Jan. 13, 1942. W. L. UPSON 2,269,799

FAN HUB AND SHAFT ASSEMBLY

Filed Sept. 23, 1939

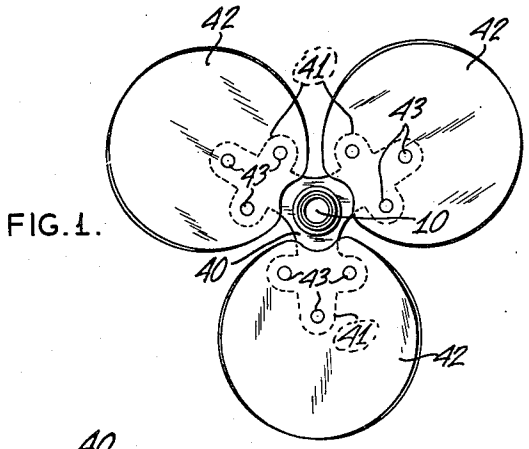


FIG. 1.

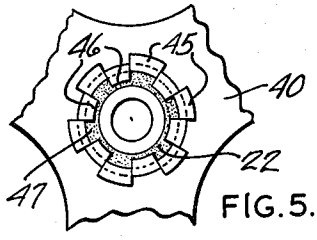


FIG. 5.

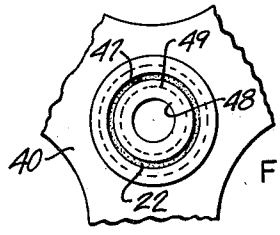


FIG. 6.

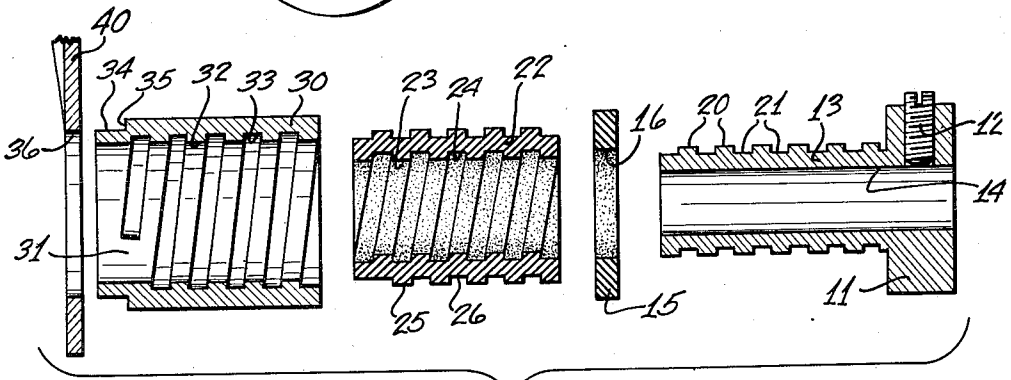


FIG. 2.

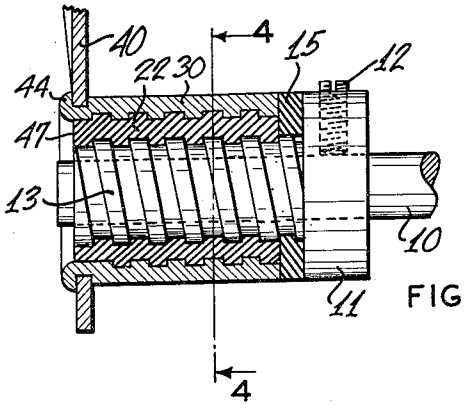


FIG. 3.

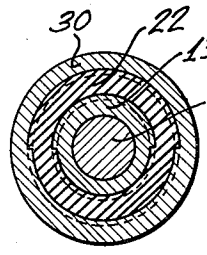


FIG. 4.

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FAN HUB AND SHAFT ASSEMBLY

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4 Claims. (Cl. 170—173)

This invention relates to improvements in fan hub and shaft assemblies, and more particularly to improved expedients for operatively assembling the bladed rotor of a propeller type fan, for example, to the rotatable shaft by which it is powered.

Numerous efforts have been made in recent months to reduce the noise and vibration transmitted from the driving motor of an electric fan, or through the fan proper, to the air impelled thereby. The most successful of such efforts along the lines of fan noise minimization, are found of course in certain recently designed types of fan blades. These improved designs do not, however, obviate entirely the resonance effects of the blades, nor serve of themselves, to prevent transmission of motor noise through the blades to the ambient air. Accordingly, the minimization of sound and vibration transmitted through the channels last referred to, constitutes the objective of the present invention.

It is well known to reduce the noise and vibrations transmitted from the prime mover, such as a motor by which the fan is powered, by cushioning the motor or other source of power with respect to the supporting base or other sub-structure. If it be assumed that this is done in accordance with accepted good design, it being well known that the cushion mounting of the driving motor on its supporting base serves materially to decrease vibration, the remaining major noise component consists of that emanating from the fan blades to the surrounding air, which part is unaffected by cushion mountings or the like. It is consequently to the reduction of fan noise from the blades that the present design work is particularly directed.

Yet another object of the invention is attained in what may be referred to as a floating mounting of the fan assembly on the shaft by which it is rotated, such as the shaft of an electric motor for example, and which permits a resilient displacement of the fan proper in any direction in a plane radial to the motor shaft, and likewise, within limits, permits a desirable yet limited displacement in either axial direction. The need for these provisions becomes more apparent when it is considered that even any slight mechanical unbalance of the fan causes a force which tends to cause the fan to rotate about its own center of mass. A somewhat different condition of unbalance sometimes arises when one or more of the blades of a propeller type fan are bent even slightly, forwardly or rearwardly with respect to the plane of rotation of the fan, a condition which results in what may be termed an operating unbalance or load unbalance. The present object is fully attained in a structure which, due to a floating support of the fan on its drive shaft, permits the fan somewhat to vary its position in a manner tending to reduce transmission of unbalanced forces to the motor shaft and driving motor which, but for the present improvements, would result in an increase in motor noise. The present improvements similarly tend to prevent transmission of vibrations from motor to fan, and thereby minimize the noise transmitted from the fan to the ambient air.

Yet another object of the invention is attained in a complete fan, spider and hub assembly of floating type, such that the parts incident to the present improvements may be assembled to the fan, prior to mounting the fan and hub assembly as a detachable unit on the motor shaft.

The foregoing and numerous other objects will more clearly appear from the following detailed description of certain preferred embodiments of the invention, particularly when considered in connection with the accompanuying drawing, in which:

Fig. 1 is a front elevation of a three blade propeller type fan to which the present improvements are applied; Fig. 2 is an exploded view of the parts of the improved hub and shaft assembly, showing the four major elements thereof in axial section; Fig. 3 is an axial section of the parts shown by Fig. 2 as they appear when in assembled relation; Fig. 4 is a transverse section along line 4—4 of Fig. 3; Fig. 5 is an end elevation showing a somewhat modified assembly of certain of the major elements of the device, and Fig. 6 is an end elevation similar to Fig. 5, but showing a slightly different means for retaining in assembly a flexible bushing element.

Referring now by characters of reference to the drawing, the driving shaft proper as indicated at 10, conveniently and usually consists of an extended portion of a shaft of an electric motor (not shown). For convenience herein, this shaft is referred to as a motor shaft, although the specific source of power for rotation of the fan, is not material to nor restrictive of the present improvements. Mounted on shaft 10 is a stub shaft or core element shown in section by Fig. 2 as including a set collar 11, carrying a set screw 12, which may be of any usual or suitable form. Projecting from one face of the set collar 11, and by preference integral therewith, is the stub shaft portion 13. The elements 11 and 13, although preferably formed integrally, may for reasons of

production economy, be separately formed and later metallically united. The diameter of the bore 14 of the stub shaft section preferably corresponds closely to the exterior diameter of shaft 10.

A preferably resilient annulus, such as a washer 15, is provided with a central opening 16 of a size sufficient to enable the washer to be inserted over the small diameter portion of stub shaft 13, so that the washer 15 is disposed with one face adjacent a face of the set collar 11, as best appears from Fig. 3.

It will have appeared particularly from Figs. 2 and 3 that the exterior surface of the stub shaft portion 13 is provided with a very coarse threading of rectangular section, these threads being indicated at 20, with the intervening reduced portion shown at 21. It is a preference that these threads be of wide rectangular section, somewhat as shown, with the intervening spiral spaces between the threads, of corresponding width and shape.

In Fig. 2 there is shown, prior to assembly, a bushing element indicated generally at 22. This is of open end cylindrical form, and may be characterized by a wall of even thickness end to end, or if desired for a somewhat firmer and more positive mechanical engagement with the associated parts, the bushing 22 may be molded or otherwise provided with threads on its internal surface as indicated by 23, with spiral intervening spaces 24. By preference also the exterior surface of bushing 22 is similarly threaded at 25, the threads 25 being intervened by the spiral recesses 26.

It is a preference to employ as a material for the bushing 23 and the washer 15, a rubber stock including a high grade sound-insulating and absorbing material, such as a synthetic rubber, several makes of such materials being available to the trade, among which is mentioned Duprene or the like. A stock formed of any of such materials has been found highly satisfactory as a sound absorbent or sound-insulating material, and has also proven advantageous as to ageing effect over natural rubber compounds, and with the further advantage of obviating in great measure, the deleterious solvent effect of petroleum lubricants. A preference has been mentioned for a rubber or rubber-like compound for the bushing 22 and washer 15. It is understood of course that these two elements may be formed up of dissimilar materials, but it is noted as a general preference, that both be formed of a non-metallic substance. The materials suitable as to sound-insulating properties, include among many others, certain types of paper or fiber tubing; compressed cellulose materials and many other fibrous substances exhibiting sound-absorbing properties and sound-insulating characteristics.

It is further desired that the stock of bushing 22 be of such nature that when disposed between the stub shaft and the hub proper (hereinafter to be described), it may be loaded as by compression into its final position, so that the resilient walls of the element are brought to engage and occupy the spaces 21 of the stub shaft or core, and the corresponding spaces intervening the threads of the hub or hub sleeve.

Referring now to the preferred form of hub element, this is preferably tubular in form, being shown as it would appear prior to assembly, at the left hand end of Fig. 2. The hub sleeve is generally indicated at 30 and is characterized by a cylindrical exterior surface, while its interior surface or the wall of the bore 31 through the sleeve, is threaded in a manner approximating that of the external surface of the bushing 22. As shown by Fig. 2, these threads are indicated at 32 with the intervening spiral areas at 33, the threads and intervening spaces being of a relatively wide rectangular type. It will be noted that the smallest internal diameter of the hub sleeve 30 is substantially in excess of the external diameter of the stub shaft portion 13, thus providing a space for accommodation of the bushing 22. The length of the sleeve, that of bushing 22, as well as that of the shaft section 13, are all or may be approximately the same.

By preference, the outermost end portion of the hub sleeve 30 is stepped or undercut to provide a portion 34 of reduced diameter, which results in a shoulder 35, the external diameter of the portion 34 closely approximating the diameter of an opening 36 which is the center aperture of a spider element 40. The latter is or may be, of itself, of conventional construction including, integrally with the center disc portion 40, a plurality (in accordance with the number of blades) of blade arms 41, to each of which is attached one of the blades 42 of the fan, this attachment being effected by any suitable means such as rivets 43. The exact construction of the spider and blades, and the manner of blade attachment, are herein mentioned only for completeness as they form of themselves no part of the present improvements.

There is shown by Fig. 5 a minor modification embodying the present improvements, according to which the stub shaft and the set collar are or may be the same as shown by Figs. 2 and 3, which is also true of the bushing 22, the spider, the spider arms, blades, etc., as described. The arrangement of Fig. 5 is, however, distinguished in that the portion 34 on the hub sleeve 30 which projects beyond the spider disc 40 when the latter is inserted over the end of the hub sleeve, is in part deformed in a radially outward direction similarly to the showing of Fig. 3, and as indicated at 44 of that figure. This deformed or upset portion may result from any suitable process such as swaging or spinning over the projecting portion of the hub sleeve 30. According to the modification of Fig. 5, only certain portions of this projection 34 are upset as by swaging or spinning over, these portions being indicated at 45, for the purpose of securement of the spider disc to the end of the hub. The angularly intervening portions 46 are similarly upset as by swaging or spinning, but are turned downwardly so as to engage the outer end face of the bushing 22. According to this arrangement the bushing 22, whether initially of preformed threaded type, or characterized by an even wall thickness, is compressed by an endwise pressure into the space between the stub shaft section and the hub sleeve, and while so compressed, the portions 46 are spun down in place over the end face 47 of the bushing.

A still further but minor modification is shown by Fig. 6, wherein an end portion 48 on the stub shaft, which is preferably initially of reduced diameter, is swaged or spun radially upwardly so as to engage the end face 47 of the bushing and so as to hold the bushing firmly in assembly, the other end being in abutment with the resilient washer 15. The swaged or spun portion of the stub shaft is indicated at 49 (Fig. 6). It

is understood that according to either of the practices exemplified by Fig. 5 or Fig. 6, the bushing, which in these cases is of compressible material, is retained under pressure in a suitable jig or the like, during the operation of spinning over the portions 46 or 49.

The manner of assembly and advantages in use of the present improvements are thought to be fully apparent from the foregoing description of parts, but it may be noted that with the parts as shown by the exploded view of Fig. 2, the washer 15 is threaded onto the stub shaft 13 to bring it firmly against the forward face of the set collar 11. Following this, the bushing 22 is threaded or sleeved over the stub shaft portion to bring it into contact with the washer; the next operation in order consisting of the application of the hub sleeve over the bushing either by threading or insertion thereover. It is preferred that the spider, with or without the blades, be first attached to the hub sleeve as by spinning over the portion 44 as heretofore described.

Depending upon the exact nature of the material employed as the sound insulating and sound absorbing medium constituting the bushing, the assembly operations may be continued by the described endwise compression of the bushing, followed by spinning over or swaging the portion 46 to bring it to bear against the bushing and thus hold it in its compressed condition, while according to the practice exemplified by Fig. 6, the same operation is carried through with respect to the portions 49, to bring them firmly and finally into engagement with the end face 47 of the bushing.

It will have appeared that when the parts are finally assembled as shown by Figs. 1 and 3, the hub sleeve, which is rigidly secured through portions 44 to the spider and hence to the blades, is susceptible of a universal movement with respect to the stub shaft portion 13, and hence also with respect to the motor shaft 10. Due to the axial resilience of bushing 22 and washer 15, the fan proper, including the hub, is susceptible of a moderate displacement along the shaft. Also, due chiefly to the preferred compressible nature of bushing 22, the fan assembly proper may assume the position of slight eccentricity with respect to the shaft 10 and stub shaft section 13. This radial displacement of the axis of rotation of the fan may occur due to mechanical unbalance of the fan, which, as heretofore mentioned, at times may result in setting up forces which tend to rotate the fan about its own center of mass rather than about the axis of the shaft 10 and stub section 13. It will have appeared further that this mounting, in providing for universal movement of the fan assembly proper with respect to the shaft, cares in great measure for noise and vibration due to load unbalance created by occasional tendencies of the fan blades when misaligned to cause the fan to bend forward or backward from its exact intended plane of rotation. From the foregoing it will have appeared that the arrangement tends to minimize the sound and vibration transmitted to the ambient air, and in cooperation with the cushioning expedients between the fan motor proper and its base of support, realizes each and all of the foregoing objects in substantial measure.

Although the invention has been described by making detailed reference to certain presently preferred embodiments of the invention, numerous changes may be made in the parts described, as well as in their combinations and described arrangement, without departing from the full intended scope of the invention as defined by the claims hereunto appended.

I claim:

1. A hub and shaft assembly for a propeller type fan or the like, including a threaded stub shaft section having a collar at one end thereof, a bushing of compressible sound-insulating material carried on the stub shaft section, a hub sleeve mounted on the bushing, the bushing being in threaded engagement with the stub shaft, and the sleeve being in threaded engagement with the bushing, and a stop for the bushing, carried by the stub shaft, the threadedly related elements having their threads directioned so that normal rotation of the fan tends to compress the bushing against the stub shaft section.

2. In a hub and shaft assembly for a propeller type fan or the like, a core element, a sound-insulating bushing of compressible material and a hub sleeve coaxially and concentrically arranged, a resilient washer at one end of the coaxial elements and threaded means on a pair of the coaxial elements tending to compress the washer and to compress the bushing toward the core element, incident to any angular displacement of the coaxial elements in the normal direction of fan rotation.

3. A fan hub and shaft assembly including, in combination with a motor shaft, a hollow shaft section including a set collar at one end and a sleeve portion of a relatively reduced diameter projecting axially from the set collar, a bushing of a resilient rubber-like material over the sleeve portion, a hub sleeve over the bushing, and threads of a relatively wide, rectangular section formed externally of the bushing and internally of the hub sleeve, the threads being directioned to tend to compress the bushing toward the sleeve portion by which it is carried, in response to normal rotation of the fan.

4. A fan hub and shaft assembly including, in combination with a motor shaft, a hollow shaft section including a set collar at one end and a sleeve portion of a relatively reduced diameter projecting axially from the set collar, a bushing of a resilient rubber-like material over the sleeve portion, a hub sleeve over the bushing, and threads of a relatively wide, rectangular section formed internally of the bushing and externally on the said reduced sleeve portion, the threads being directioned to tend to compress the bushing toward the sleeve portion by which it is carried, in response to normal rotation of the fan.

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