

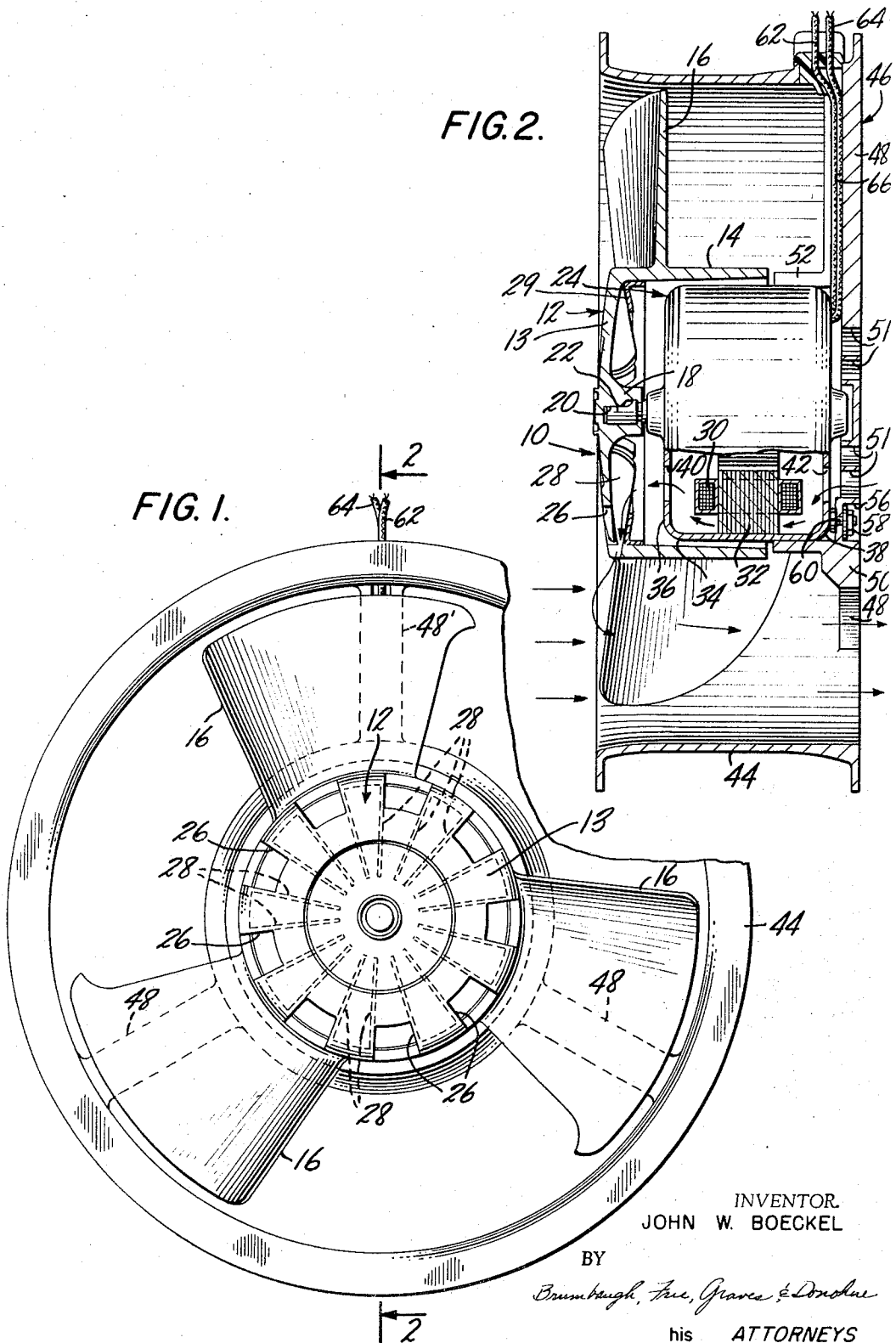
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FAN MOTOR COOLING ARRANGEMENT

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FAN MOTOR COOLING ARRANGEMENT

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6 Claims. (Cl. 230-117)

This invention relates to electric motor driven fans and, more particularly, to a novel and improved fan which is compact in size, particularly in the axial direction, and in which highly efficient means is provided for cooling the fan motor.

In many kinds of electrically driven fans, the drive motor for the propeller is located so that the fan itself forces air through or pulls air through the motor to cool it. For example, in one conventional type of axial flow fan, the propeller is carried at one end of the motor shaft, either upstream or downstream of the motor so that the air stream created by the propeller passes over the motor. The motor housing also is usually provided with suitable openings to allow the passage of air therethrough. In addition to the self-cooling provided by the air stream of the fan, the heat-conductive properties of the propeller dissipates a portion of the heat generated by the motor windings, and effective overall cooling is attained.

In one popular type of fan, however, the motor is located substantially entirely within a central hub which carries the propeller blades and thus is not in the path of the direct air flow provided by the propeller. Moreover, smaller fans of this and other types used for such purposes as cooling electronic devices generally are provided with lighter, less expensive plastic propellers, which, although equally efficient as metal propellers for providing air flow, are much poorer thermal conductors. Adequate cooling of this type of motor presents a very substantial problem, and there is a significant danger that the motor will overheat when heavily loaded or used in an unusually high-temperature environment.

This disadvantage of presently known fans of the above-described type is overcome by a novel and improved fan, in accordance with the invention. The propeller structure of the fan includes a rotatable central hub having a generally cylindrical sleeve portion extending axially from the upstream end of the fan, and carrying a plurality of fan blades on its outer surface. The fan motor is enclosed in substantial part by the sleeve, and the shaft of the rotor is coupled to the interior surface of the end wall of the hub. The end wall of the hub is provided with a plurality of centrifugal impeller vanes formed on its inner surface adjacent the motor at the upstream end of the fan, and a plurality of openings to permit air flow therethrough. The impeller vanes and openings in the hub end wall enable air to be drawn through the motor and to be discharged through the openings in the hub in a direction opposite to the main air flow generated by the propeller blades.

The above-described arrangement provides substantially improved motor cooling efficiency which increases with fan loading. The cooling air for the motor is drawn by the impeller vanes from the downstream side of the fan which is at a relatively high air pressure as compared to the upstream end at which the impeller vanes and discharge openings are located. Accordingly, the flow of cooling air through the motor is enhanced, rather than reduced, by the pressure differential across the fan created by the main air flow. As the loading of the fan increases, the pressure differential also increases, causing greater cooling air flow through the motor to compensate for the additionally generated heat. All of this is accomplished by a simple hub construction which carries both the pro-

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pellor blades and impeller vanes and which lends itself readily to integral molding out of inexpensive plastics.

For a better understanding of the invention, reference may be made to the following description thereof, taken in conjunction with the figures of the accompanying drawing, in which:

FIG. 1 is a front view of the fan in accordance with the invention, a segment of which is broken away for convenience of illustration; and

FIG. 2 is a side view in section of the fan taken generally along the line 2-2 of FIG. 1.

The fan illustrated is of the axial flow type of relatively small size such as would be suitable for cooling electronic devices, but it will be understood that the principles of the invention are equally applicable to larger fans. Referring to the drawing, the fan includes a propeller structure 10 having a central hub indicated generally at 12, which includes an end wall 13 and a generally cylindrical sleeve 14 extending axially from the perimeter of the end wall. A plurality, e.g., three, of axial flow propeller blades 16 are carried by and extend radially from the sleeve 14 for providing the main air flow. Extending axially from the center of the interior side of the end wall 13 is a cylindrical boss 18 which is provided with a bore 20 for receiving the end of the rotor shaft 22 of the fan drive motor 24, the shaft being arranged to be firmly retained in the bore 20 so that the hub and propeller structure rotates with the motor shaft. As shown by the arrows in FIG. 2, the propeller blades are arranged to generate a main air flow in a direction from the end wall of the hub towards its open end.

As best shown in FIG. 1, the end wall 13 of the hub is provided with a plurality of circumferentially spaced apart openings 26 adjacent its perimeter, thereby providing communication between the chamber defined within the hub and the upstream side of the air flow produced by the propeller blades 16. Additionally, the interior surface of the end wall 13 within the chamber is provided with a plurality of radially extending, straight centrifugal impeller vanes 28 which operate to draw air from the downstream side of the fan assembly through the interior of the hub chamber and force it radially outwardly through the openings 26. An annular shroud 29 may also be provided interiorly of the sleeve 14 adjacent the vanes 28 to prevent recirculation of exhaust air.

As previously mentioned, the impeller is preferably made of plastic, and the hub 12, end wall 13, sleeve 14, propeller blades 16, and vanes 28 may all be formed integrally, such as by molding, so that the propeller structure 10 is a single piece. The shroud 29 may be separately formed and cemented in place when used. It will be apparent, of course, that the propeller structure may be of metal or other materials and may be an assembly of parts, rather than an integrally formed element.

The drive motor 24 for the fan may be of any suitable A.C. or D.C. type, but is preferably of open design, that is, the stator coils 30 and core 32 are designed to permit the passage of air around the coils as much as possible. The motor 24 may include an outer case 34 having opposite ends 36 and 38, each of which is provided with a plurality of openings 40 and 42.

The fan is supported within a Venturi ring 44 which may desirably be made of plastic and which in addition to providing more efficient air delivery, acts as a mounting element for the entire fan assembly. The ring 44 is affixed to or formed integrally with a motor support structure 46, which includes a plurality of radially extending spokes 48 and a central support disc 50 having an annular concentric flange 52 extending forwardly for snugly receiving the rear end of the motor 24. The

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disc 50 of the motor support 46 includes a plurality of openings 51 for communication at the downstream end of the fan with the motor and the chamber within the hub 12. The disc 50 is also provided with recesses 56 which receive nuts 58 threaded onto studs 60 extending rearwardly from the motor to mount the motor on the support structure 46. Leads 62 and 64 of the motor are passed through a channel 66 formed in one of the spokes 48' of the support structure 46.

In operation, rotation of the propeller structure 10 by the motor 24 produces generally axial flow, as represented by the arrows at the lower portion of FIG. 2, thereby creating a relatively lower pressure upstream, i.e., to the left in FIG. 2, and a relatively higher pressure downstream, i.e., to the right of the fan as shown in FIG. 2. The centrifugal vanes 28 draw air from the downstream, high pressure side of the fan, through the openings 51 in the disc 50 and over the motor windings via apertures 40, 42. At the upstream end of the hub, the air is forced out by the vanes through the peripheral openings 26 in the end wall 13, where it is quickly removed under the action of the main air stream. The pressure differential across the fan considerably enhances the flow of cooling air through the motor and thus enables a relatively large cooling effect to be achieved with a small area vane assembly.

It should further be noted that if an increase in the load on the fan occurs, such as from an increase in fan speed or downstream pressure, the pressure differential between the downstream and upstream sides of the fan correspondingly increases. This, in turn, further increases the flow of cooling air through the motor. Thus, the arrangement of the invention automatically adjusts the cooling action to compensate for changes in loading.

It will be understood that the above-described embodiment of the invention is merely by way of example, and that those skilled in the art will be able to make many modifications and variations of it without departing from the spirit and scope of the invention. All such modifications and variations are intended to be included within the scope of the invention as defined in the appended claims.

I claim:

1. A fan comprising a motor, a hub member substantially surrounding said motor including a hollow sleeve portion closed at one end by an end wall provided with a plurality of apertures adjacent its circumferential edge, a plurality of propeller blades on said

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sleeve portion, means coupling said hub member to one end of said motor for rotation therewith, said propeller blades thereby creating an air flow moving in a direction from said end wall to the other end of said sleeve portion, and centrifugal impeller means on the interior surface of said end wall for creating an air flow across said motor and within said hub member moving in a direction opposite to that of the air flow created by said propeller blades, said impeller means discharging its air flow through the apertures in said end wall.

2. Apparatus according to claim 1 wherein said impeller means comprises a plurality of radially extending vanes formed on the interior surface of said end wall.

3. Apparatus according to claim 2 further comprising annular shroud means mounted interiorly of the sleeve portion of said hub member adjacent said vanes, whereby return air flow from said impeller means across said motor is substantially prevented.

4. Apparatus according to claim 1 wherein said motor includes a housing and said housing is provided with apertures at both ends thereof to facilitate air flow across said motor.

5. Apparatus according to claim 1 further comprising mounting means for said fan including a disc-like element adapted to receive the other end of said motor, means to rigidly fasten said motor to said disc-like element, a mounting ring having an inner diameter greater than the diameter of the circle described by said propeller blades, and a plurality of support members extending radially from said disc-like element to said mounting ring.

6. Apparatus according to claim 5 wherein said disc-like element is provided with a plurality of apertures to enable the air flow created by said impeller means to pass therethrough.

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