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Wooden

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[54] **FLEXIBLE BLADE FAN**

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

[51] **Int. Cl.** **F04d 29/38**

[58] **Field of Search** 416/132, 134, 240, 416/242, 243

[56] **References Cited**

UNITED STATES PATENTS

3,679,321	7/1972	Strick	416/132
2,149,267	3/1939	Bouvy et al.	416/240
3,289,924	12/1966	Weir	416/132 UX
3,594,098	7/1971	Pratinidhi	416/132

FOREIGN PATENTS OR APPLICATIONS

939,847	5/1948	France	416/240
352,507	7/1931	Great Britain	416/132

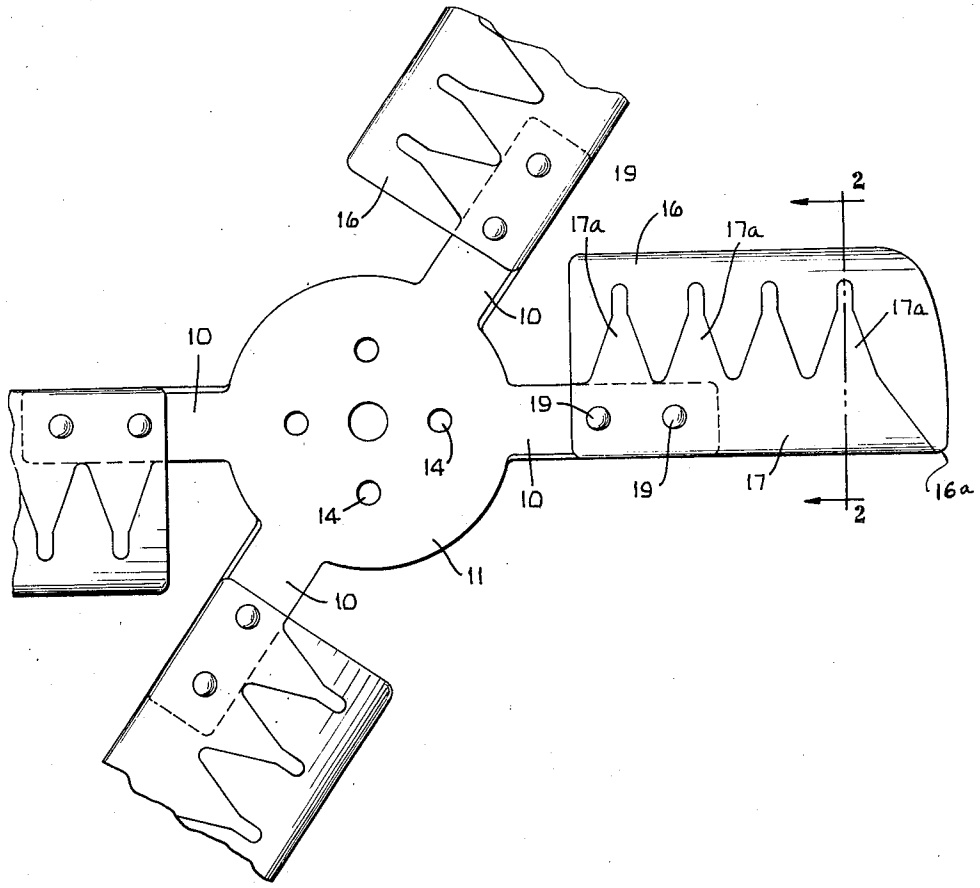
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[57] **ABSTRACT**

Disclosed is a flexible blade fan structure in which the flexible fan blades are stabilized by an overlying lamination formed to provide fingers curved and of tapering configuration. In the dynamic condition, that is, when the blade is rotated and undergoing flexure, the radius of curvature of the fingers is less than the radius of transverse curvature of the fan blade so that the fingers act as beams of uniform strength (or constant stress beams) point loaded by deflection of the fan blade under load. The rubbing between the contiguous surfaces of the blades and laminations, in the dynamic condition, serves to damp vibratory forces.

3 Claims, 2 Drawing Figures



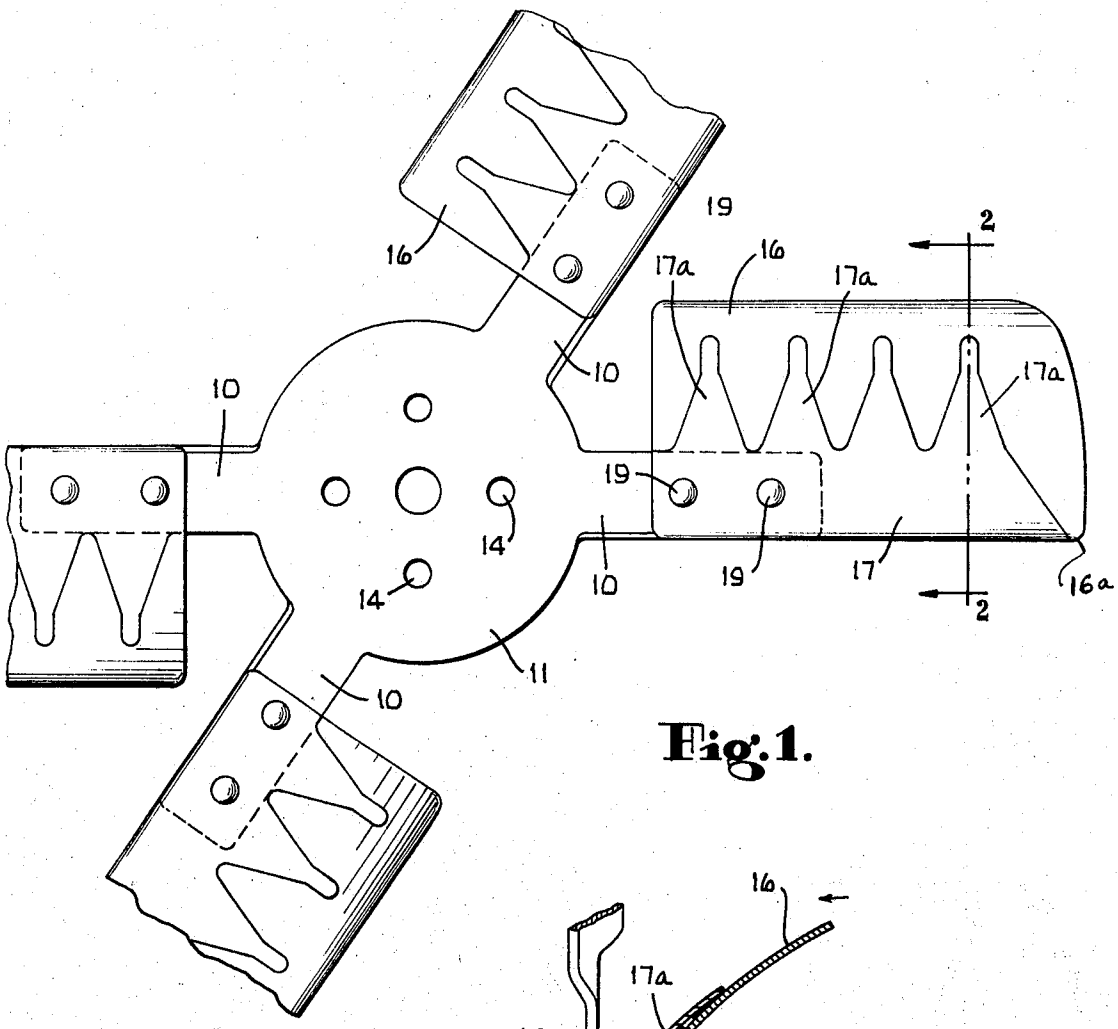


Fig. 1.

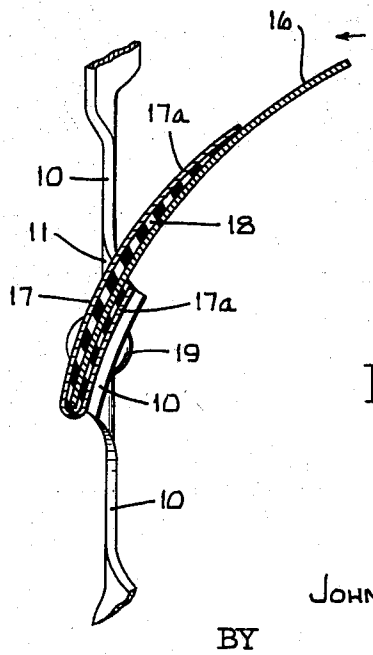


Fig. 2.

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FLEXIBLE BLADE FAN

BACKGROUND OF THE INVENTION

Air moving fans, with flexible blades, are well known in the prior art. When such fans are used for cooling an internal combustion engine, at high engine or vehicle speeds, when otherwise the fan might move more air than is necessary to cool the engine and thus waste power, the flexible blades of the fan deflect to reduce their pitch and thus unload the fan and reduce the noise level of the fan. Examples of prior art flexible blade fans are disclosed in U.S. Pat. Nos. 2,149,267 and 3,406,760.

The fan structure of the present invention stabilizes the deflection of the flexible fan blades by providing constant stress beams or fingers overlying the convex side of the transversely curved, flexible fan blades, the fingers being curved so that they are point loaded (as distinguished from uniform loading) by deflection of the fan blades. The fingers are tapered to give them uniform strength along their length with minimum mass added by their presence to the fan blade assembly.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a fragmentary, front view of a fan assembly embodying the present invention.

FIG. 2 is a fragmentary, sectional view taken generally along the line 2—2 of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring initially to FIG. 1, the fan assembly includes a spider having a hub portion 11 and a series of radially extending arms 10. The hub portion is apertured as indicated at 14 to permit attachment to the driving pulley and the arms 10 may be spaced at various angles with relation to each other.

Each of the arms 10 carries a flexible fan blade 16 which might be formed of steel or aluminum, the flexible blades having a transverse curvature as will be evident from FIG. 2. Each of the blades 16 extend beyond the ends of the adjacent spider arm and the leading edge 16*a* of each of the blades is embraced by a lamination 17 formed of relatively thin resilient material, preferably aluminum. As will be evident from FIG. 2, the lamination 17 has a portion which overlies the arm 10 when the assembly is completed. Prior to assembly, the contiguous surfaces of the blades 16 and the laminations 17 are, preferably, coated with an adhesive cushioning material, indicated at 18, and the lamination and blade are then rigidly connected by any suitable means such as the rivets 19. This cushioning coating is, of course, optional, and enhances the vibration damping action of the fingers to be subsequently described.

As will be evident from FIG. 1, the lamination 17, that portion of it overlying the convex surface of the blade 16, is formed to provide a plurality of extending fingers 17*a*. The fingers are tapered from their base to their outer ends, the tapering being such that the fingers act as constant stress beams, that is, beams of uniform strength throughout their lengths when a point load is applied at their free ends.

As may best be seen in FIG. 2, the transverse curvature of the lamination portion forming the finger 17a is, when the fan is deflected under load, of less radius than the transverse curvature of the blade 16 so that as the blade 16 flexes under load, it applies a point load to the fingers 17a which resist such flexure and the fingers rub the fan blade as it flexes.

In operation, as the fan is rotated clockwise, as viewed in FIG. 1, at relatively low rotational speeds, the fan blades 16 will be acted on by a force tending to deflect or bend the blades in the direction of the arrow shown in FIG. 2. This applies a point load to the free ends of the fingers 17*a* and, as the speed of rotation of the fan increases, this deflecting force becomes larger and the blades tend to flatten or unload. The fingers 17*a* resist or control this flexure in proportion to its magnitude over a relatively wide range of blade flexure values. These fingers, because of frictional rubbing against the blades as the blades flex, serve to transform a part of the vibrational energy in the blades to thermal energy and thus provide a vibration damping effect. The cushioning layer 18 serves to damp vibrational forces induced in the rapidly moving blades. Since the fingers 17*a* are formed as constant stress beams they provide the desired stabilizing effect on the blades 16 with a minimum of added mass to the fan assembly.

I claim:

1. A fan structure including a spider having arms extending radially outward from a central hub portion and a transversely curved flexible fan blade attached to each of said arms said fan blades each having a flexible lamination overlying the convex surface of said fan blade and formed to provide multiple extending cantilever mounted fingers of tapered configuration providing uniform stress along their length when loaded at their free end, said fingers being curved along their length with their free ends engaging said convex fan blade surface, whereby transverse flexure of the blade during rotation of the fan structure applies a point loading to said lamination fingers, said fingers reacting as constant stress beams to control blade flexure over a wide range of blade flexure values with minimum mass, and the frictional rubbing action of said fingers on said blades as blade flexure occurs serving to damp vibration of the blades.

2. A fan structure as claimed in claim 1 in which said lamination is generally U-shaped in cross-section and embraces the leading edge of the fan blade.

3. A fan structure as claimed in claim 1 in which an elastic cushioning layer is disposed between the adjacent surfaces of said blade and lamination to enhance the frictional damping of blade vibration.

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