United States Patent [19]

Strick

[11] **3,827,826**

[45] **Aug. 6, 1974**

[54] **FLEXIBLE BLADED FAN WITH STRENGTHENED LEADING EDGE**

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[21] Appl. No.: **390,010**

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

[51] **Int. Cl.** **F04d 29/36**

[58] **Field of Search** ..... 416/136, 136 A, 240

[56] **References Cited**

UNITED STATES PATENTS

3,406,760 10/1968 Weir 416/132

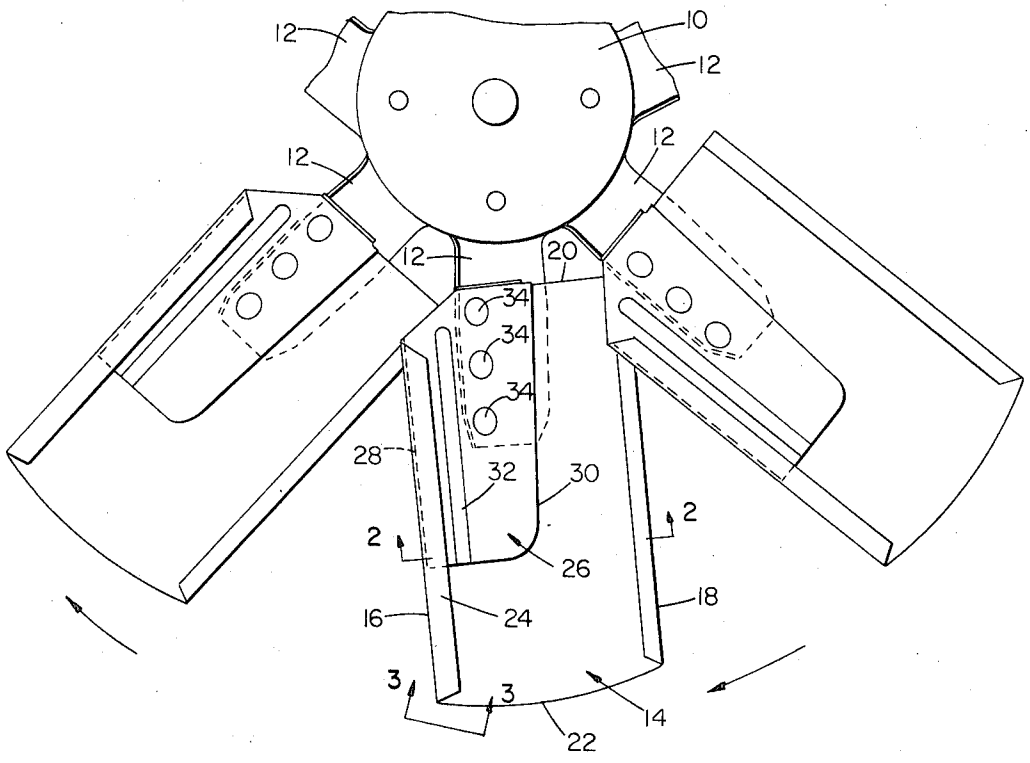
3,664,165 5/1972 Harvill et al. ..... 416/240 UX

Primary Examiner—Everette A. Powell, Jr.

[57] **ABSTRACT**

A flexible bladed automotive cooling fan having a reinforcing member on the upstream side of the blade, the reinforcing member radially spaced inwardly from the tip of the blade a distance in the range of 25–50 percent of the radial extent of the blade and the blade reversely bent continuously along its leading edge overlying the reinforcing member at an inner portion of the reverse bend.

4 Claims, 3 Drawing Figures



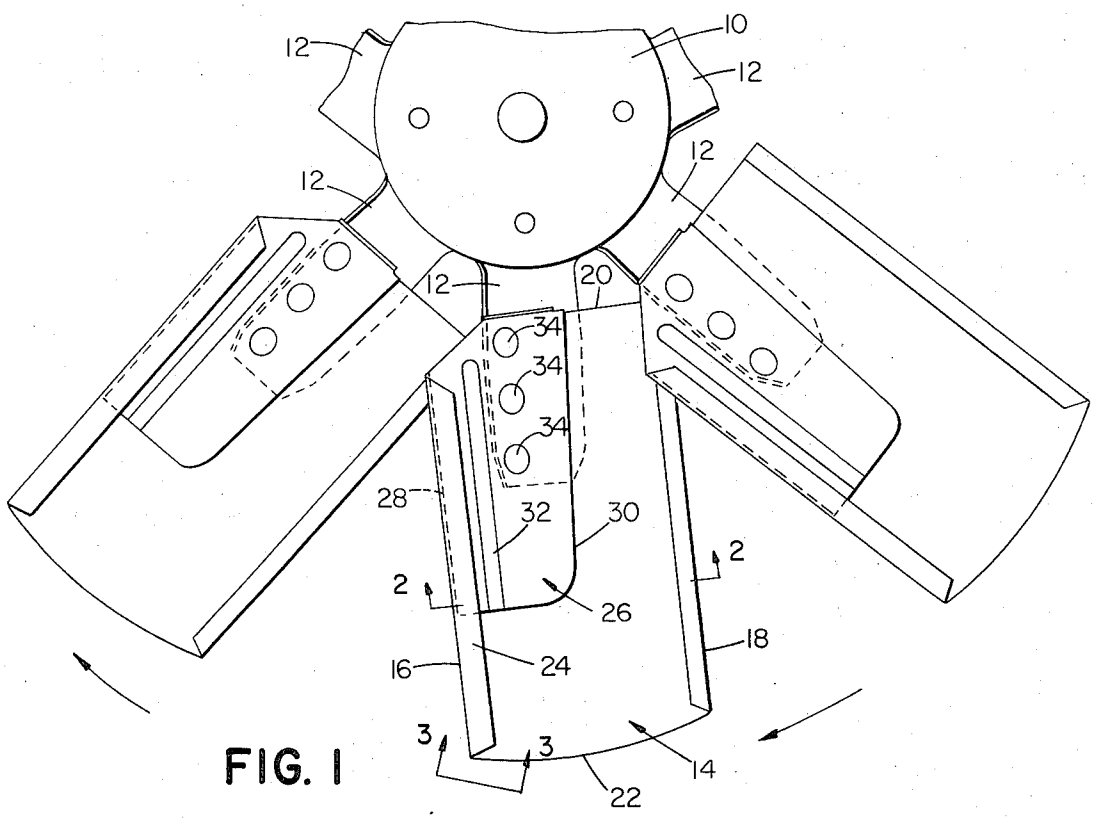


FIG. 1

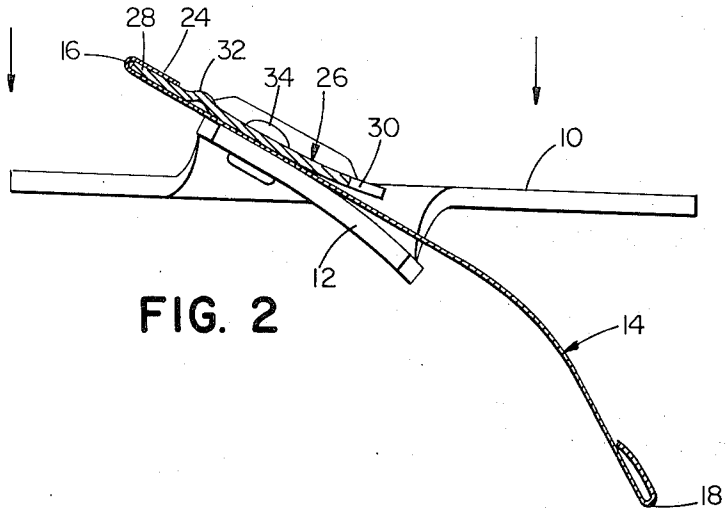


FIG. 2

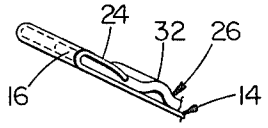


FIG. 3

FLEXIBLE BLADED FAN WITH STRENGTHENED LEADING EDGE

BACKGROUND OF THE INVENTION

1. Field Of The Invention

This invention relates to automotive fans and particularly to automotive fans employing resilient blades which decamber as rotational fan speed increases.

2. Description Of The Prior Art

Strength at the leading edge of a fan blade assembly, to prevent vibration, and minimal fan weight are basic design parameters with any automotive fan. Weight is important as, typically, the fan is mounted as a cantilevered load on the end of an engine water pump shaft and unnecessary weight is deleterious to water pump shaft and bearing life. Vibration is a matter of concern particularly at the outer tip of the fan blade as unnecessary vibration can lead to metal fatigue and premature blade failure. Vibration transmitted from the blade to an overlying reinforcing member can also lead to fatigue and failure of the reinforcing member.

Heretofore, to deal with blade tip vibration, a reinforcing member of heavier material than the blade was, in some fans, wrapped around the blade leading edge and extended along substantially the entire leading edge thereof, as in U.S. Pat. No. 3,594,098. In other fans, a reinforcing member was simply placed on the upstream side of the blade extending along substantially the entire leading edge thereof and was secured thereto by rivets including a rivet adjacent the blade tip, as in U.S. Pat. No. 3,594,098. In yet another design, as in U.S. Pat. No. 3,406,760, the reinforcing member comprised one or two reverse folds of the blade upon itself extending along the entire leading edge of the blade and having a substantial transverse width for supporting and reinforcing the blade during decambering. In each of the foregoing fans, the reinforcing member extending substantially along the entire length of the blade leading edge contributes materially to overall fan weight.

It is a principal object of this invention to strengthen the leading edges of the fan blade assemblies, increasing their resistance to destructive vibration, while at the same time minimizing fan weight.

SUMMARY OF THE INVENTION

In general the present invention features a reinforcing member overlying the fan blade and extending from the radially inner edge of the blade to a position spaced from the radially outer edge or tip of the blade a distance in the range of about 25–50 percent of the radial extent of the blade. The leading edge of the blade is reversely bent along substantially its entire length and overlies the reinforcing member thereadjacent. The reverse bend of the blade leading edge provides inherently increased strength and rigidity to the leading edge of both the blade and the reinforcing member. Additionally, since the reverse bend overlies the reinforcing member, additional strength and resistance to bending stresses is provided to the blade leading edge outwardly of the reinforcing member by the transmission of forces to the reinforcing member. This in turn permits the use of the short reinforcing member which reduces the weight of the fan. Since the reverse bend is not used for supporting the blade as it decambers, it need not extend rearwardly any substantial distance and terminates forward of fasteners connecting the blade and the reinforcing member. The reduction of material in the reinforcing member exceeds the additional blade material employed in the reverse bend.

In a preferred embodiment, the reinforcing member comprises a member separate from the supporting arm. Also in a preferred embodiment the outer portion of the blade leading edge is more tightly folded outwardly of the reinforcing member.

Advantageously, the fold of the blade leading edge provides strength to improve durability in handling of the fan and contributes to personal safety by turning back a relatively sharp blade edge. The elimination of a tip rivet, employed in certain prior art fans, eliminates weight and eliminates, as well, a stress riser at the blade tip. The folded leading edge also protects against the accumulation of foreign matter between the blade and the reinforcing members, another potential source of stress risers.

BRIEF DESCRIPTION OF THE DRAWING

Other objects, features and advantages of this invention will be apparent to those skilled in the art from the following detailed description of a preferred embodiment thereof taken together with the accompanying drawing, in which:

FIG. **1** is a fragmentary plan view of a fan embodying the invention;

FIG. **2** is an enlarged sectional view taken along the line **2—2** of FIG. **1**; and

FIG. **3** is an enlarged fragmentary end view taken along the line **3—3** of FIG. **1.**

DESCRIPTION OF THE PREFERRED EMBODIMENT

As illustrated in FIG. **1,** the fan embodying the invention comprises a central hub **10** having a plurality of arms **12,** integral with hub **10** and extending generally radially outwardly from the hub **10.**

Overlying each arm **12,** on the upstream side thereof, defined by the direction of airflow as indicated by arrows in FIG. **2,** is mounted a blade **14** of thin flexible resilient material, AISI 301 stainless steel 0.020 inch thick in the illustrated preferred embodiment. The blade **14** has generally radially extending leading and trailing edges **16, 18,** respectively defined by the direction of fan rotation indicated by arrows in FIG. **1.** The blade **14** is curved between the transversely spaced leading and trailing edges **16, 18** thereof, presenting a convex side on the upstream side of the blade **14** and a concave side on the downstream side thereof. The leading edge **16** is positioned forward of arm **12** and the trailing edge **18** is positioned behind the arm **12.**

Overlying blade **14,** on the upstream side thereof, is a relatively rigid reinforcing member **26.** Member **26** has a leading edge **28** adjacent blade leading edge **16** and extends transversely to a trailing edge **30** intermediate the blade leading and trailing edges **16, 18.** Member **26** extends radially along blade **14** from adjacent the inner edge **20** of blade **14** to a position inwardly spaced from blade tip **22** a distance in the range of about 25–50 percent, about 30 percent in the illustrated preferred embodiment, of the radial extent of the blade **14.** A radially extending strengthening rib **32** is provided along member **26** rearwardly of its leading edge **28.**

Rivet fasteners **34** extend through and fasten together arm **12,** blade **14** and reinforcing member **26.** Fasteners **34** are positioned rearwardly of blade and reinforcing member leading edges **16, 28** and rearwardly of rib **32.**

The blade **14** is reversely bent at its leading edge to provide a reversely bent portion **24** on the upstream side thereof. Reversely bent portion **24** extends continuously along substantially the entire length of blade leading edge **16,** the radially inner portion thereof overlying reinforcing member **26** and the outer portion thereof overlying the upstream side of blade **14.** The reversely bent portion **24** of blade **14** extends rearwardly from blade leading edge **16** a limited extent to a position forward of fasteners **34** and forward of reinforcing member rib **32.** As illustrated in FIG. **3,** the outer portion of reversely bent portion **24** is bent to a position more closely adjacent the underlying portion of blade **14** thereadjacent than is possible at the inner portion of reversely bent portion **24** overlying reinforcing member **26,** thus assuring tight contact of the inner portion with reinforcing member **26.**

In operation, the continuous reverse bend at the leading edge of blade **14** inherently strengthens the blade leading edge to resist vibration. Overlying reinforcing member **26,** additional resistance to vibration in use is imparted to blade **14** beyond member **26.** Advantageously, the reversely bent portion **24** overlying reinforcing member **26** also rigidifies and mutually strengthens member **26.** Thus, a shorter reinforcing member **26** may be employed without inadmissably shortening fatigue life of the blade and, additionally lighter material may be employed in the reinforcing member **26** than heretofore customary, 0.060 inch thick aluminum being used in the illustrated preferred embodiment. The result is a strenghtened leading edge in the fan blade assembly and a desirably lighter fan.

Other embodiments of this invention will occur to those skilled in the art which are within the scope of the following claims. In one such modification, the reinforcing member may comprise an integral portion of the arm.

What is claimed is:

1. In an automotive cooling fan having a hub, arms radially projecting from said hub and blade structures connected to said arms, said blade structures each comprising:

a resilient blade having generally radially extending, transversely spaced leading and trailing edges, said blade extending from its inner edge adjacent said hub to a blade tip remote from said hub, said blade having one side facing upstream of the direction of airflow and the other side facing downstream thereof, the portion of said blade adjacent said trailing edge thereof decambering in an upstream direction as fan rotational speed increases;

a blade reinforcing member positioned against the upstream side of said blade and having a leading edge adjacent said blade leading edge, said reinforcing member extending transversely from adjacent said blade leading edge in the direction of said blade trailing edge and extending generally radially from adjacent said inner edge of said blade toward said tip thereof; and

a plurality of fasteners connecting said blade and said reinforcing member, said fasteners spaced rearwardly from said blade and reinforcing member leading edges;

the improvement in said blade structure in which

said reinforcing member extends generally radially from adjacent said inner edge of said blade to a position spaced radially inwardly from said tip of said blade a distance in the range of about 25–50 percent of the radial extent of said blade; and

said blade is continuously reversely bent along substantially the length of its said leading edge providing a radially inner reversely bent portion thereof bent around said reinforcing member leading edge and transversely extending along the upstream side of said reinforcing member a limited extent to a position intermediate said reinforcing member leading edge and said fasteners and providing a radially outer reversely bent portion thereof extending radially outwardly of said reinforcing member substantially to said blade tip, said inner and outer reversely bent portions integral with said blade and with each other.

2. The improvement claimed in claim **1** in which said outer reversely bent portion is bent to a position more closely adjacent the portion of said blade which it overlies than said inner reversely bent portion.

3. The improvement claimed in claim **1** in which said blade and reinforcing member are positioned on the upstream side of one said arm and are connected thereto by said fasteners.

4. The improvement claimed in claim **3** in which said outer reversely bent portion is bent to a position more closely adjacent the portion of said blade which it overlies than said inner reversely bent portion.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,827,826 Dated August 6, 1974

Inventor(s) Karl H. Strick

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Change the Assignee from "Foram Corporation" to --Fram Corporation--.

Signed and sealed this 3rd day of December 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

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