United States Patent [19]

Freeman et al.

[11] **3,759,630**

[45] **Sept. 18, 1973**

[54] **FLEXIBLE BLADED FAN WITH IMPROVED REINFORCING**

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

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

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

[56] **References Cited**

UNITED STATES PATENTS

3,044,557	7/1962	Posh	416/132
3,406,760	10/1968	Weir	416/240
3,639,078	2/1972	Pratinidhi	416/132
3,679,321	7/1972	Strick	416/132
3,698,835	12/1972	Kelly	416/132

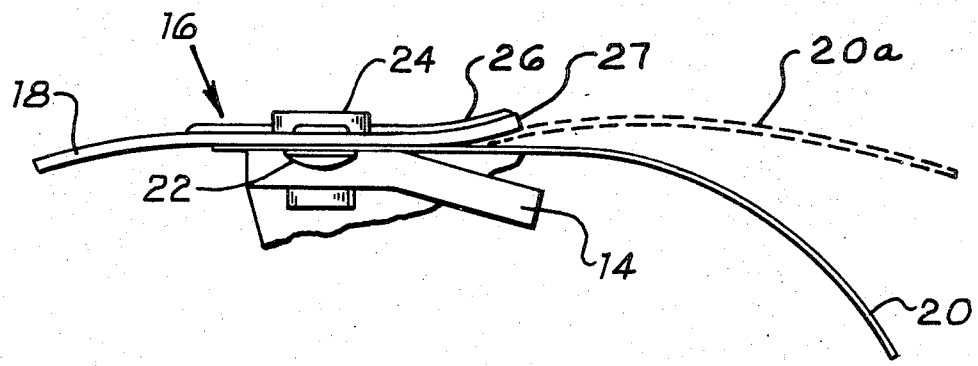
Primary Examiner—Everette A. Powell, Jr.

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[57] **ABSTRACT**

A fan having curved flexible resilient blades which decamber with an increase in rotational speed and aerodynamic forces. Each of the blades has an overlying reinforcing strip in partial contact with a trailing sheet, which decambers as the rotational speed increases. The reinforcing strip and trailing sheet, which is of significantly thinner cross-section, are joined to each other and to a supporting arm extending from a central hub. The reinforcing strip preferably has a curved trailing decamber limiting portion and a curved bending limiting portion disposed along the inner side edge of the reinforcing strip and its decamber limiting portion. As the trailing sheet decambers it also makes progressive contact with the reinforcing strip in a direction toward the inner side edge of the sheet, thus reducing stress concentration at the intersection of the inner side edge of the sheet and the decamber limiting portion of the reinforcing strip.

3 Claims, 6 Drawing Figures



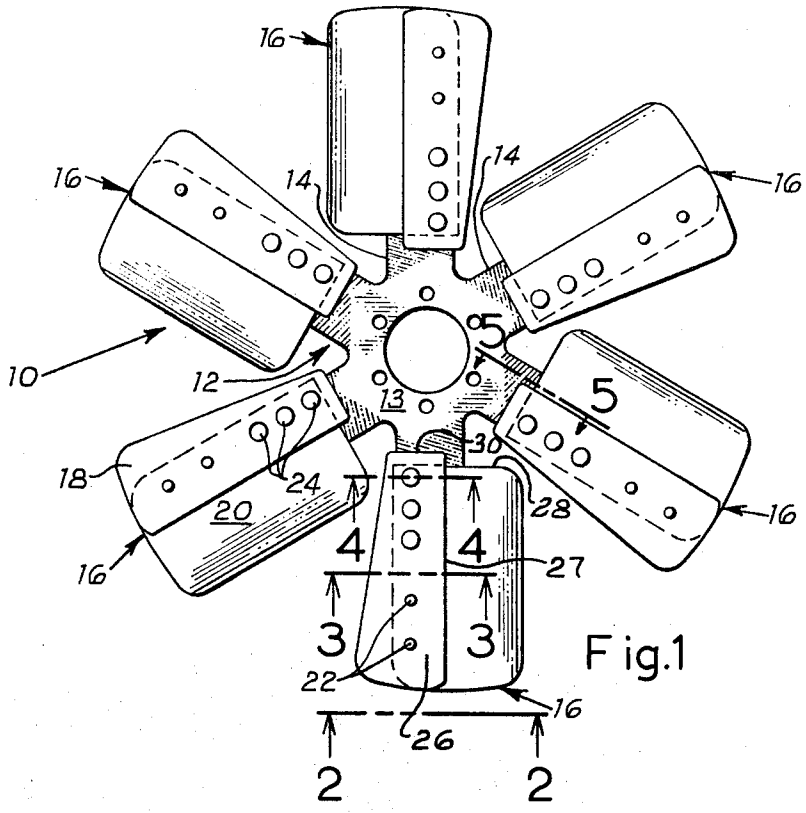


Fig.1

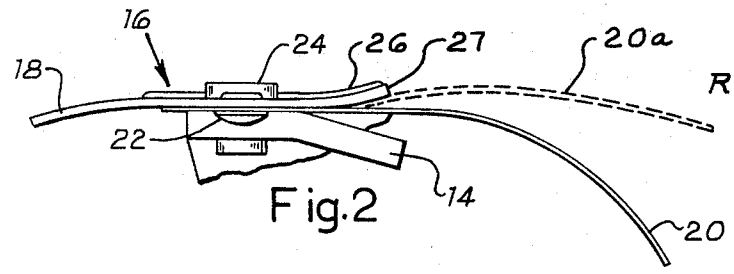


Fig.2

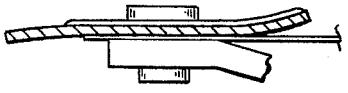


Fig.3

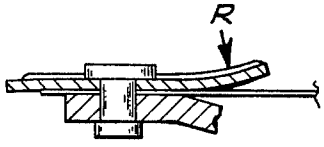


Fig.4

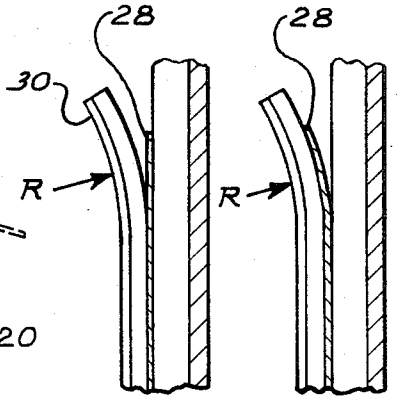


Fig.5 Fig.5a

FLEXIBLE BLADED FAN WITH IMPROVED REINFORCING

BACKGROUND OF THE INVENTION

This invention relates to cooling fans to be used primarily in automotive and truck applications, more specifically it relates to a fan having flexible blades which decamber as its rotational speed and the aerodynamic forces on the blades increase.

Since the modern concept of flexible bladed fan was disclosed in U.S. Pat. No. 3,044,557, several progressive developments have occurred as revealed in the following U.S. Pat. Nos. 3,289,924, 3,356,154, 3,406,760, 3,594,098, 3,639,078, and 3,639,079. These developments as will be noted deal primarily with supporting the blade as it decambers and various means to prevent undue weakness in the fan structure

As has been noted in U.S. Pat. No. 3,594,098, the decamber rate may be controlled by utilizing a weighted trailing edge of each blade. Another approach to achieving the same results is to make the flexible portion of the blade as thin as possible so that decambering can result with a minimum of resistance. Unfortunately, when a blade is made very thin it becomes prone to tearing at high stress concentration points. One such point is at the intersection of the inner edge of the flexible portion of the blade and the reinforcing strip used to limit the amount of decambering flexure. Because of the necessity for preventing tearing at this point, the flexing blades were normally made of a thicker cross section than would be used if this problem could otherwise be solved. The present invention offers a solution to this problem, thus resulting in an economic savings.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a plan view of the upstream side of an engine cooling fan embodying the present invention.

FIG. 2 is an enlarged end view of an arm and blade of the fan viewed as indicated by line 2—2 of FIG. 1.

FIG. 3 is an enlarged sectional view of the same arm and blade taken along line 3—3 of FIG. 1.

FIG. 4 is a partial enlarged sectional view of the arm and blade taken along line 4—4 of FIG. 2.

FIG. 5 is a partial enlarged sectional view of another arm and blade of the same fan taken along line 5—5 of FIG. 1.

FIG. 5*a* is a view similar to FIG. 5 showing a portion of a blade in a supported position.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring initially to FIG. 1 there is illustrated a cooling fan generally designated by the numeral **10** composed of a spider **12** having a hub portion **13** and a plurality of spider arms **14.** These arms are oriented perpendicularly to the axis of rotation of the fan. Joined to the spider arms are a plurality of fan blade constructions generally designated as **16.**

As seen in FIGS. **1** and **2** each blade **16** is preferably constructed of a reinforcing hub plate **18** trailing flexible sheet **20** joined together by rivets **22** and also to the spider arm **14** by rivets **24.** The trailing portion **26** of the reinforcing strip **18** is curved away from the trailing sheet **20** to act as a deflection limit stop for the sheet **20** as the sheet decambers during rotation of the fan.

In FIG. **4** this curvature, which is preferred over a sharp bend, is indicated by radius arrow R. It distributes stresses in the trailing sheet **20** more evenly than would otherwise occur if the reinforcing sheet contained a sharp bend.

As will be seen in FIG. **2** the trailing sheet **20** will progressively engage the inner surface of the curved portion **26** as the blade decambers during rotation. This will provide all the advantages hitherto recognized for flexible bladed fans in that less noise and a significant power saving will occur in the decambered position.

The feature which has not previously been recognized and which is now encompassed in the present invention is that as the blade decambered in prior art constructions the inner side edge, shown here as **28,** would engage the trailing edge **27** of the reinforcing portion thus creating a high stress concentration point at the intersection of the two edges. The present invention overcomes this problem by curving the inner edge portion **30** of the reinforcing portion upwardly from the trailing sheet. In the particular embodiment shown in FIGS. **5** and **5***a* the curvature of the reinforcing portion has a radius R which is the same as the curvature shown in FIG. **4.** These two radii, however, need not always be equal. The advantage of this type of formation is that as the trailing portion **20** decambers to position **20***a* it will not only progressively engage the curved portion **26** of the reinforcing strip, but will also engage the upwardly turned portion **30** of that reinforcing strip progressively outwardly toward the inner side edge **28** of the sheet, precluding a sharp engagement of the intersecting edges previously described. Therefore the stress concentration will be less than would otherwise occur, thus permitting the use of thinner sheet stock for the trailing edge portion **20.** As previously indicated, the use of thinner stock will create a more efficiently operating flexible bladed fan.

We claim:

1. In a fan having curved flexible resilient blades which decamber with an increase in rotational speed and aerodynamic forces, each of said blades comprising a reinforcing strip overlying and in partial contact with a trailing sheet, which decambers as rotational speed increases, joined to each other and to a supporting arm extending outwardly from a central hub portion, said trailing sheet being of significantly thinner cross-section than said reinforcing strip, said reinforcing strip comprising,

a. a trailing decamber-limiting portion extending partially coextensively with a portion of said trailing sheet and at an acute angle to said sheet, and

b. a bending limiting curved portion disposed along the inner side edge of said reinforcing strip and decamber-limiting portion

whereby, as said trailing sheet decambers, progressive contact is made by said sheet with said reinforcing strip in a direction toward the inner side edge of said sheet, thus reducing stress concentration at the intersection of said inner side edge of said sheet and said decamber-limiting portion.

2. A fan as called for in claim **1** wherein said (*a*) trailing decamber-limiting portion and said (*b*) bending limiting curved portion are both curved in a direction away from the surface of said trailing sheet which is in contact with said reinforcing strip.

3. A fan as called for in claim **2** wherein said (*a*) trailing decamber-limiting portion and said (*b*) bending limiting curved portion are both curved, with equal radii of curvature.

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