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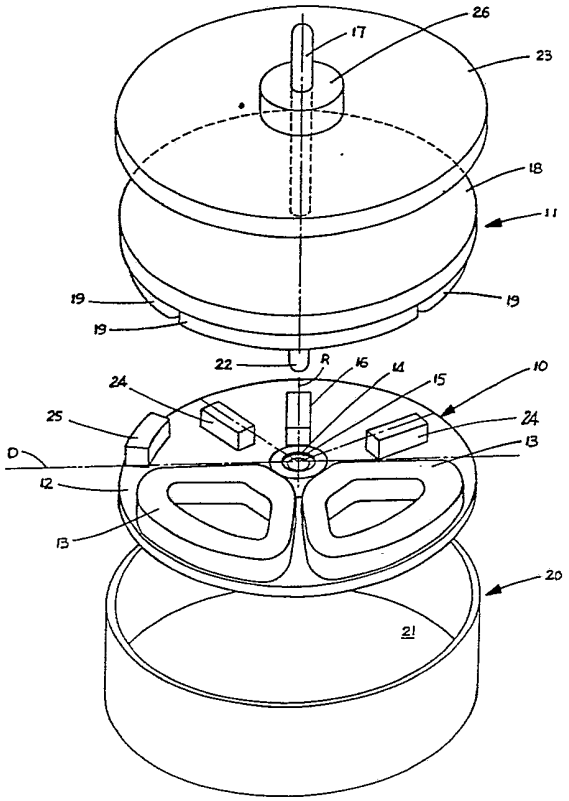
(54) Brushless d.c. electric motor

(57) In an axial air gap brushless d.c. electric motor, the winding coils (13) are disposed on one side only of a diameter (D) of the stator (10) so that position detecting means, typically a Hall I.C. (16), can be on the other side of the diameter (D) at a position where the magnetic flux passing through it is changing from one direction to the other when rotor magnets (19) are directly over the winding coils. This ensures that the windings switch at zero torque positions.



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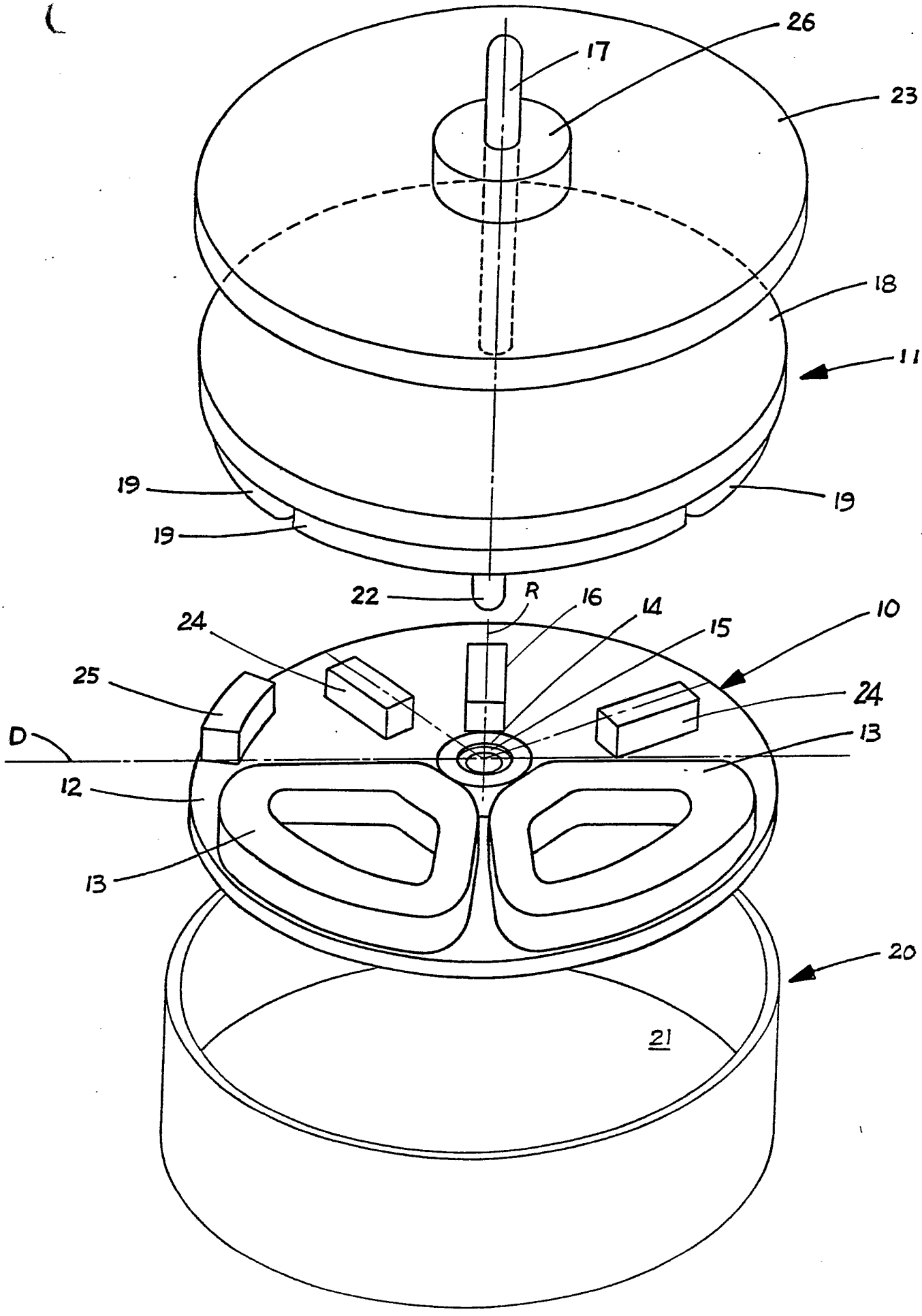

Brushless d.c. electric motor

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This invention relates to an axial air gap brushless d.c. motor.

Single phase bi-polar or two phase uni-polar windings are sometimes preferred to three phase windings in brushless motors because less positional detectors are required thus reducing the cost of the electronic components.

Known motors of this type comprise a number of winding coils arranged symmetrically about the axis of the motor. It is very preferable to switch the winding coils at zero torque positions, i.e. when the magnets are directly over the winding coils, because if the winding coils do not switch at zero torque and the rotor comes to rest in a position in which negative torque is developed on re-start there is a tendency for the motor to oscillate on start up. Moreover, when the motor is rotating the mean torque developed will be diminished by the presence of any negative torque regions. In order to ensure that the windings switch at zero torque positions the positional detector has to be sited in a position

where the magnetic flux passing through it is changing from one direction to the other when magnets are directly over the winding coils. In known motors, the winding coils occupy these positions and therefore it has been necessary to increase the axial air gap or the diameter of the motor.

In seeking to mitigate this drawback, the invention provides an axial air gap brushless d.c. motor comprising a stator, a permanent magnet rotor, a winding on the stator, means detecting the position of the rotor relative to the stator, and means for energising the winding in response to said detecting means, wherein the winding comprises winding coils disposed on one side only of a diameter of the stator and wherein the detecting means is disposed on the other side of said diameter.

Typically, the motor has two winding coils on said one side of said diameter, each substantially occupying a ninety degree sector, and in this case the detecting means is disposed on the other side of said diameter and on a radius normal thereto.

The invention will now be more particularly described, by way of example, with reference to the accompanying drawing which is an exploded view of one embodiment of an electric motor according to the invention.

Referring to the drawing, the motor shown therein comprises a stator 10 and a rotor 11. The stator comprises a disc-like winding support 12, typically of plastics material, and two discrete winding coils 13 fixed to the support, such as by glue. The support has a central hole 14 in which a journal bearing 15 is mounted. A positional detector 16 and electronic switches 24 are also mounted on the support 12.

The rotor 11 comprises a shaft 17 mounted for rotation in the bearing 15 and a disc-like metal plate 18 supporting four segmental permanent magnets 19. The magnets 19 are glued to the plate 18 and adjacent magnets are magnetised in opposite axial directions.

The stator 10 and rotor 11 are mounted in a drawn shallow metal can 20 closed at one end by an integral end plate 21 which provides a thrust face for a ball end 22 of the rotor shaft 17. The can is closed at its other end by a metal end cap 23 having an integral bearing retainer 25 for a further journal bearing (not shown).

The centres of the two winding coils 13 are geometrically spaced apart by 90 degrees and are disposed on one side of a diameter D of the stator 10. The positional detector 16, preferably in the form of an integrated circuit including a Hall effect device, is disposed on the other side of the diameter D and on a radius R normal to the diameter D.

The winding coils 13 are energised alternately by the switches 24 in response to the positional detector 16, the switches 24 being also conveniently disposed on the said other side of the diameter D.

All connections between the winding coils 13, positional detector 16, and switches 24 are on the underside of the support 12 and are thus not visible in the drawing.

When an adjacent pair of magnets 19 are directly above respective winding coils 13 the positional detector 16 will be directly below the interface between the other two magnets i.e. at a position in which it is about to become predominantly under the influence of an opposite magnetic pole. Immediately thereafter the detector will operate the switches 24 to de-energise one and energise the other of the coils 13. The winding coils 13 are thus switched at substantially zero torque positions.

If the motor were to come to rest at a zero torque position it may not start when power is switched on. Thus a low reluctance member 25 is mounted on the support 12 so that the magnetic coupling between the magnets 19 and the member 25 will always cause the rotor to cog to a start position when power is switched off, i.e. to a position in which torque will be developed when the power is next switched on.

As described above the winding coils 13 are alternately energised. However, the two winding coils 13 could be wound in opposite directions and series connected to form a single phase bi-polar winding through which current flow is reversed by

electronic switches in response to the positional detector 16. Moreover, there could be more than two winding coils on said one side of the diameter D.

The above embodiments are given by way of example only and various modifications will be apparent to persons skilled in the art without departing from the scope of the invention defined by the appended claims.

Claims

1. An axial air gap brushless d.c. electric motor, comprising a stator, a permanent magnet rotor, a winding on the stator, means detecting the position of the rotor relative to the stator, and means for energising the winding in response to said detecting means, wherein the winding comprises winding coils disposed on one side only of a diameter of the stator and wherein the detecting means is disposed on the other side of said diameter.

2. An electric motor as claimed in claim 1, wherein the motor has two and only two winding coils on said one side of said diameter and the detecting means is disposed on the other side of said diameter and on a radius normal thereto.

3. An electric motor as claimed in claim 1 or claim 2, wherein the detecting means includes a Hall effect device.

4. An electric motor as claimed in claim 1, claim 2 or claim 3, wherein the energising means comprises electronic switches also disposed on said other side of said diameter of the rotor.

5. An electric motor as claimed in any one of the preceding claims, wherein the winding and position detecting means are mounted on a disc-like support.

6. An axial air gap brushless d.c. electric motor, substantially as hereinbefore described with reference to the accompanying drawing.

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