) in the appropriate parts of the end brackets 14, 15. The provision of the terminal board within the end bracket chamber eliminates the use of a conventional externally disposed terminal box and the problems associated with the box being in a suitable position (top, right-hand side or left-hand side) met with in practice.

The other end portion 31 on the other end bracket 15 (on the right-hand side of Figure 1) is provided with apertures 40 through which cooling air may be fed from a fan 41 located beyond the bracket 15. The fan 41 is electrically energised separately from the ac motor and may alternatively be side mounted.

The fan 41 is located so as to rotate about the same axis 0-0 as the shaft 11, and within a housing 69 of moulded plastics or fabricated material. The housing 69 has a mesh 42 in an end wall 43 perpendicular to the axis 0-0 through which air may be drawn and forced in a generally axial direction over the exterior of the motor and through the various cooling ducts. The housing has a cross-sectional shape which is approximately the same as that of the end bracket 15 but has the horizontal long top side 44, two vertical long sides 45, 46 and four diagonal short sides 47, 48, 49, 50 larger than the corresponding sides of the end bracket 15, pressure plates 17, 18 and stator 16, as can be seen in Figure 2. The top horizontal long side 44, the two vertical long sides 45, 46 and the upper two short sides 47 and 48 are all extended as shown, particularly in Figure 5, to form a cowl 60 which covers the top and two sides of the end bracket 15. Gaps are formed between the inside surfaces of the cowl and the adjacent sides of the bracket, but no gap is formed at the lower long horizontal side 51 where the edge 52 of the housing slightly overlaps the bottom of the end bracket 15. Alternatively a small gap may be formed at the lower long horizontal side 51, the edge 52 not overlapping the bottom of the end bracket 15. A short cylindrical baffle 54 is moulded with or connected to the interior of the end wall

43 of the fan housing, the baffle surrounding the fan blades. The radially inner surface 55 of the baffle is frusto conical to assist in guiding air towards the motor.

The long sides of the two end brackets 14, 15 of the pressure plates 17, 18 and the laminated stator 16 are all provided with two projections 53, 56. The projections are arranged in lines parallel to the axis 0-0 of the motor and act as guides for air blown by the fan, through the gaps between the cowl 60 and the end bracket 15 and axially along the outer surface of the motor, particularly the stator 16. Channels for guiding the air are thus formed between adjacent projections.

The projections 56 at the base provide elongated feet for the motor to rest on a supporting horizontal surface and because no cowl is provided at the base, no air is guided there from the fan unless a small gap is left at the edge 52 of the lower side 51.

In use the fan 41 causes air to be drawn through the mesh 42 in the housing 69 and forced axially over the surface of the motor through the channels between the projections 53 (and 56 if the small gap is left at the edge 52 of the lower side 51), through the apertures 40 in the end brackets and thence through the ducts in the rotor, through the gap between stator and rotor, or through the ducts 29, 24 in the pressure plates and stator. The air may be caused to flow in the reverse direction.

A winding protection cowl may be provided to cover the right hand stator windings as shown in Figure 1 similar to the cowl 38 shown covering the left-hand windings.

In a modification the projections 53 on the top and side surfaces of the right-hand end bracket are omitted. Instead corresponding projections 70 are moulded with or secured to the interior of the cowl, as can be seen in Figure 5.

The invention may be adopted for all other types of electrical machines with laminated stator frame design, both ac and dc. This includes cylindrical, salient and non-salient poles stator/rotor as well as different number of poles and phase windings.

**CLAIMS:**

1. An electrical machine comprising air direction means constructed and arranged to direct air current over the exterior of the machine.
2. An electrical machine according to claim 1 wherein the air direction means covers at least part of the exterior of the machine.
3. An electrical machine according to claim 2 wherein the air direction means comprises a cowl, being either an extended part of or secured to a fan housing.
4. An electrical machine according to claim 3 wherein the cowl extends from the fan housing located at one end of the machine and over at least part of the exterior of the machine, a gap being provided between the cowl and the exterior.
5. An electrical machine according to claim 3 or 4 wherein the electrical machine comprises in a AC motor having a stator and rotor each comprising laminations, the cowl being secured to the stator laminations, to a pressure plate for holding the stator laminations together or to a bracket at one end of the motor.
6. An electrical machine according to any one of claims 3 to 5 wherein the air direction means comprises an air baffle situated within the fan housing and being of frusto conical or cylindrical shape.
7. An electrical machine according to claim 6 wherein the baffle is integrally formed within the housing or is attached thereto.
8. An electrical machine according to any one of the preceding claims wherein the air direction means also directs air through at least one hole in the machine.
9. An electrical machine according to any one of the preceding claims wherein the air direction means comprising at least one projection secured to or formed on or located immediately adjacent the exterior of the machine.
10. An electrical machine according to claim 9 wherein the projection may define one or more channels through which the air passes.
11. An electrical machine according to any one of the preceding claims

comprising a stator with windings and a stator winding protection cowl at least one end thereof.

12. An electrical machine according to claim 11 wherein the cowl is connected to a end bracket, to a pressure plate or to the stator itself.
13. An electrical machine according to any one of the preceding claims comprising two brackets and a terminal board completely enclosed within one of the brackets.
14. An electrical machine substantially as described herein with reference to and is illustrated in the accompanying drawings.