Feb. 12, 1957 T. H. TROLLER 2,781,165

MOTOR DRIVEN FAN AND METHOD OF ASSEMBLING THE COMPONENTS THEREOF

Original Filed Oct. 30, 1947

Fig. 1.

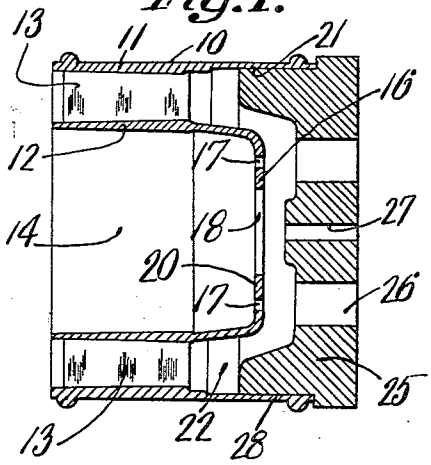


Fig. 2.

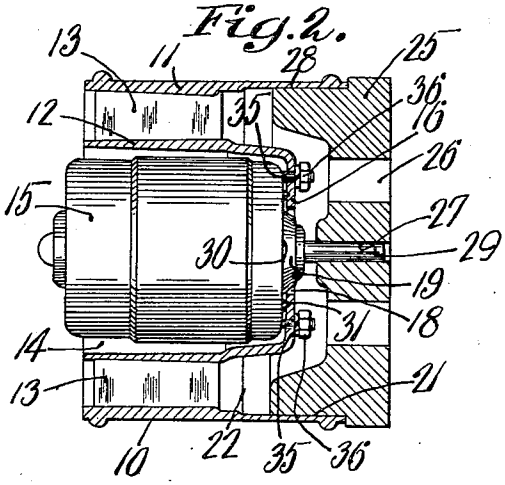


Fig. 3.

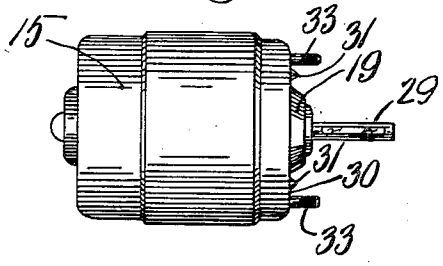


Fig. 4.

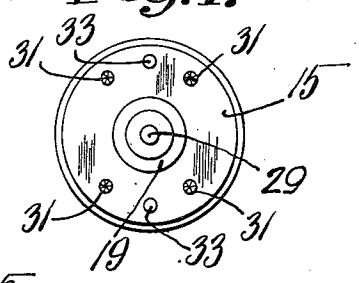
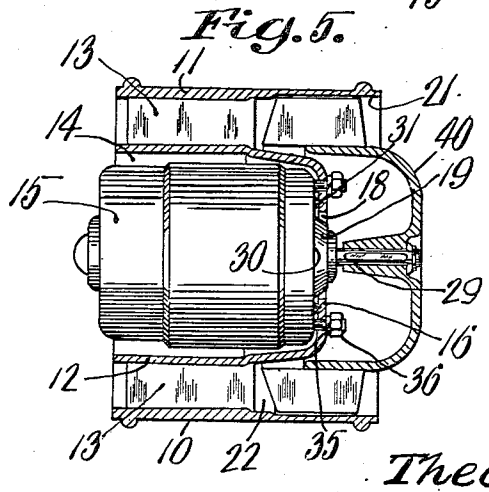


Fig. 5.



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MOTOR DRIVEN FAN AND METHOD OF ASSEMBLING THE COMPONENTS THEREOF

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Continuation of forfeited application Serial No. 783,147, October 30, 1947. This application December 14, 1953, Serial No. 397,989

10 Claims. (Cl. 230—117)

This invention relates in general to an axial flow fan and a drive therefor, and more particularly to an arrangement of a fan driving motor within a fan and drive housing—also called a fan and motor casing—for supporting a fan and the driving motor therefor, so that the fan may run with close tip clearance between the same and the housing. From another aspect, the invention relates to improved methods of effecting coaxial assembly of fans in the fan chambers of fan and motor casings.

The efficiency of axial flow fans of the vane-axial type is greatly influenced by the clearance between the tips of the fan blades and the inner wall of the fan chamber, and where this clearance can be kept down to a few thousandths of an inch, highly advantageous results may be obtained. In the volume production of small fans utilizing motors built by volume production methods, there is little probability of the finding of a peripheral motor surface so perfectly coaxial with the axis of rotation of the fan supporting and driving shaft as to permit, through the cooperation of such surface with a matingly shaped internal surface on the fan and motor casing, the desired centering of the fan in the fan chamber of the fan casing. Accordingly, a manufacturer of large numbers of fans, desiring to apply volume production methods, may be faced with serious increases in expense and additional manufacturing operations if customary methods used on larger and more expensive fans must be applied to effect minimization and uniformity of clearance between the fan blades and fan casing walls. If, on the other hand, there can be provided some method whereby the shaft of a motor which does not have unduly large clearances at its shaft bearings can be precisely centered with respect to the fan and motor casing, and particularly with respect to the fan chamber of such a casing—and especially if there be employed monobloc fan and motor casings so that serious distortion in use is not likely to be encountered—and if then simple means adequate to maintain the coaxial relation can be employed, all without having to machine a motor surface strictly coaxial with axis of shaft rotation, a very desirable result may be obtained.

It is an object of this 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 casing. 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 shaft—and consequently the fan—coaxial with the internal wall of the fan chamber. It is still another object to provide an improved axial flow fan having improved means involving 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 casing in such manner that the tip clearance between the fan and the wall of its chamber in the casing may be maintained at a small minimum. It is still another object to provide an improved axial flow fan in which the driving motor is carried by the

fan and motor casing in which the centering of the motor shaft with respect to the fan chamber is accomplished entirely by means coacting with a radially extending surface, as distinguished from a surface of revolution, either on the motor or on the fan and motor casing. It is still a further object of the 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 description and claims, taken in conjunction with the accompanying drawing, in which:

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

Fig. 2 is a corresponding view, with a fan driving motor received in the man and motor casing and fixed in coaxial relation to the latter.

Fig. 3 is a view of a motor as the same appears before being placed in the jig.

Fig. 4 is an end view of the motor of Fig. 3, showing the positioning means.

Fig. 5 is a central longitudinal section through a complete axial flow fan, assembled and held together according to the method of Figs. 1 and 2, a fan rotor having been mounted upon the motor shaft.

In a preferred embodiment of the invention, from its apparatus aspect, there is provided a fan and motor casing, desirably of monobloc construction, and comprising an outer annular wall one portion of which bounds a fan chamber and a longitudinally different portion of which has a plurality of circumferentially spaced vanes extending inwardly from it and desirably integrally connected with it, said vanes being connected at their radially inner ends by connecting means comprising a radially inwardly directed annular wall portion presenting a transversely extending surface. Such connection may also comprise an inner annular wall generally concentric with the outer annular wall to which the inner ends of the vanes are desirably directly and integrally connected. A motor having a shaft supporting and driving a fan positioned within the fan chamber is positioned within the fan and motor casing, and provides a transversely extending surface facing the transversely extending surface on the radially inwardly directed annular wall portion when the motor is disposed within the fan and motor casing in a position to support and drive a fan within the fan chamber, and the motor is so constructed that there is clearance between (around) it and the most adjacent surrounding parts of the fan and motor casing when it is so positioned. To secure the motor in fixed relation to the fan and motor casing and maintain a coaxial relation between the motor shaft and the bounding wall of the fan chamber, there is provided means for effecting forcible diminution of the distance between the transversely extending surfaces, and also means which through embedment in the material backing one of said surfaces, at least, and in non-sliding relation to the other of said surfaces fixes the motor with its shaft, and the fan on said shaft coaxial with the fan chamber and provides for uniform minimum blade tip clearance. Said means for fixing such relative radial position including partially embeddable means may take the form of elements integral with, pressed up from or formed upon the exterior of one of said surfaces, or separately formed and either fixed in or to one of said surfaces, or even merely positioned between the same, harder than the material of the surface or surfaces into which it is to be forced and partially embedded, such elements being, say, of steel when the surface, or surfaces, to be penetrated are aluminum, for example, or metal when such surface, or surfaces, are a plastic, and the pattern of arrangement of said elements and of the means for moving said surfaces together being such as to provide firmness of holding and balancing of

holding forces, and desirably to facilitate proper reassembly in the event that dismantling be for any reason required.

From the method aspect, in a preferred practice thereof my invention may include the steps of fixing a fan and motor casing to a jig which has means for positioning a motor shaft coaxial with a fan chamber surface on the casing, placing a motor with its shaft in such positioning means, forcibly moving longitudinally the motor casing relative to the fan and motor casing by means permitting radial freedom between said casings, and, through means forced into an interlocking relation to one or the other or both of said devices by such relative longitudinal movement, preventing relative lateral movement between said casings.

Referring now to the drawings, and first to Fig. 1, it will be observed that a fan and motor casing **10** comprises an outer annular portion or wall **11** connected to an inner annular portion or wall **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** surrounds a chamber **14** in which a fan driving motor **15** is adapted to be received, and the wall **12** has connected intergrally with it a radially (transversely) extending wall portion **16** traversed by openings **17** through which studs may extend and having also a central opening **18** through which a nose portion **19** of reduced diameter formed upon the motor **15** may extend. It will be noted that the wall portion **16** is a portion of a structure which rigidly and integrally connects with the inner ends of the vanes **13**. Desirably, but not necessarily, the surface **20** of the wall **16** nearer the chamber **14** may be made plane and disposed at right angles to the axis of an internal surface of revolution **21** which bounds a fan chamber **22** in the fan and motor housing **10**. Ordinarily, the surface **21** will be an internal cylindrical surface but it may be an internal frusto-conical surface, for example, or assume other forms if desired. For the purposes of the present invention it is important, however—though not vital with a differently constructed jig—that this surface shall be adapted readily to receive and closely to fit upon a corresponding external surface formed upon a jig.

Figs. 1 and 2 also show a jig **25** having openings **26** through the same so that the socket end of a torque wrench, or the like, may be inserted through them. This jig has a pair of coaxial surfaces of revolution, an internal surface of revolution **27** formed closely to fit the shaft **29** of a motor which is to be positioned and mounted in the fan and motor casing, and an external surface of revolution **28** adapted closely to fit the internal surface of revolution **21**. When the fan and motor casing **10** is positioned with its surface **21** snugly fitting upon the surface **28**, the surface **27** will be coaxial with the surface **21**, and accordingly a motor shaft closely fitting the surface **27** will be coaxial with the surface **21**, with the result that a fan, the tips of whose blades lie in a surface of revolution coaxial with a shaft-receiving socket in the fan hub will, if the socket is a close fit for the motor shaft, be coaxial with and able to have a very small but safe clearance within the surface **21**, provided the motor casing is fixed, after positioning in such relation to the fan and motor housing, that its shaft will remain coaxial with the surface **21**.

To accomplish maintained centering of the shaft **29** of the fan driving motor with the surface **21** of the fan chamber, there is provided means hereinabove described by which, through coaction of means carried by an end wall of the motor casing with the surface **20**, the desired coaxiality may be permanently established.

It will be evident that instead of providing the surface **20** on the wall **16** and providing on the end wall **30** of the casing of the motor **15** means to engage and prevent relative movement laterally between the surface **20** and the motor casing, the parts could be reversed. It will also be clear that while there are shown conical projections **31** in a generally rectangular disposition as shown in Fig. 4 upon the end wall of the motor casing, other figures adapted to prevent lateral slippage between the motor casing and the fan and motor casing and other dispositions—on either wall or merely between the walls—might be employed.

For the purpose of drawing the projections **31** into a condition of interengagement with the wall **16**, there is illustrated traction means in the form of a pair of studs **33** carried by the motor casing and extending in the assembled relation of the parts through the openings **17**, the openings **17** being of sufficiently greater diameter than the studs **33** to permit centering of the motor casing without side cramping of the studs. Lock washers **35** and nuts **36** are provided to cooperate with the studs **33**, but it will be evident that these are merely illustrative, for other suitable means for producing appropriate tension in the studs **33** and maintaining such tension may be employed. The projections **31** are illustrated as in pairs at opposite sides of a diametric plane in which the axes of the studs lie, and but two studs are shown, but it will be clear that this is but illustrative of various arrangements of studs and projections which will serve the purpose. The projections may assume various forms and may be integral with the motor head when the latter is of harder material than the wall **16**, or be in the form of inserts, and are not limited to conical form. Desirably the casing **10** may be a monobloc casting or molding, of aluminum or plastic and the projections **31** of steel or other hard metal.

The mode of operation of assembling a fan will now be readily followed from what has been said. The jig **25**, which may be supported either horizontally or vertically, may have a fan and motor casing **10** mounted upon it with the surface **21** closely surrounding the surface **28**. This will result in a coaxial relationship between the surface **27** and the surface **21**. At the time of assembly of the fan and motor casing upon the jig, a motor **15**, with its studs **33** projecting through the openings **17** and with lock washers **35** and nuts **36** loosely holding the motor in the casing, may be disposed within the chamber **14**, or the motor may be placed in the chamber **14** after the casing **10** is centered upon the jig. The motor shaft **29** will in any event be received in the bore surrounded by the surface **27** as the parts are assembled and so the motor body may be brought into such relation to the fan and motor casing that the shaft **29** will be coaxial with the internal surface of revolution **21**. Of course, if it be preferred to insert the motor in the fan and motor chamber **14** after the fan and motor casing has been located upon the jig, as indicated in Figs. 1 and 2, this is entirely feasible, and the nuts **36** and lock washers **35** may be placed in the socket of a wrench inserted through the jig-openings **26** and thus positioned on the ends of the studs without difficulty. In any event, with the motor **15** having its casing received with clearance within the chamber **14**, but with its shaft held coaxial with the surface **21** bounding the fan chamber, it will be possible, by tightening up the nuts **36** relatively uniformly, as by means of a torque wrench, to effect an interengagement of the points of the projections **31**—a partial embedding of their ends so as to form a permanent seat for them—in the radial wall **16**, and such tension may be applied to the studs **33** as to insure against the possibility of loss of coaxial relationship between the motor power shaft and the surface **21** of the fan chamber. After the parts are assembled, the nose **19** and the adjacent portion of the wall **16** may be marked or scribed so that, in the event that it is necessary to remove the motor from the fan and motor casing, correct relationship of the parts may be restored readily, and then merely by relatively uniformly tightening up the nuts again, a coaxial relationship of the parts may be again secured.

Of course if a special non-uniform pattern of the projections, or of the projections and the studs be used, scribing or the like will be unnecessary to effect assured restoration of the parts to the desired coaxial relation of the shaft 29 with the surface 21.

After the motor has been fixed with its shaft in coaxial relation to the surface 21, the fan and motor casing and motor assembly can be removed from the jig and a fan element 40 can be applied to the projecting motor shaft 29 and held in position in any desired manner as by a key and a nut and washer or a cotter pin, or the like.

It will be evident from the foregoing that there is provided not only an improved fan structure but a very economical structure to build, one which will assure close blade tip clearance, and high aerodynamic efficiency, and also that there is provided an improved method of assembling mass production motors in mass production fan and motor casings, calculated to permit rapid and inexpensive production but to provide a product having high aerodynamic efficiency.

This application is a continuation of application Serial No. 783,147, filed October 30, 1947, now forfeited.

While there is in this application specifically described one form both as to apparatus and as to method which the invention may assume in practice, it will be understood that these forms are shown for purposes of illustration and that the invention may be modified and embodied or practiced in various other forms without departing from its spirit or the scope of the appended claims.

What is claimed is:

1. In combination, in an axial flow fan, a fan and motor casing 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 circumferentially bounding a fan chamber and said inner annular wall bounding a chamber into which a motor is adapted to extend, said inner annular wall having a radially inwardly directed flange providing a transversely extending surface and surrounding an opening of substantial diameter, a motor having a casing between which and said inner wall clearance exists when said motor is assembled with said fan and motor casing, said motor having a portion extending into said opening and having a shaft, a fan for which said shaft constitutes a support and driving means, said motor casing having a wall having a surface thereon facing said transversely extending surface when said motor casing is arranged inside said inner annular wall and its shaft is supporting said fan inside said fan chamber, and means for fixing said motor casing relative to said fan and motor casing to center said fan in said fan chamber including only means adjustable to diminish the distance between said surface and means between said surfaces and substantially spaced from said opening and pressed into at least one of said surfaces and forming a seat for itself therein as the distance between said surfaces is decreased below a predetermined amount.

2. The combination defined in claim 1 in which said means between said surfaces and substantially spaced from said opening and pressed into at least one of said surfaces is carried by said wall of said motor casing and is pressed into said transversely extending surface on said radially inwardly directed flange.

3. The combination defined in claim 1, in which said means between said surfaces and substantially spaced from said opening and pressed into at least one of said surfaces projects from one of the latter and extends into material backing the other.

4. In combination, in an axial flow fan, a fan and motor casing 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 bounding a fan chamber and said inner annular wall having a radially inwardly directed flange providing a transversely extending annular surface surrounding an opening of substantial diameter, a motor having a casing and a shaft, said motor casing received with peripheral clearance within said inner annular wall and having a portion extending into said opening, 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 inside said inner annular wall and its shaft is supporting said fan inside said fan chamber, and means for fixing said motor casing relative to said fan and motor casing to center said fan in said fan chamber including means adjustable to diminish the distance between said surfaces and means producing under the action of said adjustable means permanent dents in positions substantially spaced from said opening in at least one of said surfaces and seating in said dents to prevent relative transverse movements between said surfaces.

5. In combination, in an axial flow fan, a fan and motor casing 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 bounding a fan chamber and said inner annular wall having a radially inwardly directed flange providing a transversely extending surface, a motor having a casing and a shaft, said motor casing received with peripheral clearance within said inner annular wall, 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 inside said inner annular wall and its shaft is supporting said fan inside said fan chamber, and means for fixing said motor casing relative to said fan and motor casing to center said fan in said fan chamber including means adjustable to diminish the distance between said surfaces, and a plurality of projections having sharp extremities in spaced relation to each other carried by one of said surfaces and pressed into the other of said surfaces so as to form seats for themselves therein as the distance between said surfaces is decreased below a predetermined amount.

6. In combination, in an axial flow fan, a fan and motor casing 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 circumferentially bounding a fan chamber and said inner annular wall having a transversely directed portion in the form of a radially inwardly directed flange providing an annular surface facing lengthwise of said casing and surrounding an annular opening of substantial diameter, a fan in said fan chamber, a motor having a casing and a shaft supporting said fan, said motor casing received with peripheral clearance within said inner annular wall and having a surface facing said first mentioned surface and having a portion extending into said opening and surrounded by said second mentioned surface, and means for supporting said motor with the axis of said shaft in the same straight line with the axis of said fan chamber including tension elements extending between said motor casing and said flange and position fixing means between said surfaces and having sharp portions embedded in at least one of the latter in laterally offset spaced relation with respect to said opening.

7. In combination, in an axial flow fan, a fan and motor casing comprising an outer annular wall having a portion circumferentially bounding a fan chamber and

having another portion beyond which said fan chamber is disposed, a plurality of circumferentially spaced vanes extending inwardly from said another portion of said outer annular wall and means connecting the radially inner ends of said vanes providing, for the support of a motor, a radially inwardly directed annular wall portion presenting a transversely extending surface, a motor within said fan and motor casing having a casing and a shaft and supported by said fan and motor casing wholly by said radially inwardly directed annular wall portion and about which motor casing and between the latter and the most closely adjacent portion of said fan and motor casing clearance exists when said motor is assembled within said fan and motor casing, a fan for which said motor shaft constitutes a supporting and driving means, said motor casing having a surface thereon facing said transversely extending surface when said motor casing is arranged inside said fan and motor casing with its shaft supporting said fan inside said fan chamber, and means for fixing said motor casing relative to said fan and motor casing and centering said fan in said fan chamber including only means adjustable to diminish the distance between said surfaces and means producing under the action of said adjustable means permanent dents in at least one of said surfaces and seating in said dents to prevent relative transverse movements between said surfaces, said permanent dent-producing means comprising a plurality of projections having sharp extremities in spaced relation to each other carried by one of said surfaces and pressed into the other of said surfaces as the distance between said surfaces is decreased below a predetermined amount.

8. In combination, in an axial flow fan, a fan and motor casing comprising an outer annular wall circumferentially bounding a fan chamber, a plurality of circumferentially spaced vanes extending inwardly from said outer annular wall and means connecting the radially inner ends of said vanes providing, for the support of a motor, a radially inwardly directed annular wall portion presenting a transversely extending surface surrounding an opening of substantial diameter, a motor within said fan and motor casing having a casing and a shaft and supported by said fan and motor casing wholly by said radially inwardly directed annular wall portion and about whose casing clearance exists when said motor is assembled within said fan and motor casing, said motor comprising a part thereof surrounded by said opening, a fan for which said motor shaft constitutes a supporting and driving means, said motor casing having a surface thereon facing said transversely extending surface when said motor casing is arranged inside said fan and motor casing with its shaft supporting said fan inside said fan chamber, and means for fixing said motor casing relative to said fan and motor casing and centering said fan in said fan chamber including only means adjustable to diminish the distance between said surfaces and means producing under the action of said distance diminishing means permanent seats in radially outwardly spaced relation to said opening in at least one of said surfaces and seating in said seats to prevent relative transverse movements between said surfaces.

9. The method of assembling and securing, with true coaxial relation between fan chamber and motor shaft, in a fan and motor casing which has (1) a fan chamber and (2) wall portions, including (*i*) an annular wall and (*ii*) a radially inwardly directed flange at one end of said annular wall, said wall and flange forming a motor-receiving chamber and said flange having openings through it for the reception of threaded motor-holding elements and also surrounding a further opening for a portion of a motor to enter, a fan driving motor which has (*a*) a casing rotatably supporting a fan driving shaft and receivable in said motor-receiving chamber with peripheral clearance, and (*b*) a portion receivable in the opening surrounded by said flange, which method includes (I) positioning a jig, which has a central bore of a size closely to receive the motor shaft, in interfitting relation with the fan chamber and thereby locating such central bore coaxial with the fan chamber, (II) positioning the motor with its shaft in such bore and its casing in the motor-receiving chamber in spaced relation to such annular wall and (III) establishing, by relative longitudinal movement between said motor casing and said fan and motor casing effected through the exertion of traction between said flange and said motor casing by holding elements extending with lateral clearance through the openings in said flange, an interembedding relationship between pointed elements lying between mutually adjacent opposite surfaces on the end wall of said motor casing and on said flange and that one of such surfaces towards which said pointed elements are directed, to effect a rigid securing of said motor in said fan and motor casing mainly by the coaction of said pointed elements and the seats they form for themeselves, and (IV) thereafter separating said fan and motor casing and said jig from each other.

10. The method of assembling and securing, with true coaxial relation between fan chamber and motor shaft, in a fan and motor casing which (1) provides a fan chamber and (2) has wall portions including vanes and a radially inwardly directed flange in fixed relation to said vanes, said flange having openings through it for the reception of threaded motor-holding elements and also surrounding a further opening for a portion of a motor to enter, a fan driving motor which has (*a*) a casing rotatably supporting a fan driving shaft and (*b*) a portion receivable with clearance in the opening surrounded by said flange, which method includes (I) positioning a jig, which has a central bore of a size closely to receive the motor shaft and a coaxial surface to interfit with the fan chamber, in interfitting relation with the fan chamber, and with said central bore receiving the motor shaft while the motor casing is in spaced relation to such annular wall, and (II) establishing, by relative longitudinal movement between said motor casing and said fan and motor casing effected through the exertion of traction between said flange and said motor casing by holding elements extending with lateral clearance through the openings in said flange, an inter-embedding relationship between pointed elements lying between mutually adjacent opposite surfaces on the end wall of said motor casing and on said flange and at least one of such surfaces to effect a rigid securing of said motor in said fan and motor casing mainly by the coaction of said pointed elements and the seats they form for themeselves, and (III) thereafter separating said fan and motor casing and said jig.

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