March 17, 1964 J. R. LAWLER 3,125,284

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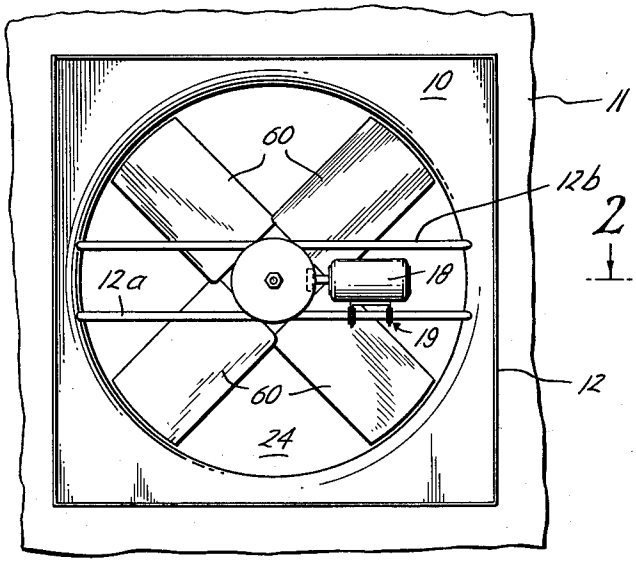


Fig. 1

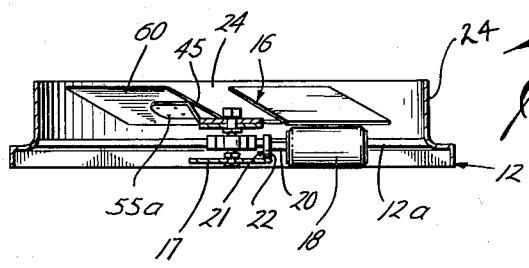


Fig. 2

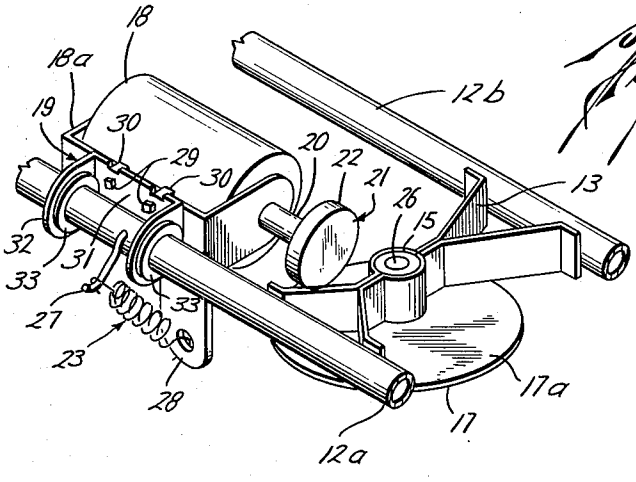


Fig. 3

James R. Lawler
INVENTOR.

BY Browning, Simms, Hyer & Eickenroht
ATTORNEYS

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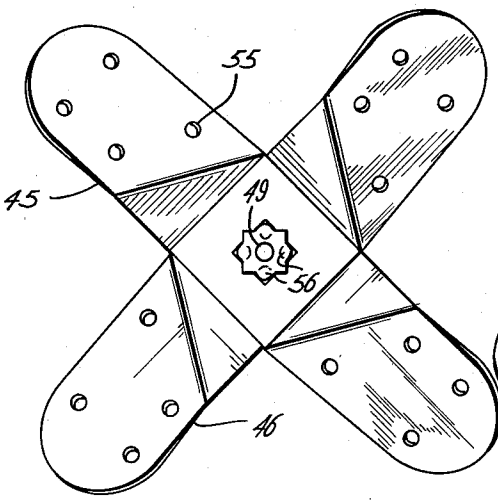


Fig. 4

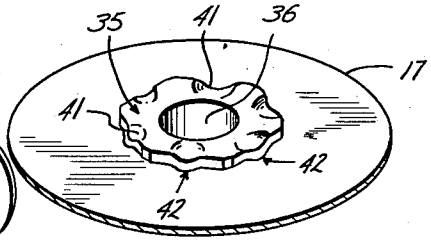


Fig. 5

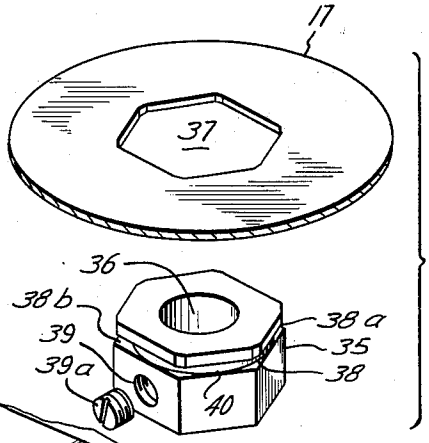
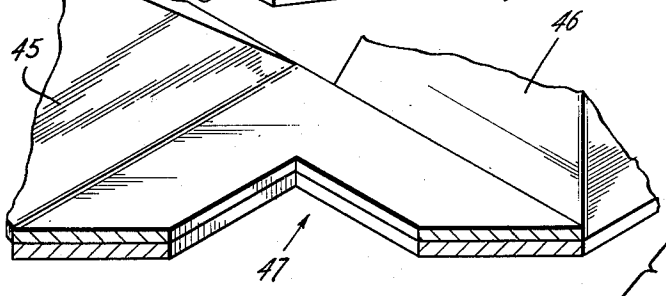


Fig. 6



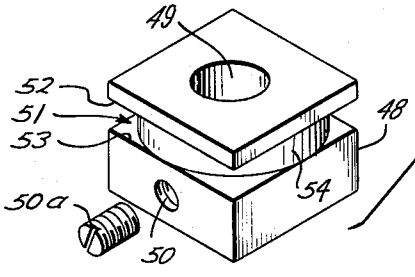


Fig. 7

James R. Lawler
INVENTOR.

BY Browning, Simms, Hyer & Eickenroht
ATTORNEYS

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James R. Lawler, Houston, Tex., assignor to Consolidated General Products, Inc., Houston, Tex., a corporation of Texas

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6 Claims. (Cl. 230—117)

This invention relates to an improved fan of the type commonly known as attic or exhaust fans that are utilized to circulate air through buildings.

The fans presently used of the above type are generally mounted above an opening in the ceiling of the building to be ventilated with the fan blade carrying shaft perpendicular to the ceiling. These fans have a frame to which is journaled a shaft carrying a fan blade assembly at one end and a pulley at the other. An electric motor is mounted on the frame with its output shaft parallel to the fan blade shaft. A pulley is provided on its output shaft. A driving connection between the pulleys is provided by a belt. Means are provided to move the motor relative to the fan blade shaft to adjust the tension of the belt against the pulleys.

The belt and pulley driving connection is noisy, tends to vibrate and requires periodic adjustments with frequent replacement of the belt. Because of the mounting of the motor with its output shaft parallel to the fan blade shaft, a compact fan having a small dimension along the fan blade shaft cannot be obtained. This is a serious disadvantage because the fan cannot be mounted in flat roofed houses having only a small clearance space between the ceiling and the structure superimposed thereabove. This arrangement also prevents use of a fan shroud that extends the full length of the fan blade shaft for the greatest fan efficiency.

In fans using such conventional belt and pulley drive connections, the rotative speed of the fan cannot be adjusted except by replacing the pulleys with ones of a different size or by using an expensive variable speed motor, neither method being satisfactory to the normal users of these fans.

The pulley and fan blade assembly mounted on the journaled shaft are generally constructed of cast metal and are bulkier than necessary to provide the required safety factor in these parts. Cast metal parts are used because they are less expensive than machined parts but decrease the efficiency of the fan due to their size and mass which must be rotated.

The fan of the present invention is proposed as a solution to the above undesirable factors in conventional fans.

It is an object of the present invention to provide a fan having an inexpensive, simple, vibration free drive connection between a prime mover and a rotatable shaft carrying a fan blade assembly without using conventional pulley and belt drives with their inherent disadvantages.

Another object is to provide a fan having such a drive connection that permits a ready adjustment to vary the speed of rotation of the fan blade assembly without altering the structure of the fan in any manner.

Yet another object is to provide a fan utilizing such drive connection that enables the fan to be constructed more compactly than conventional fans having pulley and belt drives.

A further object is to provide a fan in which the drive connection is provided without the use of heavy cast driving or driven members such as pulleys.

Yet a further object is to provide a fan in which a member of sheet material is rigidly secured to the shaft carrying the fan blade assembly by a simple and inexpensive connection.

A further object is to provide a fan in which such connection is made without welding or threading.

Another object is to provide a fan in which the assembly carrying the fan blades is secured to the shaft in a manner similar to that by which the sheet metal member is secured to such shaft.

A further object is to provide a fan having a novel motor carrying mount for resiliently mounting the prime mover to the frame of the fan which facilitates ready adjustment in the position of such motor with respect to the shaft carrying the fan blade assembly.

These and other objects will become more apparent when read in conjunction with the following detailed description and the attached drawings of certain preferred and illustrative embodiments of the present invention, wherein:

FIG. 1 is a bottom plan view of a fan of the present invention when viewed from below in its mounted position in the ceiling of a building that it ventilates;

FIG. 2 is a section taken along line 2—2 of FIG. 1 but showing only the fan;

FIG. 3 is a perspective view of the novel driving connection utilized between an electric motor and the rotatable shaft carrying the fan blade assembly in such fan;

FIG. 4 is an enlarged plan view of the arms and mounting hub of the fan blade assembly illustrated in FIG. 1 in integral connection;

FIG. 5 is a perspective view of a driven disc integrally connected with its mounting hub that forms part of the driving connection illustrated in FIG. 3;

FIG. 6 is an exploded perspective view of the disc and hub of FIG. 5 before their integral connection; and

FIG. 7 is an exploded partial perspective view of the arms and mounting hub of the fan blade assembly illustrated in FIG. 4 before their integral connection.

Referring now in more detail to the drawings, there is illustrated a fan 10 embodying the present invention in a horizontal position with its fan blade carrying shaft perpendicular to the ceiling 11 wherein it is mounted. The fan 10 has an air passageway 24 therethrough. The fan 10 is provided with a frame 12 of a conventional design suitable for securing it to the ceiling 11 and has a pair of side-by-side disposed tubular support members 12*a* and 12*b* extending across the air passageway 24 adjacent the lower extremity of the frame 12 when viewed in its position shown in FIG. 2.

An angular framework 13 is secured between tubular members 12*a* and 12*b* centrally of the passageway 24 and provides a support for journal bearing 15. Journaled within bearing 15 is a rotatable shaft 26 which extends perpendicularly to the ceiling 12 within air passageway 24. Shaft 26 carries a fan blade assembly 16 on its upward extremity and a driven disc 17 on the other end remote from the fan blade assembly.

An electric motor 18 is provided as a prime mover and is mounted on tubular member 12*a* by swingable and slidable means 19 which also provide a resilient mounting so as to reduce the vibrations of the motor as it operates that would otherwise be transmitted to the frame 12 of fan 10. The electric motor 18 is provided with an output shaft 20 which extends therefrom and on one end of which is mounted a drive wheel 21. Drive wheel 21 is provided with a driving edge 22. The swingable and slidable means 19 are adapted to position motor 18 relative to the shaft 26 in such a manner that the rotative axis of the output shaft 20 is perpendicular to the rotative axis of the shaft 26 and intersects such rotative axis between the shaft connections to the drive disc 17 and the fan blade assembly 16.

Means are provided for swinging the motor 18 on its mountings to the tubular member 12*a* so that the driving edge 22 of wheel 21 is urged into driving engagement

with the driven disc **17**. With the fan in the position illustrated in FIGS. 1 and 2, gravity provides such means for swinging the motor. However, should it be desired to utilize a fan in some other position or with auxiliary swinging means, means other than gravity may be provided for such use and can take the form of spring **23** which is connected between an arm **27** secured to tubular member **12***a* and a support **28** carried on the motor. This arrangement, of course, swings the motor on its mounting on tubular member **12***a* in a manner to urge the driving edge **22** into engagement with a face **17***a* of the disc **17**.

The fan operates in the following manner. With the motor **18** operating, rotation is imparted to its output shaft **20** which rotates wheel **21** and driving edge **22**. With driving edge **22** urged into driving engagement with disc **17** there, of course, will be transmitted rotational movement at a reduced rate between driving wheel **21** and the disc proportional to the circumference of wheel **21** and the circumference of the path which this wheel travels about disc **17**. Preferably, the driving edge **22** is provided with a resilient material to achieve the desired co-efficient of friction between these two elements to reduce slippage. Utilizing the disclosed driving connection provides a simple, inexpensive, vibration-free driving connection between motor **18** and shaft **26** without using belts and pulleys of a conventional nature. Further, the drive connection requires no periodic maintenance or replacement of elements, nor need the tension between wheel **21** and disc **17** be periodically adjusted.

An additional advantage of the driving connection of the present invention is apparent when viewed in FIG. 2 wherein is clearly illustrated the compactness of the fan which has a very small dimension along the fan blade assembly carrying shaft **27** due to the particular arrangement used. Such arrangement permits the fan to operate more efficiently because the frame **12** is provided with a shroud portion **24** which extends substantially the length of shaft **26** and also because the electric motor **18** is mounted directly in the air stream of the fan blade assembly **16**. In such mounting the motor **18** runs much cooler, which permits a smaller electric motor to provide the same cubic feet per minute air delivery from the fan as was formerly provided by a substantially larger electric motor utilizing conventional pulley and belt drive connections.

The swingable and slidable means **19** resiliently mounting said motor **18** to the tubular support **12***a* are most clearly shown in FIG. 3. The motor **18** is provided with a conventional base member **18***a* to which it is rigidly secured. The base member **18***a* is releasably secured to the swingable and slidable means **19** by means of bolts **29**.

The swingable and slidable means **19** is comprised of base portion **31** to which is secured motor **18** by means of bolts **29** and has a pair of angularly disposed spaced-apart flange portions **32**. A pair of stops **30** can be provided the base portion **31** to assist in aligning motor **18** with shaft **26**. The flanged portions have coaxially aligned openings therethrough in which are mounted resilient grommets **33** of a size to be mountable about the tubular support **12***a*. The grommets **33** provide a resilient mounting of the motor **18** to the frame of the fan. This arrangement of the swingable and slidable means is of special utility in that it serves not only to resiliently mount the motor to the frame so that it can be swung about such mounting to achieve the drive connection desired but it also permits the speed of the fan blade assembly to be readily adjusted. As previously described, the rotative axis of shaft **20** of motor **18** is perpendicular to and intersects the rotative axis of shaft **26**. Thus, with the arrangement shown the motor **18** can be moved laterally with respect to shaft **26** by sliding the means **19** on support **12***a* thereby changing the ratios of the circumferences of driving edge **22** of wheel **21** to the path this driving edge travels on the face **17***a* of the disc **17**. Moving the motor toward shaft **26** increases the rotational speed of the fan assembly and reverse movement decreases the speed of the fan assembly. This is an especial advantage in the present fan because the speed of the fan blade assembly is easily adjusted and once adjusted by sliding the means **19** on tubular member **12***a* it will not unintentionally be varied. No auxiliary locking mechanisms are necessary to hold the motor in any desired position because the forces created in the driving connection are perpendicular to tubular support **12***a*.

The arrangement of the swingable and slidable means **19** is of additional utility in the present invention in that the speed of rotation of the fan blade assembly can be adjusted from the accessible side of the fan; that is, the side displayed in FIG. 1, and such adjustment can be achieved without utilizing an interchange of pulleys, belts or the like, nor through use of an expensive variable speed motor.

The driving connection heretofore described has enabled the use of thinner members carried on shaft **26** than otherwise possible because no pulley grooves, gear teeth or the like are necessarily formed therein. Thus, it has been found that the disc **17** can be readily constructed from a sheet metal stamping and likewise the components of the fan blade assembly **16**. More particularly, it has been found that a thin circular member can be used to construct disc **17**. This is because the drive connection is achieved directly between the driving edge **22** of wheel **21** and the side face **17***a* of disc **17**. Thus, the disc **17** need only be sufficiently rigid to withstand the moderate force applied downwardly against it by the engagement of driving edge **22** therewith. However, it has been found that a problem was encountered with securing such a thin member to shaft **26** in a simple yet effective way of forming an integral connection between these two members. For example, welding the disc to the end of the shaft has two disadvantages; first it becomes non-removable and second the disc suffers from warping during such connection. To utilize a threaded connection on shaft **26** with a pair of locking nuts or the like, with a keyway, is prohibitive from the standpoint of manufacturing costs in fans of this type which are extremely competitive. Thus, it has been found that the method of integrally connecting the disc **17** to shaft **26** to be hereafter described is an additional particular advantage arising from the fan **10** of the present invention.

Referring more particularly to FIGS. 5 and 6, the construction of such integral connection will be described. In FIG. 6 there is illustrated the disc **17** which may be readily constructed from sheet metal by stamping or otherwise forming same, and which is provided with a non-circular opening **37** that is centrally located in the disc. The opening **37** may be of any configuration as long as it is non-circular. The outer periphery of disc **17** should be circular with the final integral connection with shaft **26** aligned in such manner that as little as possible dynamic unbalancing of the disc and shaft occurs upon rotation of the shaft during operation of the fan **10**. The opening **37** is adapted to receive insertion of a hub **35** to intermediate its ends. The hub **35** is provided with such external configuration that it is axially insertable into opening **37** but cannot be rotated therein. A central opening **36** is provided in hub **35** so that it is mountable upon the lower end of shaft **26**. The hub **35** is releasably securable to shaft **26** by means of a set screw **39***a* held in a threaded hole **39**. The hub **35** is provided intermediate its ends with a reduced radial dimensional portion to form a recess **38** about its side exterior surface in a plane at right angles to the axis of rotation of shaft **26**. The recess **38** has such dimensions of width and depth that it will permit the hub to be rotated relative to the disc when received within the recess. Also, the portions of the hub in which the

disc resides upon such rotation provide or present closely adjacent confronting surfaces 38*a* and 38*b* to the disc 17 about such opening 37 so that the disc 17 is held against longitudinal movement relative to the hub. When the disc 17 and hub 35 are in such rotative positions so as to be held together against longitudinal movement, one or more portions 41 of the hub 35 are displaced longitudinally into the recess 38 to lock the disc into an integral connection with the hub in such rotative position. The displaced portions that fill the recess are designated 42. Because the opening 37 in disc 17 is non-circular the displaced portions 42 that fill recess 38 prevent any subsequent relative rotation and also any longitudinal movements between the hub 35 and disc 17.

The non-circular opening 37 is illustrated as a hexagonal configuration and likewise the hub is provided with a complementary hexagonal cross section to be axially insertable into the opening in the disc but not rotatable. In a preferred form the recess 38 has its bottom of a circular cross section with a diameter preferably only slightly smaller than the minimum dimension of the hexagonal opening so that the disc and hub can rotate relative to one another when the disc is received within the recess so that the disc will be substantially centered on the hub. This self centering feature is of utility in dispensing with the need for using jigs or the like to center the hub within the disc prior to their integral connection. Other shaped openings 37, of course, can be utilized embodying the disclosed structural arrangement.

It has been similarly found that the method of integrally connecting the disc to the shaft of the present invention is readily applicable to integrally connect the fan blade assembly to the shaft at its other end. This allows for the fan blade assembly components to be constructed from sheet metal stampings. Referring particularly to FIGS. 4 and 7, there is shown a spider which forms a basic component of the fan blade assembly of the present invention. The spider is constructed in the following manner. A pair of arms 45 and 46, preferably stamped from sheet metal and bent to provide the necessary pitch angle for the blades, are utilized and are each provided with a non-circular opening centrally located therein. The arms and their integral connection with shaft 26 should be so arranged that as little dynamic unbalancing as possible occurs upon rotation of shaft 26 during operation of the fan 10. The outer extremities of the arms 45 and 46 are provided with a plurality of holes 55 to receive rivets 55*a* or the like by means of which the fan blades 60 can be readily secured. A hub 48 for integrally connecting the arms together and to the shaft is provided. The hub 48 has an axial opening 49 to receive the upper end of shaft 26 therein and is releasably secured to shaft 26 by means of a set screw 50*a* held in a threaded hole 50. The hub has such external configuration as to be axially insertable to intermediate its ends into the openings in the arms when they are disposed at right angles to one another but not rotatable therein. The hub has a reduced radial dimension portion to form a recess 51 at right angles to the angle of rotation of the shaft 26. The recess 51 has such dimensions of width and depth that when the hub is inserted into opening 47 it can be rotated relative to the arms when they are received in recess 51. Upon such rotation, the portions of the hub in which the recess is formed present closely adjacent confronting surfaces 52 and 53 to the arms 45 and 46 about opening 47 so that the arms are held together and against longitudinal movement relative to the hub 48. The hub 48 has, while in such rotative position, one or more portions 56 displaced longitudinally into recess 51 to lock the arms into an integral connection with the hub.

In the illustrative embodiment shown the opening 47 in arms 45 and 46 is square and likewise the hub 48 is square so as to be insertable into the opening formed

in the arms but not rotatable. The reduced dimensional portion or recess 51 has a circular cross section with a diameter slightly smaller than the minimum dimension of said opening (the length of one side of the square) in the fan assembly whereby the arms and hub can be rotated relative to one another when the arms are received within recess 51 and the arms will be substantially centered on the hub. This centering feature avoids using jigs or the like to insure centrally mounting the arms on their hub. Other non-circular openings and hubs can be utilized if so desired.

Preferably, in both the disc 17 and hub 35 and also the arms 45, 46 and hub 48, the parts are rotated relative to one another to a position where there is a maximum of overlapping of the confronting surfaces about the recesses with the members held within them and then parts of the hubs are displaced longitudinally into the recess. This is most desirable in providing the strongest integral connection between these parts.

The use of the driving connection of the present invention enables the use of a relatively thin disc carried on the shaft to which the fan assembly is secured. This avoids utilizing efficiency reducing and expensive, massive and bulky cast metal parts for the disc 17 and also for the arms 45 of the fan blade assembly 16. The advantages of fans having such drive connection are further enhanced by the simple and inexpensive means disclosed for integrally connecting both the disc and the arms to the shaft 26. Because of the use of such unique integrally connecting means between the disc and shaft and the fan blade assembly and shaft the efficiency of the fan is greatly increased and the construction of it is proportionally simplified and the cost thereof decreased without sacrificing compactness.

From the foregoing it will be seen that this invention is one well adapted to attain all of the ends and objects hereinabove set forth, together with other advantages which are obvious and which are inherent to the apparatus.

It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of the claims.

As many possible embodiments may be made of the invention without departing from the scope thereof, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

The invention having been described what is claimed is:

1. In a fan having a frame to which is journaled a shaft carrying a fan assembly at one of its ends and a driven disc at its other end, and a motor mounted on the frame, a drive connection between said motor and the disc, and a means for integrally connecting the disc to the shaft which comprises a hub with a non-circular cross section carried on the shaft, said disc provided with a non-circular opening centrally located, and adapted when in one rotary position relative to said hub to receive insertion of said hub to intermediate its ends and when in another rotary position relative to said hub to interfere with said hub so as to prevent movement of said hub therethrough, said hub provided with a recess about its side exterior surface in a plane at right angles to the axis of rotation of said shaft, the recess having dimensions that permit the hub to be rotated relative to the disc when the disc is in register with said recess to place said disc in said other rotary position relative to the hub and within the recess, the portions of the hub in which the disc resides upon such rotation to said other position, presenting closely adjacent confronting surfaces to the disc about such opening so that the disc is held against longitudinal movement relative to the hub and the hub having a portion displaced longitudinally into said recess and into the opening in said disc at a position further from the hub axis than the edge portion of the

disc opening immediately adjacent thereto to lock the disc against rotation relative to the hub and into an integral connection with said hub in its said other position.

2. The means for integrally connecting the disc to the shaft of claim 1 wherein said non-circular central opening in the disc is polygonal and the hub is provided with a complementary polygonal cross section, said recess is a reduced radial dimension portion in the side exterior surface of the hub in a plane at right angles to the axis of rotation of said shaft and has a circular cross section in such plane with a diameter slightly smaller than the minimum dimension of said opening in said disc whereby the hub and disc are rotatable relative to one another when the disc is received within the recess a greater than minimum dimensional portion of the hub is in alignment with a lesser dimensional portion of said opening in said disc when said disc is in said other rotary position relative to the hub.

3. In a fan having a frame to which is journaled a shaft carrying a fan assembly at one of its ends and a driven disc at its other end, and a motor mounted on the frame, a drive connection between said motor and the disc, and a means for integrally connecting the fan blade assembly to the shaft which comprises a hub with a non-circular cross section carried on the shaft, said fan blade assembly provided with a non-circular opening centrally located and adapted when in one rotary position relative to said hub to receive insertion of said hub to intermediate its ends and when in another rotary position relative to said hub to interfere with said hub so as to prevent movement of said hub therethrough, said hub provided with a recess about its side exterior surface in a plane at right angles to the axis of rotation of said shaft, the recess having dimensions that permit the hub to be rotated relative to the fan blade assembly when the assembly is in register with said recess to place said assembly in said other rotary position relative to the hub and within the recess, the portions of the hub in which the fan blade assembly resides upon such rotation to said other position presenting closely adjacent confronting surfaces to the fan blade assembly about such opening so that the fan blade assembly is held against longitudinal movement relative to the hub and the hub having a portion displaced longitudinally into said recess and into the opening in said assembly at a position farther from the hub axis than the edge portion of the disc opening immediately adjacent thereto to lock the fan blade assembly against rotation relative to the hub and into an integral connection with said hub in its said other position.

4. The means for integrally connecting the fan assembly to the shaft of claim 3 wherein said non-circular central opening in the fan assembly is polygonal and the hub is provided with a complementary polygonal cross section, said recess is a reduced radial dimension portion in the side exterior surface of the hub in a plane at right angles to the axis of rotation of said shaft and has a circular cross section in such plane with a diameter slightly smaller than the minimum dimension of said opening in the fan assembly whereby the hub and fan assembly are rotatable relative to one another when the fan assembly is received within the recess and a greater than minimum dimensional portion of the hub is in alignment with a lesser dimensional portion of the opening in the fan assembly when said disc is in said other rotary position relative to the hub.

5. A fan having a frame to which is journaled a shaft carrying a fan blade assembly at one of its ends and in which is mounted a motor with a drive connection between the motor and shaft, a hub carried on the shaft connecting the fan blade assembly to the shaft, the fan blade assembly comprising a pair of arms each provided with a non-circular opening centrally located therein and adapted when in one rotary position relative to each other and said hub to receive insertion of said hub to intermediate its ends and when in another rotary position relative to said hub to interfere with said hub so as to prevent movement of said hub therethrough, said arms positioned crosswise with the openings therein in alignment when in said one rotary position relative to each other, said hub provided with a recess about its side exterior surface in a plane at right angles to the axis of rotation of said shaft, the recess having dimensions that permit the hub to be rotated relative to the arms when the arms are in register with said recess to place said arms in said other rotary position relative to the hub and within the recess, the portions of the hub in which the arms reside upon such rotation to said other position presenting closely adjacent confronting surfaces to the respective arms about such openings so that the arms are held against longitudinal movement relative to the hub, and the hub having a portion displaced longitudinally into said recess and into the opening in each of said arms at a position farther from the hub axis than the edge portion of the opening immediately adjacent thereto to lock the arms against rotation relative to the hub and each other and into an integral connection with said hub in their said other position, and each arm having a fan blade secured to each of its ends.

6. The fan blade assembly of claim 5 wherein said non-circular central openings in said arms are polygonal and the hub is provided with a complementary polygonal cross section, said recess is a reduced dimensional portion in a plane at right angles to the axis of rotation of said shaft and has a circular cross section in such plane with a diameter slightly smaller than the minimum dimension of said opening whereby the hub and arms are rotatable to one another when the disc is received within the recess and a greater than minimum dimensional portion of the hub is in alignment with a lesser dimension of each of the openings when said arms are in said other rotary position relative to the hub.

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