AXIALLY COMPACT SMALL FAN

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Related U.S. Patent Documents

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ABSTRACT

A flat portable fan with an impeller on a motor shaft and a commutatorless direct current motor is provided having a printed circuit board in the stator and an axially magnetized permanent magnet in the rotor. The circuit board comprises a printed circuit having electronic components of the fan drive and is made from an iron base material with an insulating layer, which carries the stator windings and an axial starting bearing for the rotor. The impeller is mounted in a cylindrical rotor mounting support and is driven by the axially magnetized permanent magnet. The iron base material and the permanent magnet substantially define a planar air gap.
Fig. 4
AXIALLY COMPACT SMALL FAN

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

The invention relates to a flat or shallow constructed small or portable fan with an impeller or fan wheel on a motor shaft and with a commutatorless direct current (d.c.) motor as the drive. The said direct current motor has only one coil on a circuit board in the stator. The rotor has an axially magnetized permanent magnet.

Such fans are known from German Utility models G 87 02 271 and G 87 14 988.

The known fans are characterized by a relatively small volume. However, an even flatter fan construction is required for various applications, also in connection with measures for minimizing sound transmission from the fan to the environment.

The problem of the invention is to make such a fan more compact in the axial direction, while simultaneously reducing manufacturing costs.

In order to solve this problem, the invention provides a configuration of the fan drive and the fan in which the radial and the axial direction are taken into account. The arrangement of the driving coil, driving electronics and magnetic yoke is kept axially compact through the use of a printed circuit board, and iron is used as the so-called base material. The overall height of the portable fan is less than 30 mm.

Further details, features and advantageous developments of the invention can be gathered from the non-limitative embodiment described hereinafter, the claims and the attached drawings, wherein:

FIG. 1 is a cross-section through a portable fan with a commutatorless drive motor;

FIG. 2 is a sectional view displaced relative to FIG. 1;

FIG. 3 is an exploded view better showing details of FIG. 2.

FIG. 4 is a circuit for operating the drive motor; and

FIG. 5 is a sectional view of a fan, similar to that of FIG. 2 but with an alternative construction of the motor casing. FIGS. 1, 2 and 3 show the following details of the fan.

An impeller 2 is mounted on a shaft 13 and driven by a four-pole permanent magnet 15. Air is sucked in through an opening 6a in a casing 6 positioned above the shaft 13 and is blown out laterally via radially positioned opening 6b of the casing 6.

The casing can be fixed to a printed circuit board 1 by an inwards or outwards directed snap-action connection 43 (FIG. 2) or 44 (FIG. 1). The printed circuit board 1 is made from iron as the base material with a laminated insulating layer and printed or etched on conductors 18, which contact electric circuit components 17.

The printed circuit board 1 also has grooves or depressions 40 in which are located permanent magnets 16. When no current is applied to the drive motor a working permanent magnet 15 of the impeller 2 is brought into a clearly defined starting position by the field of the magnets 16.

The printed circuit board 1 also carries an oval or elliptical coil 10 which may be, for example, a bifilar winding or a monofilar winding with an open center tap. The coil wire ends are fixed to connection points 30, 31, 32, 34 (cf. FIG. 3). The coil 10 surrounds a bearing tube 12 which carries the shaft 13 and which is constructed, for example, [for example as a sintered part or as a plastic moulding. The bearing tube 12 is additionally supported at a point spaced from the printed circuit board 1, by a supporting member 11, which is engaged by its terminal protuberances 21 in recesses 20 of the circuit board.

The impeller 2 is fixed by conventional technology to the shaft 13. The supporting member 11 has a centrally positioned opening 11a for receiving an upper, tubular portion 12a of the bearing tube 12. The member 11 also has widened feet 11b for engaging in planar manner on the circuit board 1. With its central opening the coil 10 can be placed accurately around the feet 11b of the supporting member 11. Recessed 23 positively allow an alignment of a foot 22 of the bearing tube 12 with respect to the printed circuit board 1.

The shaft 13 of the impeller 2 mounted by the bearing tube 12 carries at the lower end an abutment ring 5, a retaining ring 4, and a track cap 13a of the shaft 13 runs on the bearing part 3, which substantially constantly absorbs the axially directed force caused by the working magnet 15 and the iron yoke of the circuit board 1. The track cap 13a and the bearing part 3 form a starting bearing. The bearing part 3 is preferably snapped in and has snap-action projections 41 or 42, which engage in recesses 42 (FIG. 3).

When current is applied to the coil 10 a magnetic field is formed, which has opposite polarity inside and outside the coil. As a result of the diverging magnetic field of the coil 10, and as a function of the direction of the coil current, the working magnet 15 of the impeller 2 is positioned in such a way that its north pole surfaces point towards the south pole regions of the coil or vice versa. In order to improve the motor efficiency the four-pole, axially magnetized magnet 15 preferably has an iron yoke member 14.

The auxiliary magnets 16 are so positioned that on switching on there is a rotary movement of the impeller 2. Simultaneously the working magnet 15 induces a voltage in part of the coil 10, so that the coil current is interrupted by series-connected electronic circuits and the impeller 2 can continue to rotate freely.

After a certain time the phase position of the induced back-emf is reversed, so that the electronic circuit again allows current to be applied to the coil and the impeller can rotate on. Thus, starting can take place in both rotation directions, so that the blades of the impeller 2 are radially positioned. The air speed is increased in each drive motor rotation direction and a uniform airflow is produced in the circular shape of the coil 10, and as a function of the direction of the coil current, the working magnet 15 of the impeller 2 is positioned in such a way that its north pole surfaces point towards the south pole regions of the coil or vice versa. In order to improve the motor efficiency the four-pole, axially magnetized magnet 15 preferably has an iron yoke member 14.

When current is applied to the coil 10 a magnetic field is formed, which has opposite polarity inside and outside the coil. As a result of the diverging magnetic field of the coil 10, and as a function of the direction of the coil current, the working magnet 15 of the impeller 2 is positioned in such a way that its north pole surfaces point towards the south pole regions of the coil or vice versa. In order to improve the motor efficiency the four-pole, axially magnetized magnet 15 preferably has an iron yoke member 14.

The auxiliary magnets 16 are so positioned that on switching on there is a rotary movement of the impeller 2. Simultaneously the working magnet 15 induces a voltage in part of the coil 10, so that the coil current is interrupted by series-connected electronic circuits and the impeller 2 can continue to rotate freely.

After a certain time the phase position of the induced back-emf is reversed, so that the electronic circuit again allows current to be applied to the coil and the impeller can rotate on. Thus, starting can take place in both rotation directions, so that the blades of the impeller 2 are radially positioned. The air speed is increased in each drive motor rotation direction and a uniform airflow is produced in the circular shape of the coil 10, and as a function of the direction of the coil current, the working magnet 15 of the impeller 2 is positioned in such a way that its north pole surfaces point towards the south pole regions of the coil or vice versa. In order to improve the motor efficiency the four-pole, axially magnetized magnet 15 preferably has an iron yoke member 14.

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the iron base material and the permanent magnet defining substantially a planar air gap.

3. Portable fan according to claim 1 or 2, wherein the stator windings are formed by an oval coil, the motor shaft is located approximately in the center of the coil, and further comprising magnetically acting means provided for a specific starting position of the rotor.

4. Portable fan according to claim 1 or 2, wherein the starting bearing for the rotor is formed by a plastic bearing supporting the motor shaft with a track cap.

5. Portable fan according to claim 4, wherein openings are provided in the circuit board, and motor casing parts are provided with projections which can snap into the openings in the circuit board.

6. Portable fan according to claim 4, wherein openings are provided in the circuit board, and motor bearing parts are provided with projections which can snap into the openings provided in the circuit board.

7. Portable fan according to claim 1 or 2, wherein the rotor mounting support has a bearing tube and a support member for the bearing tube.

8. Portable fan according to claim 7, wherein the bearing tube is formed by a sintered part and is inserted in non-rotary manner in an opening of the printed circuit board and is additionally retained and centered by the supporting member constructed as a plastic moulding.

9. Portable fan according to claim 8, wherein the supporting member for the bearing tube at the same time centers and orient the coil.

10. Portable fan according to claim 7, wherein openings are provided in the circuit board, and motor casing parts are provided with projections which can snap into the openings in the circuit board.

11. Portable fan according to claim 5, wherein openings are provided in the circuit board, and motor bearing parts are provided with projections which can snap into the openings provided in the circuit board.

12. Portable fan according to claim 5, wherein the bearing tube is formed by a plastic moulding and is inserted in non-rotary manner in an opening of the printed circuit board and is additionally retained and centered by the supporting member also constructed as a plastic moulding.

13. Portable fan according to claim 1 or 2, wherein openings are provided in the circuit board and motor casing parts are provided with projections which can snap into the openings in the circuit board.

14. Portable fan according to claim 1 or 2, wherein the electronic components are combined in an integrated circuit.

15. Portable fan according to claim 1 or 2, wherein the coil comprises a bifilar winding.

16. Portable fan according to claim 1 or 2, wherein axially the overall height of the portable fan is less than 30 mm.

17. Portable fan according to claim 1 or 2, wherein the impeller can start in both rotation directions and has radially oriented blades, the air being sucked in axially and blown out radially.

18. Portable fan according to claim 1 or 2, wherein the further comprising a casing having an outer circumference of the casing which is profiled by depressions for fastening therein the apparatus to be ventilated.

19. Portable fan according to claim 1 or 2, wherein openings are provided in the circuit board, and motor bearing parts are provided with projections which can snap into the openings provided in the circuit board.