

[54] **FLEXIBLE-BLADED FAN WITH IMPROVED REINFORCING CAP**
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 [58] Field of Search.....416/132, 240

[57] **ABSTRACT**

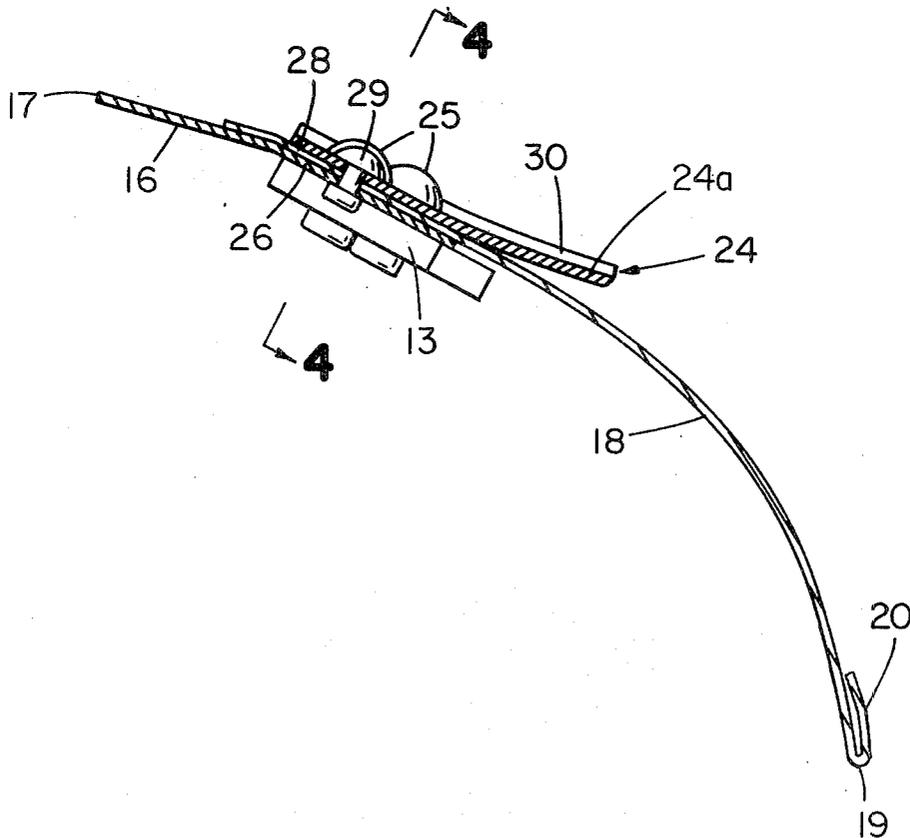
A fan having a hub, a plurality of arms extending radially outwardly of the hub, blade structures, one secured to each arm, each comprising resilient trailing portions which decamber as rotational speed increases, and a reinforcing cap secured to each arm and blade which has a decamber-limiting portion extending partially coextensively with the trailing blade portion at an acute angle thereto, and two integrally formed upstanding lips, one disposed along each opposed radially spaced edge of the cap and of the decamber-limiting portion thereof which reduce metal fatigue in the cap.

[56] **References Cited**

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6 Claims, 5 Drawing Figures



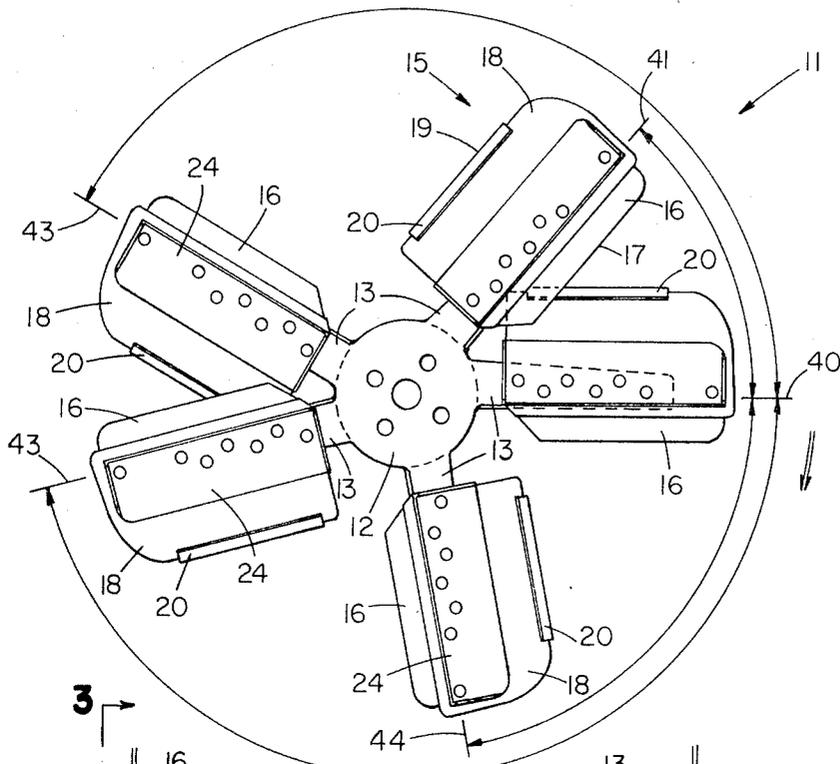


FIG 1

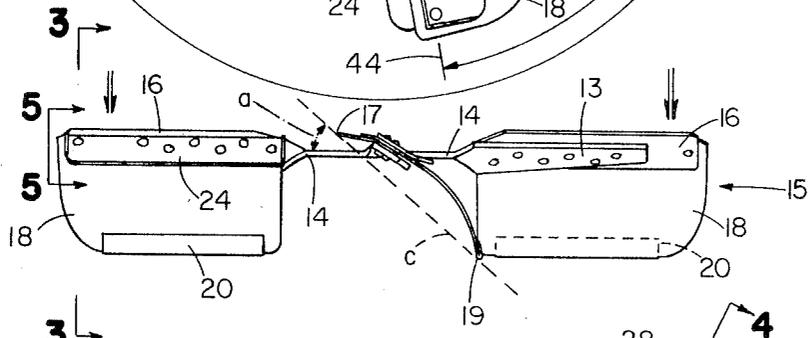


FIG 2

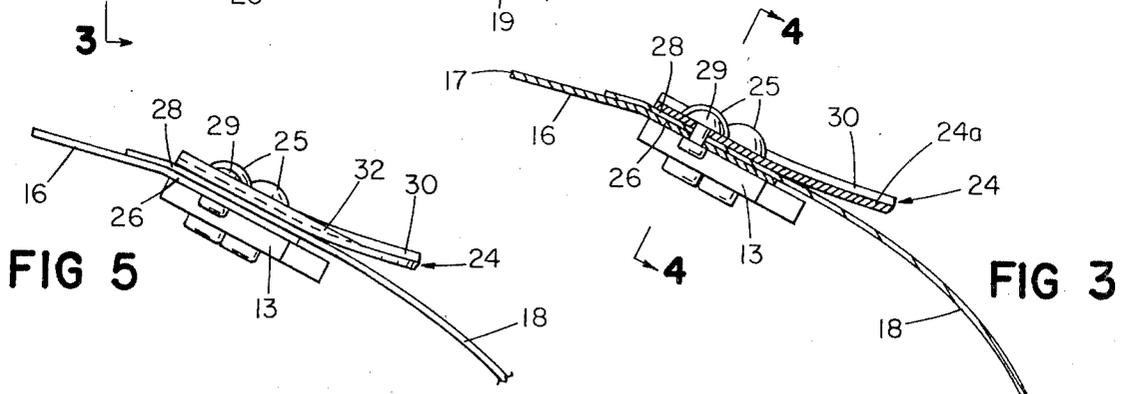


FIG 3

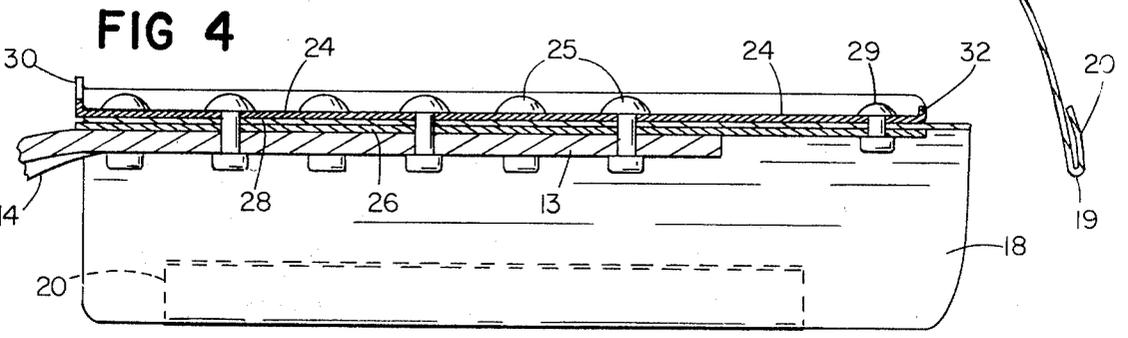
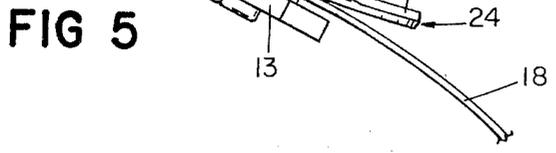


FIG 4

FLEXIBLE-BLADED FAN WITH IMPROVED REINFORCING CAP

This invention relates to fans having flexible blades which decamber as rotational speed increases.

The principal object of this invention is to relieve stresses and reduce metal fatigue in high-capacity, large-bladed fans. Other objects are to reinforce such fan blades without substantially altering the overall size, weight or conformation of the fan, while preventing excessive blade vibration and maintaining low-fan noise levels.

The invention features, in a fan having a hub, a plurality of arms extending radially outwardly of the hub, and blade structures comprising resilient trailing portions which decamber as rotational speed increases, one blade structure being secured to each arm, reinforcing caps, one said cap secured to each blade structure and the respective arm and each said cap comprising a trailing decamber-limiting portion extending partially coextensively with the trailing portion of the blade at an acute angle to the trailing portion of the blade, and two radially spaced integrally formed upstanding lips, one disposed along each opposed radially spaced side edge of said cap and of this decamber-limiting portion thereof, whereby periodic stresses induced in the cap during decambering of the trailing portion of the blade against the decamber-limiting portion are resisted without excessive metal fatigue in the cap.

In a preferred embodiment, the lips are each up to one-eighth inch high, and are parallel to one another; the cap is sized to be partially coextensive with the blade structure past the end of the arm; and, a plurality of fasteners (e.g., rivets) extend through cap, blade structure, and arm, and at least one fastener extends through the cap and blade only.

Other objects, features and advantages will be apparent to one skilled in the art from the following description of a preferred embodiment of the invention, taken together with the attached drawings thereof, in which:

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

FIG. 2 is a side elevational view of the fan of FIG. 1;

FIG. 3 is an enlarged sectional view of an arm and blade structure of the fan taken along the line 3—3 of FIG. 2;

FIG. 4 is a sectional view of an arm and blade structure of the fan taken along the line 4—4 of FIG. 3; and,

FIG. 5 is an end view of a reinforcing cap taken along the line 5—5 of FIG. 3.

There is shown in FIGS. 1 and 2 generally at 11 an engine cooling fan adapted for use on a motor vehicle. The fan has a central planar hub 12, with asymmetrically disposed arms 13 extending therefrom. As best shown in FIG. 2, each arm has a twisted section 14 joining it to the hub so that the plane of each arm is at an angle to the plane of the hub.

A blade structure 15 is secured to the upstream side of each arm 13, and includes a leading blade member 16 formed of a relatively rigid steel (SAE 950, prepainted, 0.024 inch thick) and defining a leading edge at 17, and a trailing blade portion defined by member 18, formed of a resilient steel (AISI 301 stainless steel, 0.018 inch thick), and defining a trailing edge at 19, which is substantially parallel to leading edge 17.

Provided at the trailing edge of each blade member 18 is a weight 20. As illustrated the weight 20 is an integral portion of blade member 18 folded upon itself at the trailing edge so as to engage the convex side of the blade member, and has a mass of about 15 percent of the total mass of the blade member 18. Such weights are fully described in my copending U.S. Pat. application Ser. No. 857,849, filed Sept. 15, 1969, now U.S. Pat. No. 3,594,098 entitled "Fan with Weighted Flexible Blades."

As shown in greater detail in Figs. 3 and 4, each blade member 16, 18 overlies the arm 13 to which it is mounted on the upstream side of the arm, and is secured to the arm by a reinforcing cap 24 and rivets 25.

As shown in FIGS. 3 and 4, the overlapping flat portion 26 of leading member 16 and flat portion 28 of trailing member 18 are secured between reinforcing cap 24 and the upstream side of arm 13 by the rivets 25 therethrough, and additionally to the cap 24 and to one another by the rivet 29. The trailing

portion of trailing member 18 is curved through the plane of arm 13 toward the downstream end of the fan, convexly as viewed in FIG. 1, away from the plane of hub 12, whereas the leading portion of leading member 16 is bent toward the plane of hub 12. The angle a of the chord plane c between the leading edge 17 and the trailing edge 19 with the plane of hub 12 is about 32° . To provide this chord angle, leading member 16 as illustrated is bent at an angle of about 15° relative to the plane of arm 13.

The reinforcing cap 24 (0.048 inch-thick prepainted SAE 950A steel) is of convex shape on its upstream side to provide a decamber-limiting trailing portion 24a disposed at an acute angle to the adjacent trailing blade member 18. Cap 24 has along its convex upstream side a first integrally formed lip 30 extending along its one side edge and a second integrally formed lip 32, parallel to lip 30, extending along its opposite side edge radially spaced from said one side edge, as shown in FIG. 4, the lips also extending along the portion of said edges defined by the decamber-limiting portion of the cap. Cap 24 is sized to be partially coextensive with blade members 16 and 18 past the outer end of arm 13 to receive rivet 29, thereby to reduce vibrations of the blade members 16, 18 and also fan noise. The lips 30, 32 are integrally formed by turning up the edges of cap 24 toward the concave side of the cap. The amount of turnup depends on the strength required for adequately supporting a decambered blade, but is preferably not greater than about one-eighth inch.

The arms 13 are arranged for balance of the fan, and the arcuate distances between the reference lines 40, 41, 42, 43, 44 (drawn radially of hub 12 and parallel to the edges 17, 19) are as follows:

40-41 : $48^\circ 30'$

40-42 : $150^\circ 30'$

40-44 : 80°

40-43 : 165°

In operation as the fan rotates clockwise, in the direction indicated by the arrow in FIG. 1, air is moved from upstream to downstream as indicated by the arrows in FIG. 2. As fan speed increases, air pressure and centrifugal force cause the trailing blade members 18 to decamber, in general, to move toward the plane of hub 12. The decamber-limiting portions 24a are contacted by the decambering blades, and are therefore subjected to stresses. The reinforcing lips 30, 32, however, allow the cap to resist these stresses without undue metal fatigue, even when the fans are of the relatively large-bladed, high-capacity type. Yet the conventional shape and simple lightweight construction enables the reinforcing caps to resist large stresses without substantially altering the weight, size, or conformation of the fan.

Other embodiments will occur to those skilled in the art and are within the following claims.

What is claimed is:

1. In a fan having a hub, a plurality of arms extending radially outwardly of said hub, and blade structures comprising resilient trailing portions which decamber as rotational speed increases, one blade structure being secured to each said arm, reinforcing caps, one said cap secured to each blade structure and the respective said arm, and each said cap comprising (a) a trailing decamber-limiting portion extending partially coextensively with the trailing portion of said blade structure at an acute angle to said trailing portion of said blade structure, and (b) two radially spaced integrally formed upstanding lips, one disposed along each opposed radially spaced side edge of said cap and of said decamber-limiting portion thereof, whereby periodic stresses induced in said cap during decambering of said trailing portion of said blade structure against said cap are resisted without excessive metal fatigue in said cap.
2. The fan of claim 1 wherein each said lip extends no more than one-eighth inch above the remaining surface of said cap.
3. The fan of claim 1 wherein said cap is also sized to be partially coextensive with said blade structure past the end of said arm, and is secured to said blade at a point past said arm.

4. The fan of claim 3 including a plurality of fasteners extending through said cap, said blade structure, and said arm and at least one fastener extending only through said cap and said blade structure.

5. The fan of claim 4 wherein each said lip extends no more than about one-eighth inch above the surface of said cap.

6. The fan of claim 5 wherein said lips are substantially parallel to one another.

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