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
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. 5a 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 edge side, 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 5a 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 20a 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.