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De Jong

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[54] **FLEXIBLE BLADED FAN WITH TAB CONNECTED REINFORCING MEMBER**

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

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

[58] **Field of Search** ..... 416/132, 240, 241 A, 210

[56] **References Cited**

UNITED STATES PATENTS

3,289,924	12/1966	Weir	416/240 X
3,594,098	7/1971	Pratinidhi	416/132
3,711,219	1/1973	Strick	416/132

Primary Examiner—Everette A. Powell, Jr.

[57] **ABSTRACT**

An automotive cooling fan having a flexible blade connected to a reinforcing member along the blade leading edge by lance tabs integral with the reinforcing member.

7 Claims, 3 Drawing Figures

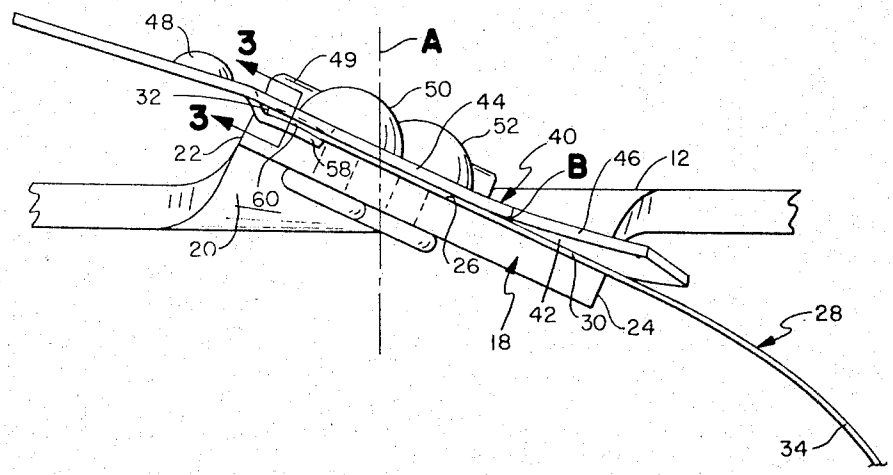
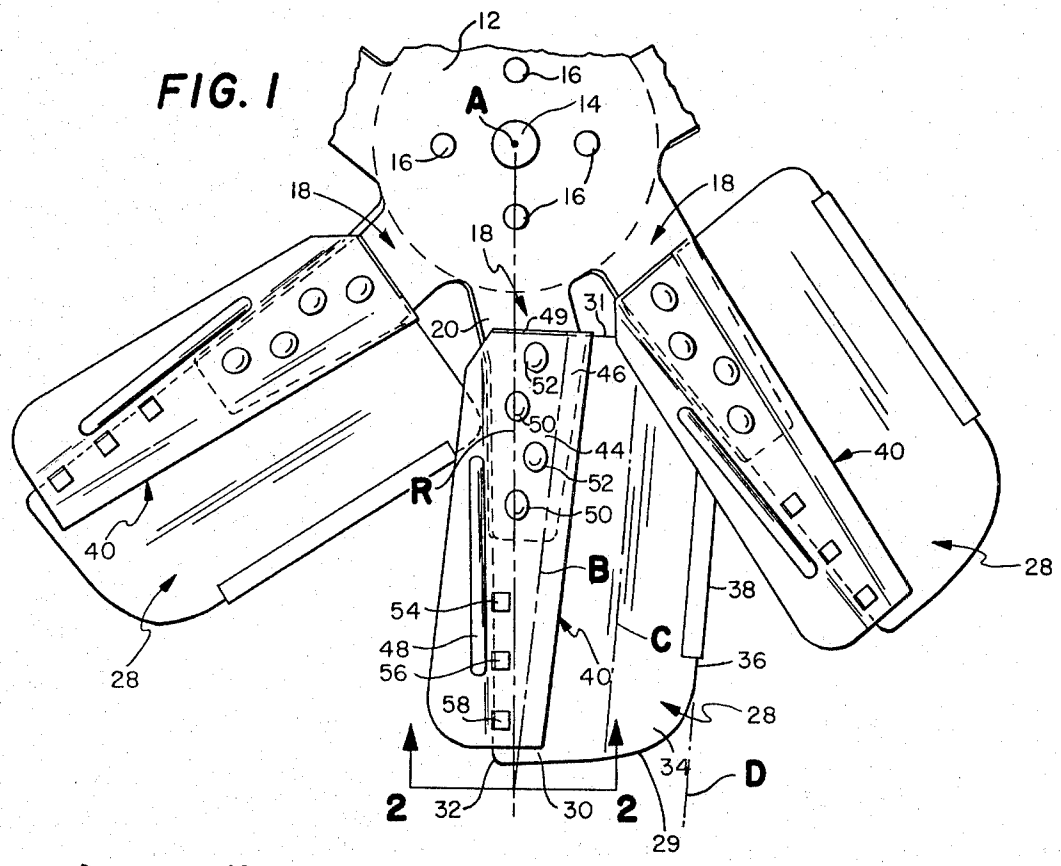


FIG. 1



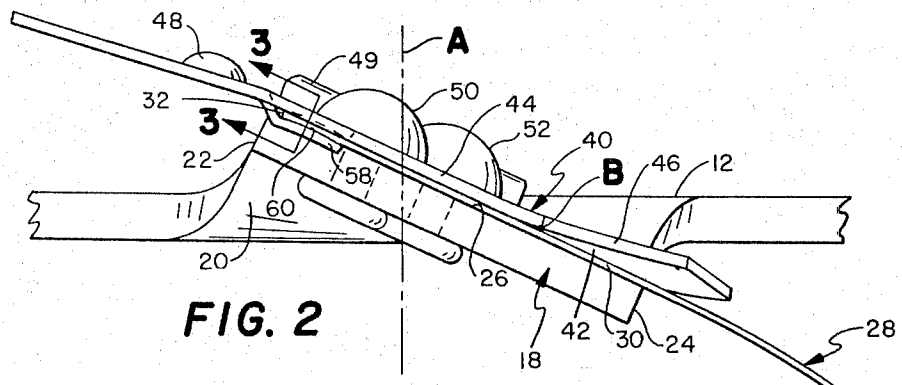


FIG. 2

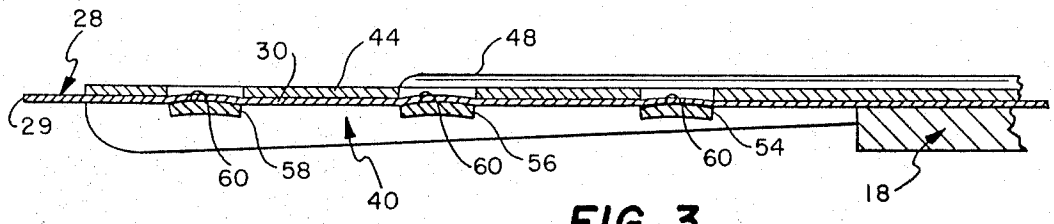


FIG. 3

FLEXIBLE BLADED FAN WITH TAB CONNECTED REINFORCING MEMBER

FIELD OF THE INVENTION

This invention relates to automotive cooling fans and more particularly to such fans having flexible, resilient blades connected to reinforcing members against which they decamber as rotational speed increases.

SUMMARY OF THE INVENTION

It is a principal object of this invention to connect the blade to the reinforcing member, adjacent the blade tip, along the blade leading edge and to reduce stress concentrations in the blade. Further it is an object of this invention to reduce fan weight and to simplify assembly.

In general the invention features, in a fan having a reinforcing member extending radially along and forwardly of the leading edge of the fan blade, fastening means adjacent the blade connecting the blade and reinforcing member, the fastening means comprising a tab integral with the reinforcing member, extending from the blade leading edge toward the trailing edge and bent around the leading edge and against the side of the blade opposite the reinforcing member. In preferred embodiments the tab is connected to the reinforcing member parallel to the blade leading edge and the tab contacts the blade at a central depression in the tab.

The resulting structure positively restrains the blade leading edge preventing any tendency of the leading edge to separate from the reinforcing member adjacent the outer tip during operation. Stress concentrations in the blade are reduced by eliminating rivet holes therein adjacent the outer tip. The elimination of tip rivets reduces fan weight. Finally, the use of tabs eliminates rivet hole alignment problems during assembly.

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:

BRIEF DESCRIPTION OF THE DRAWING

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

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

FIG. **3** is a fragmentary, sectional view taken along the line **3—3** of FIG. **2**.

DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in FIGS. **1** and **2**, the fan comprises a hub **12** having a centrally located pilot hole **14** centered on the axis of rotation A and mounting holes **16**. Hub **12** lies in a plane normal to the axis of rotation A.

A plurality of arms **18**, integral with hub **12**, extend generally radially outward from hub **12**. Each arm **18** is twisted at its root **20**, adjacent hub **12**, to extend outwardly therefrom at an acute angle, 25° in the preferred embodiment, relative to the plane of fan rotation, the arm leading edge **22**, defined by the direction of rotation, lying upstream, defined by the direction of airflow, relative to the arm trailing edge **24**. The outer portion of arm **18** lies in a plane, extending transversely between the leading and trailing edges **22, 24** thereof to define a flat blade mounting surface **26** on the upstream side thereof.

A blade **28** is positioned on the upstream side of each arm **18** and extends from adjacent root **20** radially to a position outwardly of arm **18**. Blade **28** comprises a flat leading portion **30** positioned against mounting surface **26** and extending transversely from blade leading edge **32** adjacent arm leading edge **22** to a position trailing arm **18**. Blade **28** also comprises a trailing portion **34**, integral with leading portion **30** and extending transversely therefrom to trailing edge **36** including a folded weighting portion **38** as disclosed in U.S. Pat. No. 3,594,098. Trailing portion **34** is cambered about an axis of curvature C downstream, the convex side of blade **28** facing upstream and the concave side facing downstream.

Overlying leading portion **30** of blade **28**, against the upstream side thereof opposite arm **18**, is a reinforcing member **40** radially, substantially coextensive with blade **28** and extending transversely from adjacent blade leading edge **32** to a position adjacent arm trailing edge **24** intermediate the blade leading and trailing edges **32, 36**. Member **40** comprises a support surface **42** on the downstream side thereof adjacent blade **28** having a flat leading portion **44** against blade leading portion **30** and a trailing portion **46** curved upstream and progressively more remote from blade **28** toward the blade trailing portion **34**, the trailing portion **46** separating from blade **28** on a line of separation B. Reinforcing member **40** extends forwardly of arm **18** to provide an extended air foil structure, in accordance with the disclosure in U.S. Pat. No. 3,639,078 and includes a radially extending strengthening rib **48**. In accordance with U.S. Pat. No. 3,639,079 the inner edge **49** of member **40** is turned upwardly to strengthen member **40**.

A plurality of fasteners, rivets **50, 50, 52, 52**, extend through arm **18** and the leading portions **30, 44** of blade **28** and reinforcing member **40** securing them together. Rivets **50, 50** are spaced apart along a radial line R and rivets **52, 52** are spaced apart in staggered relation to rivets **50, 50**.

As best shown in FIG. **1**, the line B, on which the trailing portion **46** of reinforcing member **40** separates from blade **28**, lies at an acute angle to radial line R, intersecting line R outwardly of blade tip **29**. In the illustrated embodiment the acute angle between lines B and R is 8°. The trailing edge **36** of blade **28** extends a greater distance behind the line B adjacent blade tip **29** than at the root **31** of blade **28**. The trailing edge **36** may and preferably is, however, also disposed at an acute angle to radial line R, a line D extending therefrom intersecting (not shown) line R outwardly of blade tip **29**, the angle between line R and the line D being less than the angle between lines B and R, 5° in the illustrated embodiment. The axis of curvature C of blade **28** is parallel to the blade trailing edge **36**.

As best shown in FIGS. **2** and **3**, fastening means in the form of lance tabs **54, 56, 58**, cut from reinforcing member **40**, are provided in reinforcing member radially outwardly of arm **18** securing the blade leading edge **32** to reinforcing member **40**. Each tab **54, 56, 58** is connected to member **40** along a line parallel to blade leading edge **32** and extends therefrom toward the blade trailing edge **36**. Each tab **54, 56, 58** is bent from reinforcing member **40** downstream and thence

toward the blade trailing edge **36** against the side of blade **28** opposite reinforcing member **40.** Each tab **54, 56, 58** includes a central depression **60** extending toward and contacting blade **28** to prevent stress risers in blade **28** which would be created by contact with the edges of tabs **54, 56, 58.**

In operation, as the fan rotates the trailing portion **34** of blade **28** decambers in an upstream direction. The progressively longer moment arm from root **31** to tip **29** of the blade **28,** provided by the angled separating line B, results in greater deflection toward the tip of the blade, improving blade profile in operation and thereby resulting in a significant reduction of fan noise. As blade **28** is decambered and stressed, tabs **54, 56, 58** retain the leading edge **32** of blade **28** in flush contact with reinforcing member **40** outwardly of arm **18,** lowering stress concentrations in the blade adjacent the outer leading portion **30** thereof.

Other embodiments of this invention will be apparent to those skilled in the art which are within the scope of the following claims.

What is claimed is:

1. In an automotive cooling fan comprising a hub, a plurality of arms projecting radially outwardly from said hub, a blade positioned against one side of each of said arms, said blade extending transversely from a leading edge, defined by the direction of fan rotation, adjacent said arm to a trailing edge behind said arm, a reinforcing member positioned against each said blade on the side thereof opposite the arm against which the blade is positioned and extending forwardly of said leading edge, each said blade thereby positioned between an overlying reinforcing member and an arm, said blade and said reinforcing member extending together radially beyond said arm, fasteners adjacent said arm securing said blade, reinforcing member and arm together, and fastening means radially beyond said arm securing said blade and said reinforcing member together, that improvement in which each said fastening means comprises a lance tab integrally connected to said reinforcing member parallel to and adjacent said blade leading edge, the remainder of said tab cut from said reinforcing member, said tab extending from adjacent said blade leading edge toward said trailing edge, and said tab bent from said reinforcing member around said blade leading edge and against the side of said blade opposite said reinforcing member.

2. The improvement claimed in claim **1** in which said blade lies on the upstream side of said arm and said reinforcing member lies on the upstream side of said blade.

3. The improvement claimed in claim **1** in which said fastening means comprises a plurality of said tabs.

4. The improvement claimed in claim **1** in which said tab includes a central depression, said depression contacting and lying against said blade on said side thereof opposite said reinforcing member.

5. The improvement claimed in claim **4** in which said tab is integrally connected to said reinforcing member parallel to and adjacent said blade leading edge and the remainder of said tab is cut from said reinforcing member.

6. The improvement claimed in claim **5** in which said blade lies on the upstream side of said arm and said reinforcing member lies on the upstream side of said blade.

7. The improvement claimed in claim **6** in which said fastening means comprises a plurality of said tabs.

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