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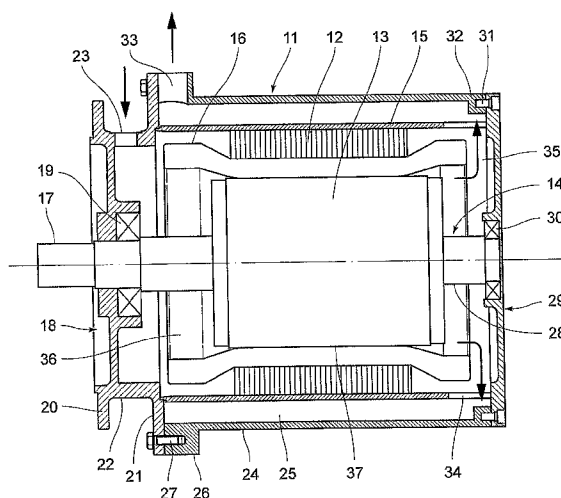
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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: DEVICE FOR COOLING OF ELECTRIC MOTORS



(57) Abstract: Arrangement at an electric motor with a tubular motor housing (15) which at each end is covered by a closed cover (18, 29) with bearings. The motor housing is carrying a rotor (13) which is arranged within or around a stator (12) with an interposed air gap (37). A cooling fluid is pumped through a chamber (36) at one end of the motor and through the magnetic air gap (37) between the stator and the rotor. From an outlet (33) heated cooling fluid is withdrawn for circulating and cooling in a cooling system. The cooling is improved if at least a part of the electric motor is surrounded by a cap (24) providing a conduit for circulating cooling fluid. It is an advantage if the motor housing is surrounded by a tubular cap (24) providing a conduit for circulating cooling fluid.

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Device for cooling of electric motors

The invention relates to a device as stated in the introductory part of claim 1, for cooling of
5 electric motors. More specifically, it relates to a device for cooling of electric motors with a
tubular housing which at each end is covered by a closed cover with bearings, for
receiving a rotor which is arranged within or around a stator with an interposed air gap,
and wherein a cooling fluid is provided for pumping through a chamber at one end of the
motor, wherein heat from the electrical components is drained to the cooling fluid, said
10 cooling fluid being circulated through the magnetic air gap between the stator and the
rotor, an outlet being arranged for withdrawing heated cooling fluid for recirculating and
cooling in a cooling system. The invention should be suitable both for electric motors with a
stator enclosing the rotor, and motors where the rotor encloses the stator.

15 Background

From WIPO Publication WO 2005/119883 (Rapp Hydema 2005) it is known to pump
cooling fluid through the air gap between the stator and rotor of an electric motor. This can
provide a simple and relatively effective cooling which can be used in a cooling circuit. This
device however has its limitations.

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Objects

The main object of the invention is to provide a device which can increase the cooling
effect without substantial costs. Particularly, it is an object to increase the heat exchanging
area without substantial increase in the overall dimensions of the electric motor.

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Further, it is an object to utilize existing basic elements of electric motors, to lower the
costs.

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To increase the efficiency in heat exchange, and the cooling respectively, it is desirable to
extend the cooling surfaces to comprise external surfaces.

It is desirable to provide a motor with reduced noise, which is particularly of importance for
rotating frequency converters.

35 A particular object is to provide a motor suited for use at high ambient temperatures.

The Invention

The invention is stated in claim 1. The main feature is that at least a part of the electric
5 motor is enclosed in a cap providing a channel for a flow of cooling fluid.

The invention provides an electric motor based mainly on prior art parts and still brings a substantially improved cooling.

10 Correspondingly to the cooling method described in WO 2005/119883, the pumping of cooling fluid through the air gap between the stator and rotor occurs without undesirable braking effect up to a speed of ca. 1500 RPM. At higher speeds, the braking effect will increase exponentially. This will allow the motor according to the invention to be operated with the advantages mentioned in the most preferred range of use, i.e. at low rotation
15 down to stagnation. Simultaneously a braking effect is achieved, which will prevent racing, e.g. by releasing from a winch.

An important advantage of the invention, in addition to efficient cooling, is the possibility to allow cooling in different areas and modes of operation by use of the cooling channels,
20 with alternating serial and parallel connection and interchanging the flow. This allows provision of different cooling characteristics. At the extremity cooling the stator is most efficient, where most heat loss is generated, with the windings as a heat sensitive part. At another extremity cooling the cap is most efficient. This is most of interest in a hot environment. Details are given in the Examples.

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The invention allows for a controlled release of energy from the motor, making a utilization of the heat for practical purposes possible, avoiding loss of energy.

It is particularly advantageous for manufacturing reasons, if the housing of the motor is
30 surrounded by a tubular cap providing an annular channel as stated in claim 2. Thus the main part, i.e. the rotor, stator, and a motor housing of a prior art motor be used.

To adapt the cooling to various purposes, the tubular channel may be placed serially to the air gap between the stator and rotor, as stated in claim 3, or parallel as stated in claim 4.

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It is particularly advantageous when the cooling fluid is pumped through the air gap

between stator and rotor before being conducted through the annular channel surrounding the motor housing, as stated in claim 5. This will release the heat from the stator and the windings most efficiently. But it is also possible to pump the cooling fluid in the opposite direction, e. g. when the tubular cap is heated and is to be cooled.

5

When introducing and withdrawing cooling fluid at the same end of the motor, as stated in claim 6, the connection to the outer part of the cooling system may be simplified.

It is advantageous if at least one cover has an axial web with one or more sockets for connection to a cooling system, as stated in claim 7.

10

More details on the invention and more about the significance of the various features will appear from the following description of an example.

15 **Example**

The invention is described with reference to the drawing, which shows an axial section through an electric motor according to the invention.

The Figure shows an electric motor 11 with a stator 12 accommodating a rotor 13 with a passing shaft 14. The stator 12 is surrounded by a tubular cover 15 providing a motor housing. The stator 12 has windings 16 in slots according to prior art.

20

At the powering end 17 of the shaft 14, the motor housing 15 is closed with a first cover 18 with a bearing 19. The cover 18 has an axially outer radial mounting flange 20 for mounting to a carrying structure (not shown) and an axially inner carrying flange 21 adjoining closely the juxtaposed end of the motor housing 15. Between the mounting flange 20 and the carrying flange 21, the cover 18 has an annular wall 22. In this wall 22, a number, e.g. four, threaded holes are distributed around the circumference, for attaching a sleeve coupling to connect to a cooling system of the kind shown in WO 2005/119883.

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The motor housing 15 is surrounded by a tubular cap 24 providing an annular channel 25. The annular cap 24 bears against the carrying flange 21, where a carrying ring 26 is welded or provided by moulding, for holding a series of axial mounting bolts 27 extending through the carrying flange.

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At the rear end 28 of the shaft 14, a second cover 29 with a bearing 30 is arranged, with

axial bolts 31 into an annular reinforcement 32 arranged inside the tubular cap 24.

The covers 18 and 29 together with the motor housing 15 is a closed unit carrying the operative parts of the motor, i.e. the stator 12 and rotor 13, with the shaft 14 and the bearings 19, 30.

A number, e.g. four, of distributed threaded holes 33 radially in the ring 26, provides access to the annular channel 25 for connecting to a cooling system as mentioned above. In the example, one of said holes will provide outlet for cooling fluid, while the rest are plugged.

At its rear end the motor housing 15, may have a series, e.g. four, openings 34 connecting a rear motor chamber 35 with the annular channel 25. Thus, connection for the flow of cooling fluid from the inlet 23, through an outer motor chamber 36, through the magnetic air gap 37 between the stator 12 and the rotor 13, through the openings 34, through the annular channel 25 and to the outlet 33 is provided.

The magnetic air gap 37 may have a thickness of 0,4 – 1 mm, particularly 0,5 – 0,7 mm. By this dimension, the cooling fluid will cause braking at a rotation over ca. 1500 RPM. Thus, the cooling fluid will cause no remarkable energy loss in the range of rotation normal for most uses, while causing braking when the rotation is exceeding ca. 1500 RPM. Hydraulic oil may be used as cooling fluid.

Modifications

The embodiment of the example may be modified by reversing the flow of cooling fluid, by changing the inlet 23 and the outlet 33. It is also possible to make both openings 23 and 33 be inlets or outlets, a further opening at the other end of the motor, e.g. at the rear cover 29, being connected to the cooling circuit. Said paths of flow will then be parallel.

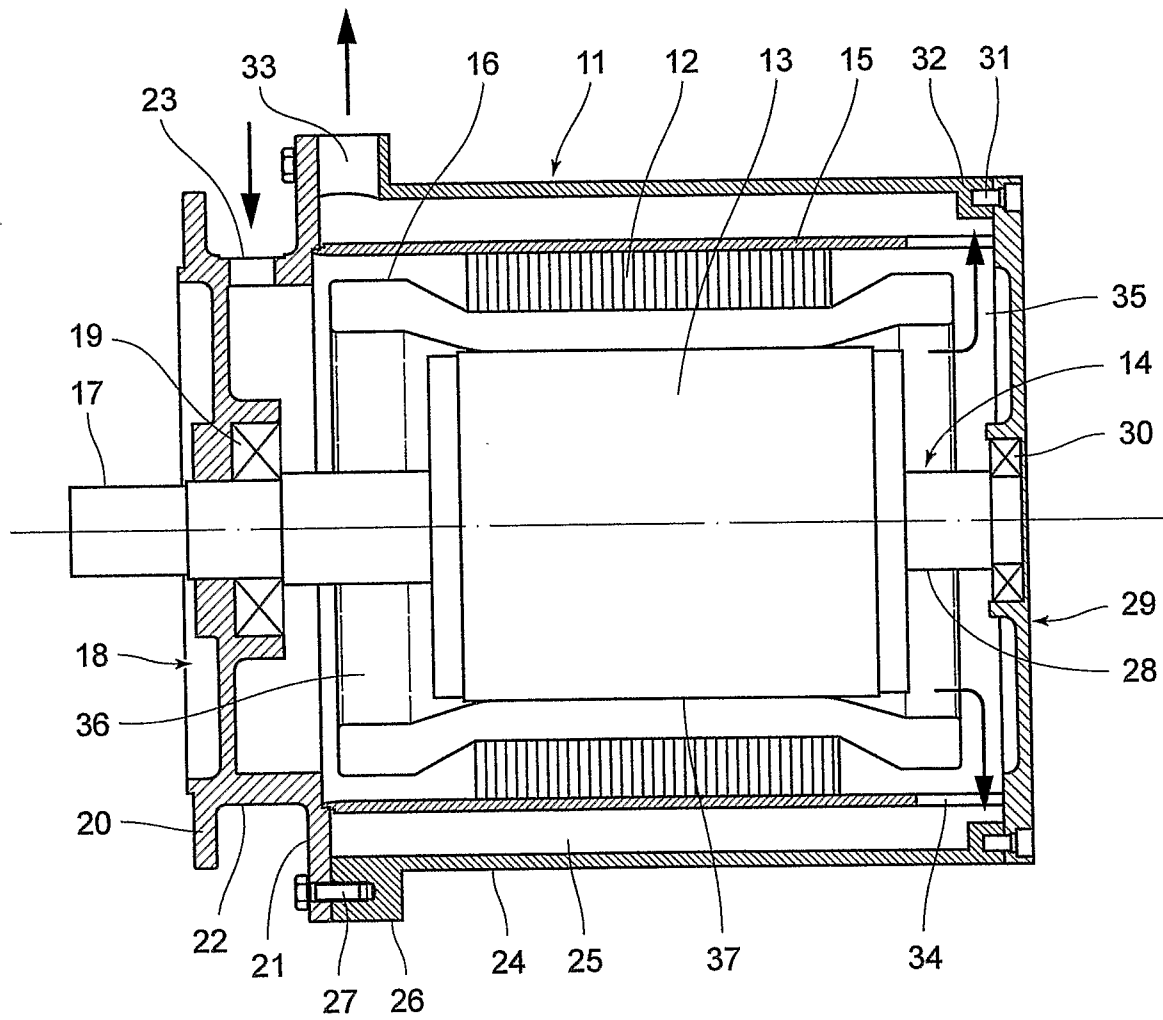
The invention may also be used when the motor is connected to a gear with hydraulic fluid, which can be used as cooling fluid. It will be possible to connect both inlet and outlet directly to such a gear.

The invention may also be used with motors with an inner stator and an outer rotor, e.g. wheel motors.

Claims

1. Device for cooling of electric motors with a tubular housing (15) which at each end is covered by a closed cover (18, 29) with bearings, for receiving a rotor (13) which is arranged within or around a stator (12) with an interposed air gap (37), and wherein a cooling fluid is provided for pumping through a chamber (36) at one end of the motor, wherein heat from the electrical components is drained to the cooling fluid, said cooling fluid being circulated through the magnetic air gap (37) between the stator and the rotor, an outlet (33) being arranged for withdrawing heated cooling fluid for recirculating and cooling in a cooling system, **characterized** in that the stator (12) is associated with an axial channel (25) connected to the channel provided by the tubular magnetic air gap (37), for circulation of cooling fluid.
2. Device according to claim 1, with an outer stator (12), **characterized** in that the housing (15) of the motor is surrounded by a tubular cap (24) providing an axial annular channel (25).
3. Device according to claim 2, **characterized** in that the annular channel (25) provided by the tubular cap (24) is serially connected to the air gap (37) between the stator and the rotor.
4. Device according to claim 2, **characterized** in that the annular channel (25) provided by the tubular cap (24) is connected in parallel to the air gap (37) between the stator (12) and the rotor (13).
5. Device according to claim 3, **characterized** in that the cooling fluid is pumped through the air gap (37) between the stator (12) and the rotor (13) before it is fed to the axial annular channel (25) surrounding the motor housing (15).
6. Device according to one of the claims 1 to 5, **characterized** in that the inlet and the outlet for cooling fluid are arranged at the same end of the motor.
7. Device according to one of the claims 1 to 6, **characterized** in that at least one cover (18) is provided with an axial wall (22) with at least one outlet (23) for connecting to a cooling system.

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/NO2007/000075

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: H02K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim. No.
X	US 6489697 B1 (MASARU OZAWA ET AL), 3 December 2002 (03.12.2002), column 3, line 1 - line 2; column 3, line 9 - line 26; column 3, line 35 - line 42, page 6, line 36 - line 67; page 7, line 13 - line 17; figure 1,2 -- -----	1-7

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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Paper copies can be ordered at a cost of 50 SEK per copy from PRV InterPat (telephone number 08-782 28 85).

Cited literature, if any, will be enclosed in paper form.

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Information on patent family members

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