United States Patent

Kelly

[15] **3,698,835**

[45] **Oct. 17, 1972**

[54] **FAN CONSTRUCTION**

[72] Inventor: **John C. Kelly,** 1320 Kathmar, Jackson, Mich. 49203

[22] Filed: **Feb. 1, 1971**

[21] Appl. No.: **111,586**

[52] **U.S. Cl.**.....**416/132,** 416/240

[51] **Int. Cl.**.....**F04c 29/36**

[58] **Field of Search**.....416/132, 240, 132 A

[56] **References Cited**

UNITED STATES PATENTS

3,044,557	7/1962	Posh	416/132 A
3,406,760	10/1968	Weir	446/240
3,490,686	1/1970	Weir	416/132 A X

FOREIGN PATENTS OR APPLICATIONS

559,674	9/1932	Germany	416/240
12,846	1909	Great Britain	416/240

Primary Examiner—Everette A. Powell, Jr.

Attorney—Harness, Dickey & Pierce

[57] **ABSTRACT**

A fan construction suitable for cooling internal combustion engines has flexible blades clamped on the inside faces of the spider arms, each blade having a hinge section in the form of a tapered bead or corrugation extending along its length with the concave part of the bead facing the spider arm so that both longitudinal edges of the bead engage the arm over a substantial portion of the length of the blade.

7 Claims, 6 Drawing Figures

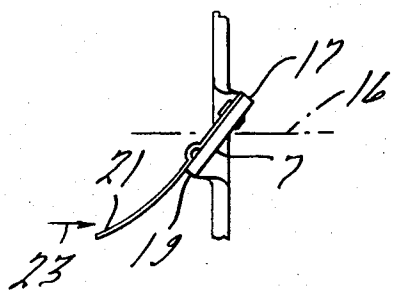
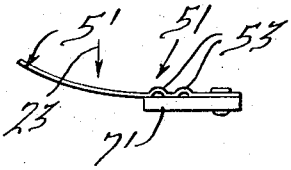


Fig. 6.



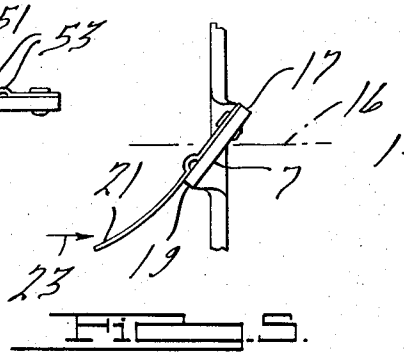
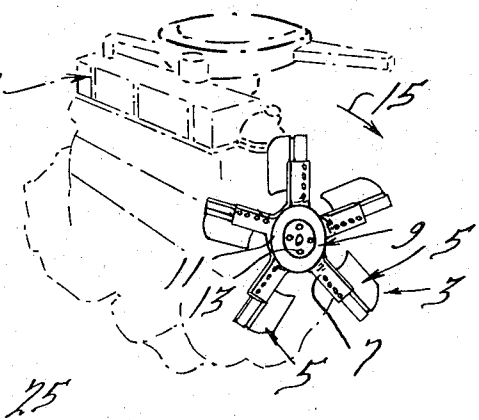


Fig. 5.

Fig. 1.



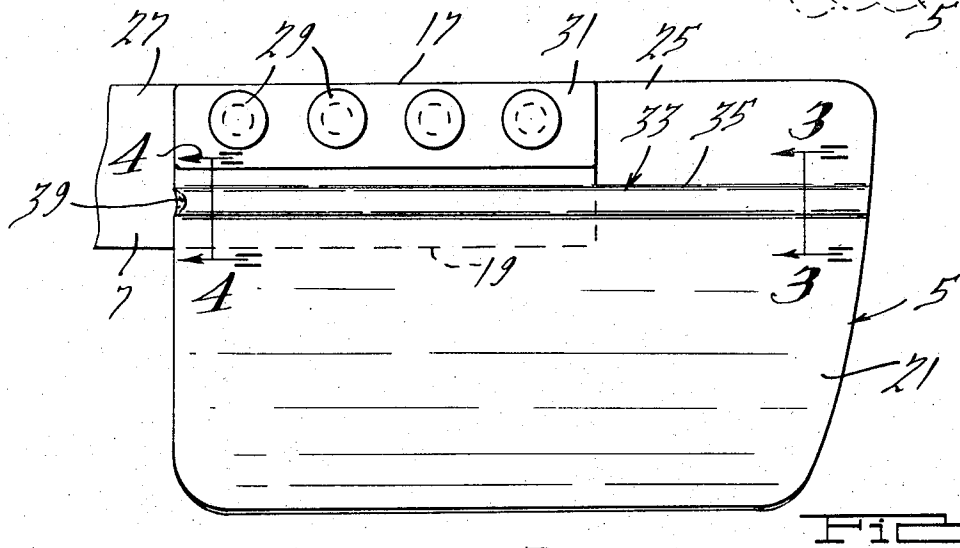


Fig. 2.

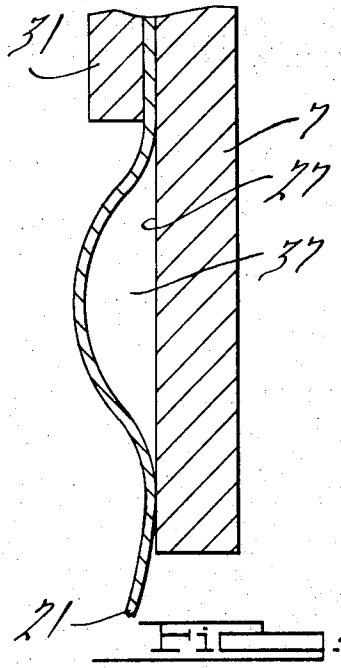


Fig. 4.

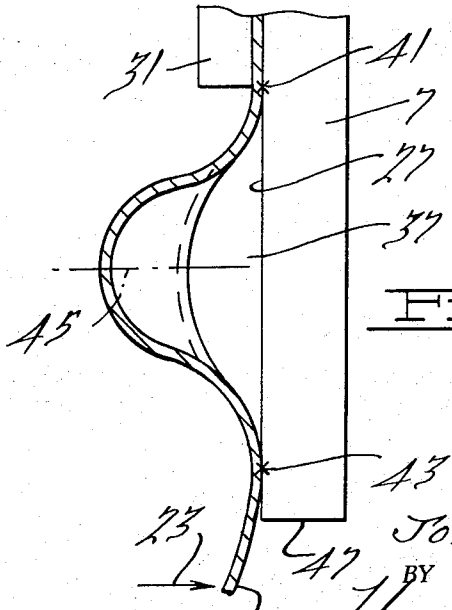


Fig. 3.

INVENTOR.
John C. Kelly
BY
Harness, Dickey & Pierce
ATTORNEYS.

FAN CONSTRUCTION

SUMMARY OF THE INVENTION

It is the purpose of the invention to improve the design of flexible blade type fan constructions so as to stiffen the blades against undesired vibration or flexing and, at the same time, provide a controlled and better flexing action.

The invention accomplishes this purpose through the use of a beaded or corrugated section extending lengthwise of the fan blade. This section acts as a hinge to permit the blade to flex transversely in a controlled manner and also acts as longitudinal rib means to stiffen the blade to flex transversely in a controlled manner and also acts as longitudinal rib means to stiffen the blade against undesired longitudinal deflection.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view showing a flexible fan construction embodying the invention mounted on an internal combustion engine (shown in phantom);

FIG. 2 is an enlarged view of one of the fan blades of FIG. 1, mounted on its spider, as viewed from the back of the fan construction, i.e., as seen from the left or rear of the engine of FIG. 1;

FIG. 3 is an enlarged cross section along the line 3—3 of FIG. 2;

FIG. 4 is an enlarged cross section along the line 4—4 of FIG. 2;

FIG. 5 is a schematic side view of one of the fan blades mounted on a spider arm with plate 31 omitted; and

FIG. 6 is a schematic view similar to FIG. 3 but with plate 31 omitted showing a modified form of hinge structure.

DESCRIPTION OF THE INVENTION

In FIG. 1 the internal combustion engine 1 includes an axial flow fan construction 3, embodying the present invention, that has a plurality of flexible fan blades 5 mounted on the arms 7 of a spider 9 which includes a hub section 11 that is secured by bolts 13 to a rotary part of the engine 1. The blades 5 are made of elastically flexible material, preferably metal but certain plastics are also feasible, and are, in general, constructed and mounted in such a way that upon rotation of the fan 3 in the direction of the arrow 15 air will be pumped in a direction parallel to the rotary axis 16 of the fan inwardly or toward the rear of the engine 1. To provide a pitch to accomplish this movement of air, the spider arms 7 are twisted or curved as seen in FIG. 6 so that their leading edges 17 are axially forward of their trailing edges 19 and the blades 5 each have a rearwardly curved trailing section 21.

In operation, the blade sections 21 are subjected to pressure acting in the direction of arrow 23 which is proportional to the speed of rotation and tends to axially flax and flatten them or reduce their pitch. As they flatten, they pump less air and use less horsepower to thereby increase the efficiency of operation of the engine 1. Repeated flattening or flexing of the blades 5 introduces fatigue stresses into the blades and their connections with the spider arms 7 that may lead to early failure. Accordingly, it is one of the objects of the

present invention to provide a fan blade construction, and connection with the spider arm, that distributes the stresses on the blade and on the connection so as to lower the maximum stress levels and thereby increase the life of the fan construction.

As seen best in FIG. 2 each fan blade 5 comprises a longitudinally extending side portion 25 which is transversely coextensive with and overlapping the spider arm 7 to which it is attached. Extending transversely from the attachment portion 25 is the curved downstream trailing edge section 21. The attachment portion 25 is secured against the downstream face 27 of the spider arm 7 by means of a series of rivets 29 or the equivalent, the rivets preferably seating against a clamp plate 31 which is somewhat less in thickness than the spider arm 7 as can be seen in FIG. 3. As can be seen in FIG. 2 the outer longitudinal end of the fan blade 5 may extend beyond the outer end of the arm 7. It is desirable, however, that the overlap section being of sufficient length to provide the necessary strength of connection between the blade and spider arm and a degree of stiffness against deflection of the blade 5 about an axis transverse to its length.

In accordance with this invention, the attachment section 25 of the fan blade is provided with a hinge means 33 for deflection of the trailing edge section 21 that is integral with and formed as a part of a structure of the blade 5. In FIGS. 2 to 4 the hinge means 33 is in the form of a single arcuate corrugation or bead 35 which extends the full length of the blade 5. The bead 35 extends in a downstream direction and since the fan blade 5 is attached to the downstream spider arm face 27 the bead 35 is concave on its upstream surface whereby it is spaced from the surface 27 as seen by the channel 37. The outer end of the channel 37 is preferably open whereas the inner end is preferably substantially closed by bending of a flap 39 across the inner end of the bead 35. Preferably, and as shown in FIGS. 3 and 4, the bead 35 is uniformly tapered with respect to its depth or height so that the outer end is considerably deeper than the inner end, the width preferably being constant throughout the length of the bead.

The curved side edges on the leading and the trailing sides of the bead 35 have lines of tangency 41 and 43 with the surface 27 of the spider arm 7. The line 43 is preferably located inwardly from the side edge 47 of the arm 7 by about one-eighth inch in the average size fan construction used on modern U.S. automobiles. The lines 41 and 43 along with the center line 45 of the bead 35 (i.e., the line defined by the points at which curvature of the circular bead sections reverse) constitute the axes about which the trailing edge 21 of the blade will flex as it moves under the variation of pressure indicated by the arrow 23. Thus, the fixed end or side condition on the attachment side 25 of the blade 5 as the section 21 deflects in the manner of a cantilever includes three transversely spaced parallel axes 41, 43, and 45 instead of a single axis as is commonly the condition under cantilever loading. Accordingly, the stress level and the possibility of fatigue failure are minimized. The bead 35 also stiffens the blade 5, particularly with respect to longitudinal deflection or vibration in a plane perpendicular to arm 7. The tapered shape of the bead 35 provides for a more

uniform stress distribution along the length of the blade 5.

FIG. 6 shows a modified form of hinge means 51 attaching the fan blade 5' to the spider arm 71 wherein a pair of parallel beads 53 are pressed into the sheet from which the blade 7 is formed. These act in accordance with the principles described to furnish a plurality of hinge axes to accommodate cantilever deflection of the blade 5' as a result of pressure variation 23 on the blades.

Modifications in the specific structure shown may be made without departing from the spirit and scope of the invention.

I claim:

1. An axial flow flexible fan construction of the type used on variable speed engines comprising a rotatable spider having an axis of rotation and arms extending radially with respect to said axis and fan blades secured along a line of attachment to said arms and inducing fluid flow in a direction parallel to said axis, said blades each comprising an attachment side portion overlapping said arm and a trailing edge side portion extending away from said arm and attachment portion, said attachment portion including a corrugated flexible hinge section spaced from said line of attachment extending the full length of the blade and forming the fixed side about which the blade deflects due to variations in fluid pressure on the blade, said attachment portions being secured to the downstream sides of the arms.

2. A fan construction as set forth in claim 1 wherein said hinge section engages the arm along at least two lines of tangency and said trailing edge section deflects about said lines as axes of deflection and also about a line located centrally between said lines of tangency.

3. A fan construction as set forth in claim 2 wherein said hinge section comprises a single arcuate bead.

4. A fan construction as set forth in claim 3 wherein said bead varies uniformly in size from the inner to the outer ends of the blade.

5. A fan construction as set forth in claim 4 wherein said bead is of constant width but tapered in depth so that its shallow end is at the inner end of the blade.

6. A fan construction as set forth in claim 5 including means substantially closing the inner end of the channel formed by the bead.

7. A fan construction as set forth in claim 1 wherein said hinge sections each comprises a plurality of parallel ribs tangent along a plurality of lines with the downstream side of the arm to which it is secured.

* * * * *