May 19, 1953 C. F. GOEDE 2,639,087

AXIAL FLOW FAN

Filed Nov. 4, 1947

Fig. 1.

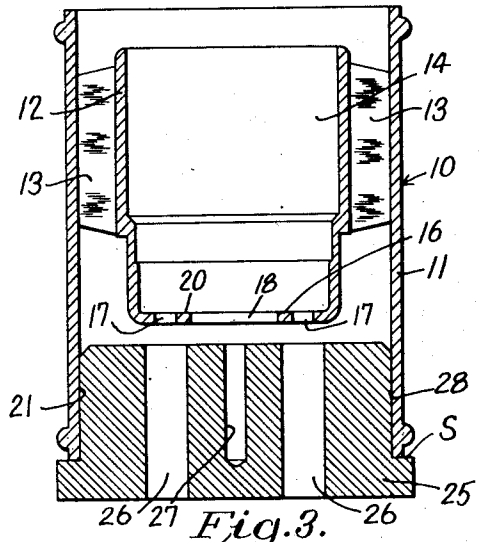


Fig. 2.

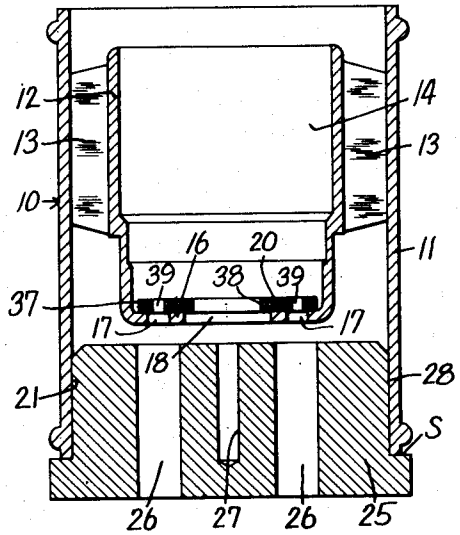


Fig. 3.

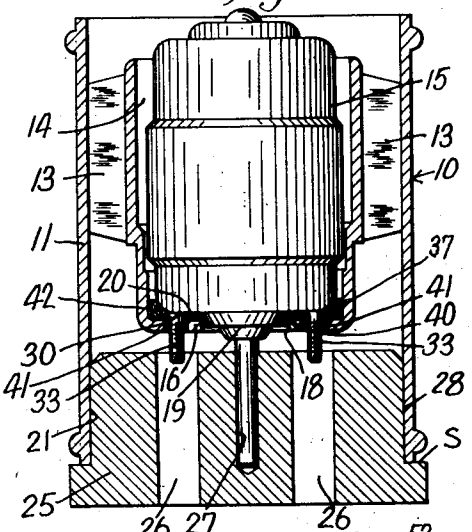


Fig. 4.

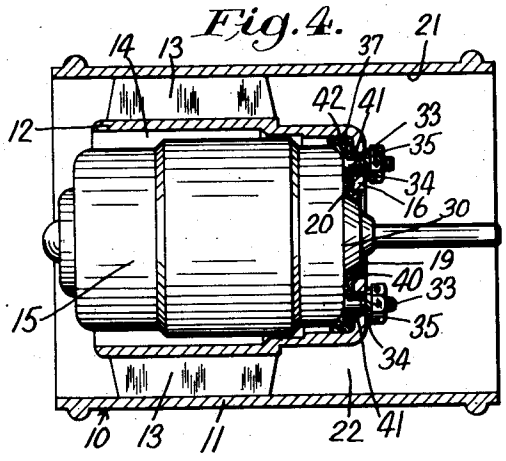
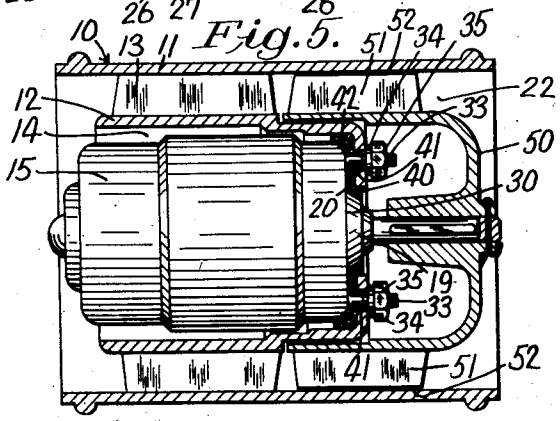


Fig. 5.



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2,639,087

AXIAL FLOW FAN

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8 Claims. (Cl. 230—117)

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This invention relates in general to axial flow fans and drives therefor, and in particular to arrangements of fan driving motors, the fans driven thereby and fan and motor casings by which the fan driven by the driving motor is so supported with respect to the fan and motor casing that the fan may operate with minimum tip clearance between the fan and the peripheral wall of the fan chamber. From another aspect, my invention relates to a method of coaxial assembly of a fan in the fan chamber of a fan and motor casing.

The efficiency of axial flow fans of the vane axial type is determined in great degree by the running clearance between the tip of the fan blades and the inner wall of the fan chamber, and if this clearance can be maintained at a uniform minimum of a few thousandths of an inch, a highly advantageous result, from the aspect of efficiency, may be obtained. In the volume production of small fans utilizing motors built by volume production methods, it is highly improbable that there will be available peripheral surfaces on the motor casings so perfectly coaxial with the axis of rotation of the fan driving motor shafts as to permit, through the mere cooperation of such surfaces with matingly shaped internal surfaces on the fan and motor casing, the desired centering of the fan in the fan chamber of the fan and motor casing. The manufacturer of relatively inexpensive fans on a volume production basis, with utilization of volume production methods, will find his production costs seriously increased, if it is necessary to take the motors which are to be incorporated in the fans and turn upon them surfaces in true coaxial relation with the motor shafts. If such a manufacturer can avoid this operation and yet effect a proper centering of the motor shaft with respect to the fan chamber by a method which will not itself add materially to production costs, there will be a considerable advantage obtained, and, particularly if mono-bloc fan and motor housings are utilized, so that distortion in use is unlikely, a permanent minimum running clearance may be expected.

It is an object of my invention to provide an improved axial flow fan. It is another object to provide an improved axial flow fan of the type in which the motor is carried by the fan and motor housing. It is a further object to provide an improved axial flow fan, having a driving motor carried by a fan and motor casing and employing improved means for maintaining the motor with its driving shaft coaxial with the internal

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wall of the fan chamber which is provided in the fan and motor casing. It is still another object of the invention to provide an improved axial flow fan having improved means, which require no special machining of surfaces of revolution on the motor casing, for maintaining the fan driving motor with its shaft in coaxial relation with the inner wall of the fan chamber of a fan and motor housing, in such manner that the tip clearance between the fan and such wall may be maintained at a small minimum. It is still another object of the invention to provide an improved axial flow fan of the type in which the driving motor is carried by the fan and motor housing, in which fan the centering of the motor shaft with respect to the fan chamber is accomplished by bedding a portion of the motor casing in a material plastic during assembly of the motor in the fan and motor casing, but which material hardens into a rigid mass, and which not only provides a seat for the motor casing but also, as it were, keys itself into a locked relation to the fan and motor casing in such a manner that removal of the motor, if necessary, and its replacement with its shaft in true coaxial relation to the fan chamber, is possible. It is still another object of my invention to provide an improved method for the volume production and precision assembly of axial flow fans. Other objects and a fuller understanding of the invention may be had by referring to the following discourse and claims, taken in conjunction with the accompanying drawings.

In these drawings,

Fig. 1 is a longitudinal section through a fan and motor casing mounted on a jig used in effecting assembly.

Fig. 2 is a similar view with a plastic ring positioned in the motor housing preparatory to the insertion and securing of the motor in such housing.

Fig. 3 is a view similar to Figs. 1 and 2, showing the motor inserted in the motor housing, and the plastic substance reshaped by pressure, and the parts ready for the application of holding means to maintain the motor in desired position.

Fig. 4 is a view showing the fan assembly removed from the jig after the motor has been fixed in desired relation to the fan and motor housing.

Fig. 5 is a view in longitudinal central section through the complete fan, with the fan rotor mounted on the motor shaft.

Referring to the drawings, and first to Fig. 1, it will be observed that a fan and motor casing 10 comprises an outer annular portion 11 con-

nected to an inner annular wall portion 12 by a series of radially extending vanes 13, these vanes being appropriately spaced about the axis of the casing and shaped to produce the desired effect upon the flow of the air displaced by the fan later described. The inner wall 12 constitutes a motor housing and surrounds a chamber 14 in which a fan driving motor 15 is adapted to be received, and the wall 12 has connected integrally with it a radially extending wall portion 16 traversed by openings 17, through which studs or the like may extend, and the wall 16 also has a central opening 18, through which a nose portion 19 of smaller diameter than the overall diameter of the motor 15 may extend. The surface 20 of the wall 16 which is nearer the chamber 14 may desirably (but need not necessarily) be made plane and be so disposed that the axis of an internal surface of revolution 21 which bounds a fan chamber 22 in the fan and motor casing is perpendicular to it. The fan and motor casing 10 may desirably be cast or molded, so that the same may be free of distortion.

Ordinarily the surface 21 will be an internal cylindrical surface, but it is obvious that any other surface of revolution permitting the assemblage of an appropriately shaped fan rotor in close running relation to the wall 21 might be employed subject to the condition that, if a jig of the character here illustrated is to be used, such surface shall be adapted readily to receive and closely fit upon a corresponding external surface formed upon the jig.

Figs. 1 to 3 show a jig 25 having openings 26 extending through it so that the socket end of a torque wrench or the like may be inserted through them. This jig has two coaxial surfaces of revolution, an internal surface of revolution 27 formed closely to fit the shaft of a motor which is to be positioned in the fan and motor housing, and an external surface of revolution 28, adapted closely to fit within the internal surface of revolution 21. When the fan and motor casing is positioned with its surface 21 snugly surrounding the surface 28 it will be evident that the surface 27 will be coaxial with the surface 21, and therefore that a motor shaft which closely fits the surface 27 will be coaxial with the surface 21, with the result that if, while the shaft of the motor is so held, the body of the motor can be securely fixed within the chamber 14, the motor shaft will remain in coaxial relation to the wall 21 when the jig 25 is removed from the fan and motor casing 10, or vice versa. Moreover, a fan, the tips of whose blades lie in a surface of revolution coaxial with a motor shaft receiving socket in the fan hub, which socket is a close fit for the motor shaft, will, when assembled upon the shaft of the motor, be coaxial with the fan chamber wall 21 and capable of operating with a very small but safe clearance within the fan chamber.

To secure the fan driving motor in position in the chamber 14 with the motor shaft coaxial with the wall 21, I employ a material which may be positioned in the form of a plastic layer between an end surface 30 of the motor 15 and the opposed surface 20 of the wall 16. This material may assume many forms, subject only to the conditions that it be suitably plastic when put in place and hardenable with reasonable speed and remain hard at the temperatures encountered in use. It may, for example, be iron cement, or may be somewhat like the well known "Smoothon," but very desirably it may be in the form of a thermoplastic ring, which is heat softenable and which may be deformed under pressure sufficiently to cause it to be squeezed up around the lateral edges of the motor head and also to "key into" the openings 17 through which the mounting studs for the motor extend and into the opening 18 around the nose 19. This material, when in the form of a perforated disc, after being softened by heat, may be placed in the end of the motor housing and "squashed" into the desired relation to the motor housing either by applying a force on the end of the motor or by applying tension to the studs provided for fixing the motor in position. It will be understood that if the forming or moulding of the plastic is to be accomplished by traction on the studs, openings 26 must extend completely through the jig to permit a socket wrench to have access to the holding studs, but if it be desired simply to apply pressure axially upon the end of the motor 15, while the end of the casing 10 rests upon a shoulder S on the jig 25, to cause the plastic layer to be pressed into the desired shape, the openings 26 may merely be sockets sufficiently long to permit the motor mounting studs to enter them without interference, and, after the jig is removed, following the hardening of the plastic substance, lock washers and nuts may be applied to the studs, with the exertion of uniform torques, without disturbing the coaxial relation of the motor shaft with the fan chamber surface 21.

It will be noted that in the specific construction illustrated, the motor 15 is provided with mounting studs 33 to which lock washers 34 and nuts 35 are adapted to be applied.

It will further be noted that the motor casing and the inner annular wall of the housing have spaced, respectively external and internal, surfaces of revolution, the latter surrounding the former, which surfaces are cut by common planes to which the axis of the motor shaft is perpendicular, and that the hardened plastic material, in the assembled relation of the fan parts, extends between and simultaneously contacts said surfaces of revolution and thereby provides radial support for the motor casing in the housing.

Reviewing the disclosures of the figures of the drawings, it will be observed that in Fig. 1 the fan and motor casing 10 has been mounted on the jig 25 in such a manner as to position the surface 21 in coaxial relation with the surface 27. A plastic disc 37, one softenable at a temperature below the boiling point of water and adapted to become hard upon cooling and to remain hard at temperatures above any which would normally be developed during the operation of the fan, is illustrated in Fig. 2 upon the surface 20, with a central opening 38 in the plastic disc, of smaller diameter than the opening 18, coaxial with the latter opening, and with stud receiving openings 39 of smaller diameters than the stud receiving openings 17 overlying these latter openings. In Fig. 3 the motor 15 is shown as having been inserted in the chamber 14, and pressure applied to its upper end has caused the plastic disc 37 to be deformed so that an annular portion thereof, 40, has been projected into the opening 18. Other annular portions 41 thereof have been projected into the annular spaces between the studs 33 and the walls of the openings 17, and a further annular portion 42 thereof has been projected or squeezed outwardly, and at least partially surrounds the convex outer edge of the motor head through which the motor shaft extends. In Fig. 4, the

fan has been removed from the jig **25** and, prior to this, preferably, the lock washers **34** and nuts **35** have been applied to the studs **33** and further pressure has been applied to the plastic disc **37** to increase the depth of the seating of the motor casing in the plastic body, and the plastic has been permitted to harden so that further deformation as the assembly is handled will not occur. It will be understood that the nuts and lock washers may be applied, and preferably are applied, while the jig is still in position, but that this is not necessarily done at that time. In Fig. 5 there will be observed the location of a fan **50** upon the rotor shaft with the fan blades **51** arranged to operate with a close and substantially uniform clearance at **52**, between their edges and the internal surface **21**.

As a result of this invention, it will be observed that I have provided a very simple and effective method for the production of high efficiency fans, utilizing comparatively inexpensive motors, without special machining of the casings of these motors, the only prerequisite to satisfactory results being that the bearings of the motors be adapted to maintain the motor shaft so that it shall be incapable of much radial displacement of its axis in operation. In other words, the bearings should hold the shaft without much play. It will be also obvious that the arrangement is one in which, through very simple operations, assembly can be accomplished, that the use of plastic discs or other plastic bedding material is a simple and inexpensive process, that the inter-keying of the plastic and the casing, etc. provides for a very effective and secure centering of the motor shaft in the motor casing with respect to the fan chamber in the fan and motor housing, and, in other words, that both an improved, inexpensive, simple, and effective method of fan construction providing fans of high aerodynamic efficiency, and an improved fan construction per se of high aerodynamic efficiency, are provided.

While there is in this application specifically described one form which my invention may assume in practice, it will be understood that this form has been shown for purposes of illustration and that the invention may be modified and embodied in various other forms without departing from its spirit or the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent is:

1. In combination, in an axial flow fan, a fan and motor housing comprising an outer annular wall and an inner annular wall in substantially concentric relation, the outer annular wall providing a fan chamber and the inner annular wall a motor housing, and a plurality of circumferentially spaced vanes connecting said walls in fixed spaced relation, said inner wall having a radially inwardly extending portion to provide a transversely extending surface toward which a motor received in the motor housing moves upon insertive movement, a motor having a casing and a rotating shaft, said motor casing and said inner annular wall having spaced, respectively external and internal, surfaces of revolution, the latter surrounding the former, which surfaces are cut by common planes to which the axis of said rotating shaft is perpendicular, a fan for which said shaft constitutes both a support and driving means, said motor casing having a surface thereon facing said transversely extending surface when said motor casing is arranged within the motor chamber, and means for fixing the motor relative to the fan and motor housing with the fan centered in the fan chamber, including a hardened thermoplastic annulus having portions extending between and simultaneously contacting said surfaces of revolution and thereby providing a radial support for the motor casing and other portions extending between said transverse surface and the oppositely facing surface of the motor casing and means for maintaining said plastic annulus under compression between said transverse surface and the oppositely facing surface of the motor casing.

2. In combination, in an axial flow fan, a fan and motor housing comprising an outer annular wall and an inner annular wall in substantially concentric relation, the outer annular wall providing a fan chamber and the inner annular wall a motor housing, and a plurality of circumferentially spaced vanes connecting said walls in fixed spaced relation, said inner wall having a radially inwardly extending portion open at its center and providing a transversely extending surface toward which a motor received in the motor housing moves upon insertive movement, a motor having a casing and a rotating shaft, a fan for which said shaft constitutes both a support and driving means, said motor casing having a surface thereon facing said transversely extending surface when said motor casing is arranged within the motor chamber and having a projecting portion receivable in the open center of said radially inwardly extending portion, and means for fixing the motor relative to the fan and motor housing with the fan centered in the fan chamber, including a hardened plastic annulus having portions providing radial support for the motor casing with respect to said housing both at the periphery thereof and at said projecting portion, and means for maintaining said plastic annulus under compression between said transverse surface and the oppositely facing surface of the motor casing.

3. In combination, in an axial flow fan, a fan and motor housing comprising an outer annular wall and an inner annular wall in substantially concentric relation, the outer annular wall providing a fan chamber and the inner annular wall a motor housing, and a plurality of circumferentially spaced vanes connecting said walls in fixed spaced relation, said inner wall having a radially inwardly extending portion providing a transversely extending surface toward which a motor received in the motor housing moves upon insertive movement and having motor holding stud receiving openings, a motor having a casing and a rotating shaft, a fan for which said shaft constitutes both a support and driving means, said motor casing having a surface thereon facing said transversely extending surface when said motor casing is arranged within the motor chamber, and having projecting studs extending through said stud receiving openings for fixing the motor relative to the fan and motor housing with the fan centered in the fan chamber, nuts on said studs, and a hardened plastic annulus having portions received in said openings around said studs and through their cooperation with the peripheries of said studs and the walls of said openings fixing the position of said studs in said openings, said hardened plastic annulus maintained under compression, by said studs, between said surfaces.

4. In combination, in an axial flow fan, a fan and motor housing comprising an outer annular

wall and an inner annular wall in substantially concentric relation, the outer annular wall providing a fan chamber and the inner annular wall a motor housing, and a plurality of circumferentially spaced vanes connecting said walls in fixed spaced relation, said inner wall having a radially inwardly extending portion providing a transversely extending surface toward which a motor received in the motor housing moves upon insertive movement and having motor holding stud receiving openings, a motor having a casing and a rotating shaft, a fan for which said shaft constitutes both a support and driving means, said motor casing having a surface thereon facing said transversely extending surface when said motor casing is arranged within the motor chamber, and having projecting studs extending through said stud receiving openings for fixing the motor relative to the fan and motor housing with the fan centered in the fan chamber, nuts on said studs, and a hardened plastic annulus having portions received in said openings around said studs, and other portions extending between the motor casing and a surrounding surface on said housing and providing a radial support for the motor casing relative to said housing, said annulus maintained under compression, by said studs, between said surfaces.

5. In combination, in an axial flow fan, a fan and motor housing comprising an outer annular wall and an inner annular wall in substantially concentric relation and a plurality of circumferentially spaced vanes connecting said walls and maintaining them in spaced relation, said outer annular wall extending beyond one end of said inner annular wall and circumferentially enclosing a fan chamber and said inner annular wall circumferentially enclosing a motor chamber and having a radially inwardly directed wall providing a transversely extending surface, a motor having a casing and a rotating shaft, a fan for which said shaft constitutes a support and driving means, said motor casing having a surface thereon facing said transversely extending surface when said motor casing is arranged within said motor chamber and its shaft is supporting said fan within said fan chamber, and means for fixing said motor casing relative to said fan and motor housing with said fan centered in said fan chamber including studs carried by said motor casing, openings in said radially inwardly directed wall through which said studs extend, nuts on said studs, and a hardened plastic material molded between said surfaces and at least partially filling the spaces between said studs and the walls of the openings in said radially inwardly directed wall and through their cooperation with the peripheries of said studs and the walls of said openings fixing the position of said studs in said openings.

6. In combination, in an axial flow fan, a fan and motor housing comprising an outer annular wall and an inner annular wall in substantially concentric relation and a plurality of circumferentially spaced vanes connecting said walls and maintaining them in spaced relation, said outer annular wall extending beyond one end of said inner annular wall and circumferentially enclosing a fan chamber and said inner annular wall circumferentially enclosing a motor chamber and having a radially inwardly directed wall providing a transversely extending surface, a motor having a casing and a rotating shaft, a fan for which said shaft constitutes a support and driving means, said motor casing having a surface thereon facing said transversely extending surface when said motor casing is arranged within said motor chamber and its shaft is supporting said fan within said fan chamber, and means for fixing said motor casing relative to said fan and motor housing with said fan centered in said fan chamber including studs carried by said motor casing, openings in said radially inwardly directed wall through which said studs extend, nuts on said studs, said motor having a projecting portion surrounding said shaft and said radially inwardly directed wall having another opening into which said projecting portion extends, and a hardened plastic material molded between said surfaces and at least partially filling the space between said projection and the wall of the opening into which it projects and through its cooperation with the peripheral wall of said projecting portion and the wall of said another opening fixing the position of said projection radially with respect to said opening.

7. In combination, in an axial flow fan, a fan and motor housing comprising an outer annular wall and an inner annular wall in substantially concentric relation and a plurality of circumferentially spaced vanes connecting said walls and maintaining them in spaced relation, said outer annular wall extending beyond one end of said inner annular wall and circumferentially enclosing a fan chamber and said inner annular wall circumferentially enclosing a motor chamber and having a radially inwardly directed wall providing a transversely extending surface, a motor having a casing and a rotating shaft, a fan for which said shaft constitutes a support and driving means, said motor casing having a surface thereon facing said transversely extending surface when said motor casing is arranged within said motor chamber and its shaft is supporting said fan within said fan chamber, and means for fixing said motor casing relative to said fan and motor housing with said fan centered in said fan chamber including studs carried by said motor casing, openings in said radially inwardly directed wall through which said studs extend, nuts on said studs, said motor having a projecting portion surrounding said shaft and said radially inwardly directed wall having another opening into which said projecting portion extends, and a hardened plastic material molded between said surfaces and at least partially filling the space between said projection and the wall of the opening into which it projects and also at least partially filling the spaces between said studs and the walls of the openings through which the studs extend, such material through its filling portions fixing the motor casing against lateral displacement relative to said housing.

8. In combination, in an axial flow fan, a fan and motor housing comprising an outer annular wall and an inner annular wall in substantially concentric relation and a plurality of circumferentially spaced vanes connecting said walls and maintaining them in spaced relation, said outer annular wall extending beyond one end of said inner annular wall and circumferentially enclosing a fan chamber and said inner annular wall circumferentially enclosing a motor chamber and having a radially inwardly directed wall providing a transversely extending surface, a motor having a casing and a rotating shaft, a fan for which said shaft constitutes a support and driving means, said motor casing having a surface thereon facing said transversely extend-

ing surface when said motor casing is arranged within said motor chamber and its shaft is supporting said fan within said fan chamber, and means for fixing said motor casing relative to said fan and motor housing with said fan centered in said fan chamber including studs carried by said motor casing, openings in said radially inwardly directed wall through which said studs extend, nuts on said studs, said motor having a projecting portion surrounding said shaft and said radially inwardly directed wall having another opening into which said projecting portion extends, and a hardened plastic material molded between said surfaces and at least partially filling the space between said projection and the wall of the opening into which it projects and also at least partially filling the spaces between said studs and the walls of the openings through

which the studs extend, said hardened plastic material also forming a bed for the outer periphery of the front end of the motor casing, said motor casing being spaced at all points from the walls of said housing.

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