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Bentley et al.

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[54] **FLEXIBLE BLADED FAN**

[75] Inventors: **Allen J. Bentley**, Plymouth; **Ashok K. Goyal**, Livonia, both of Mich.

[73] Assignee: **Ford Motor Company**, Dearborn, Mich.

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

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

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

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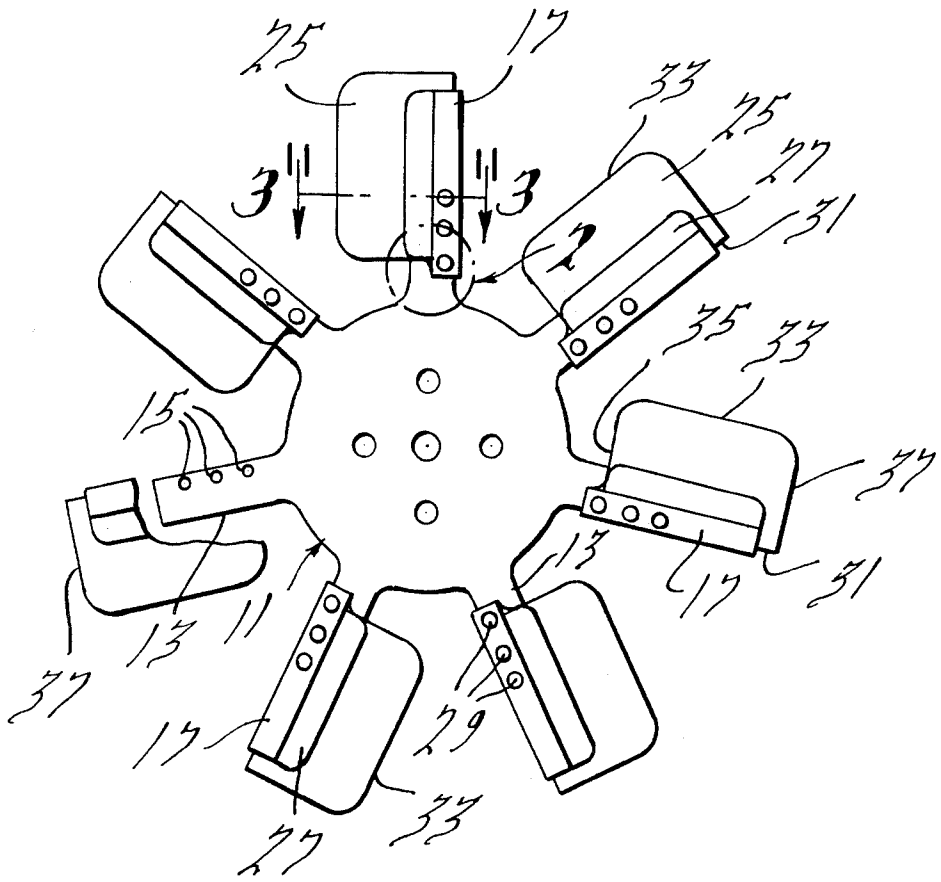
Primary Examiner—Everette A. Powell, Jr.

Attorney, Agent, or Firm—Roger E. Erickson; Keith L. Zerschling

[57] **ABSTRACT**

A flexible blade fan assembly suitable for use as an automobile radiator cooling fan. The leading edges of the flexible blades are riveted between the fan spider arms and reinforcement strips or clamps. The radially inner edges of the blades are shaped to minimize or reduce stress concentrations at their intersections with the edges of the reinforcement strips, i.e., the inner radial edge of each fan blade approaches the trailing edge of the adjacent reinforcement strip either tangentially or at an acute angle.

4 Claims, 6 Drawing Figures



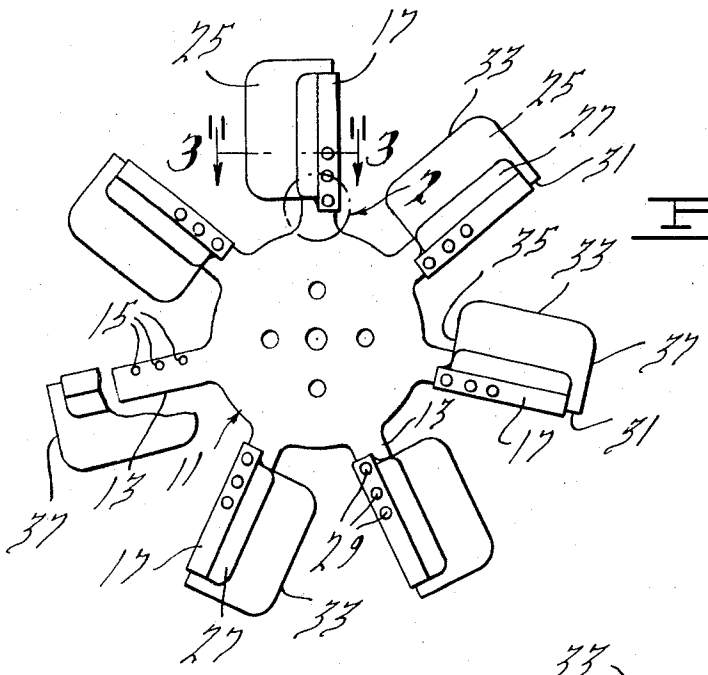


Fig. 1.

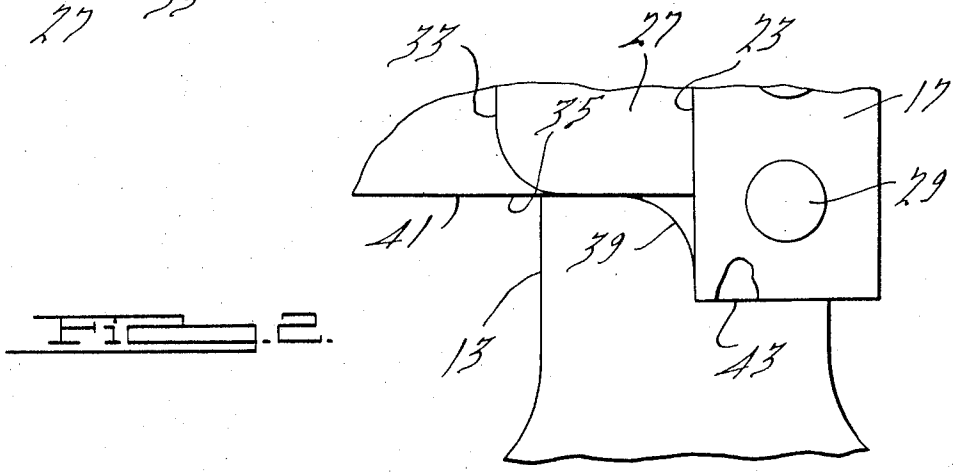


Fig. 2.

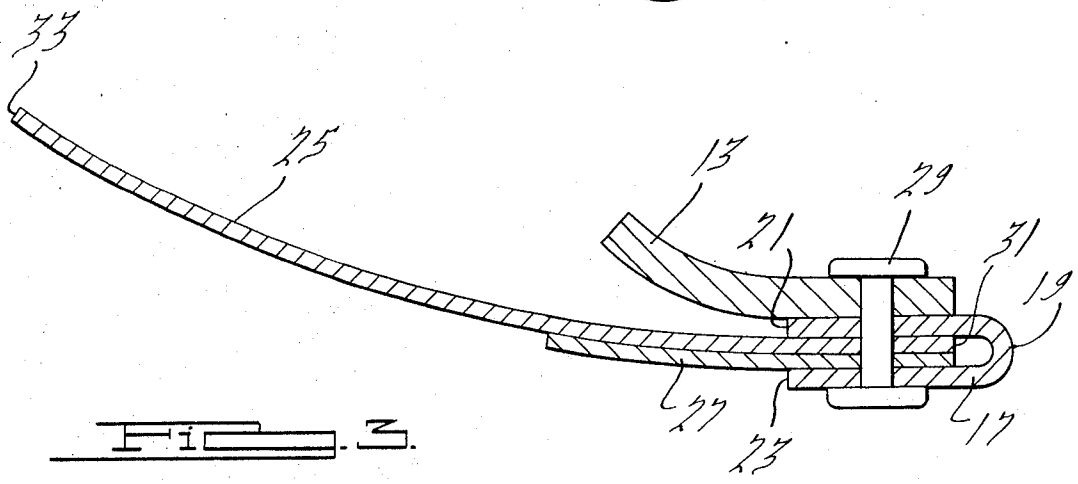


Fig. 3.

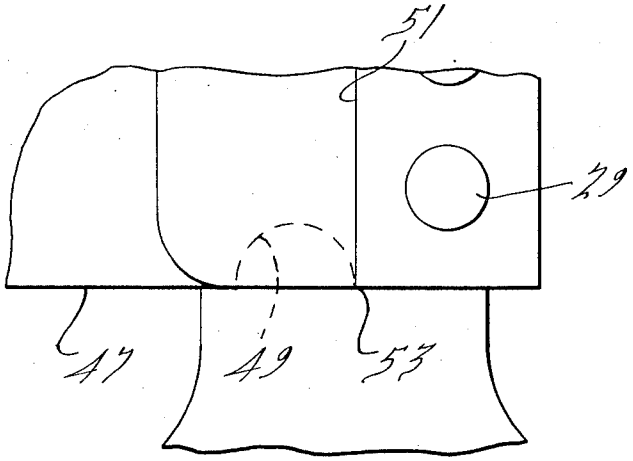


FIG. 4.

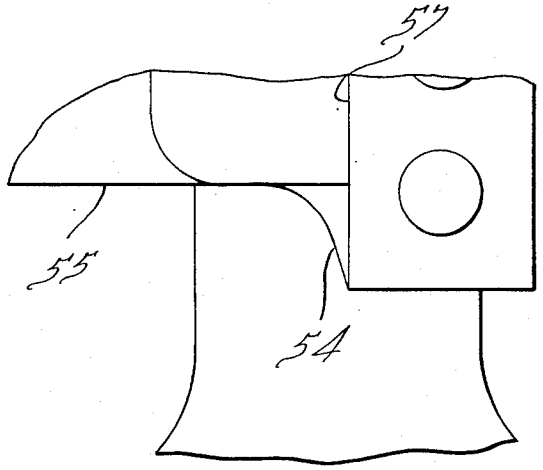


FIG. 5.

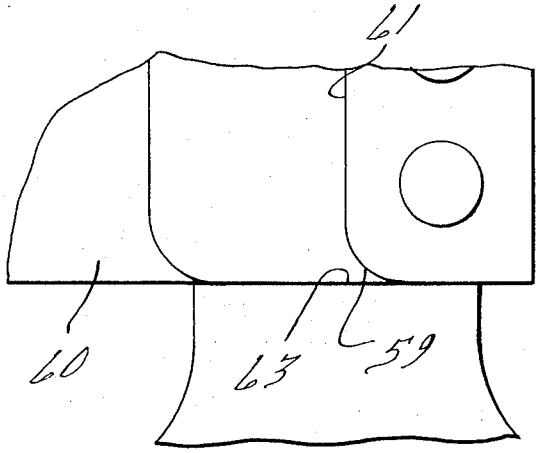


FIG. 6.

FLEXIBLE BLADED FAN

BACKGROUND AND SUMMARY OF THE DISCLOSURE

It has been found that an automobile engine radiator cooling fan having flexible blades that decamber as the angular velocity of the fan increases provides adequate air delivery with less use of engine power than a comparable rigid blade fan. This is because a high angular velocity of the fan is usually representative of a high vehicle speed in which the thrust of air entering the grill of the vehicle is nearly sufficient to provide the necessary radiator cooling. Conversely, in a fixed blade fan the minimum pitch angle for adequate air flow at lower vehicle speeds may result in unnecessary loading of the engine at higher vehicle speeds.

A disadvantage or problem associated with the use of flexible blade fans is that the flexible blades tend to experience more rapid failure than those of a comparable rigid blade fan.

This invention provides a flexible blade fan construction in which stresses at the points in the blades where failures most often occur are reduced and redistributed. It is a further object of this invention to provide a flexible blade fan assembly construction which is economical to produce and reliable in service.

A fan structure constructed in accordance with this invention includes a spider having arms extending radially outwardly from a central hub portion and reinforcing members overlying one face of each of the arms and extending radially beyond the ends of the arms. The leading edge of each flexible fan blade is positioned within or under one of the reinforcing members. Fastening means such as rivets rigidly join the arms, reinforcing members and blades. Each of the blades have a trailing edge and radially inner and outer side edges. The radially inner edge of each of the blades has a first portion which the reinforcing member overlies and a second free portion. Each of the reinforcing members has a generally radially extending trailing edge. The free portion of the radially inner edge of the blade is curbed adjacent the trailing edge of the reinforcing member so that it approaches the trailing edge substantially tangentially or at an acute angle.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front elevational view of an engine cooling fan constructed in accordance with this invention.

FIG. 2 is an enlarged view of the encircled portion of FIG. 1.

FIG. 3 is a cross sectional view taken along line 3—3 of FIG. 1.

FIG. 4 is a view similar to FIG. 2 illustrating an alternate embodiment of the invention.

FIG. 5 is a view similar to FIG. 2 illustrating a third embodiment of the invention.

FIG. 6 is a view similar to FIG. 2 illustrating a fourth embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The fan assembly includes a hub or spider **11** having a plurality of radially extending arms **13.** A number of holes **15** are formed in each of the arms and are positioned lengthwise along a line parallel to a radial line drawn as the center line of each of the arms. A clamp or reinforcement **17** overlies one face of each of the arms and extends radially beyond the ends of the arms. The reinforcement has a U-shaped cross section. The front edge **19** and trailing edges **21** and **23** of the reinforcement are substantially parallel to the radial line drawn as the center line through the spider arm. Received within each of the clamp members are a flexible fan blade **25** and an extension or leaf **27.** The fan blade extension and reinforcement have holes formed therein adjacent their leading edges corresponding to the holes formed in the arm and are attached within the reinforcement to the arm by a plurality of rivets **29.**

Each blade **25** when viewed from its tip in a radially inward direction has a predetermined camber or radius of curvature as shown in FIG. **3** of the drawings. The extensions **27** are positioned over portions of the front sides of the flexible fan blades and provide support for the fan blades adjacent the trailing edges **23** of the reinforcements **17.** Each of the fan blades includes a leading edge **31** positioned substantially parallel to the center line of the corresponding arm **13,** trailing edge **33** and inner and outer side edges **35** and **37,** respectively. Each of edges **31, 33** and **37** is substantially straight except for rounded corners. The inner side edge **35** includes a curved portion **39** which tangentially approaches the trailing edge **21** of the reinforcement **17.** The curved portion **39** is circular as shown in the drawings. The remaining portions of edge **35** of each fan blade are straight portions **41** and **43.** Portion **43** is radially spaced a greater distance from the center of the hub **11** than portion **41.**

Conventionally constructed fans in which the radially inner edges of the blades are straight and essentially perpendicular to their reinforcements often experience fatigue failures which initiate at or near the points of intersection of the blade inner edges and the trailing edges of the reinforcements. In the invention, such high stresses are substantially reduced or eliminated because the theoretical stress at the point of tangential intersection of a curved edge and the straight edge is zero. The inner edge **39** of the blade **25** tangentially intersects the trailing edge **23** of the reinforcement **17.** Theoretically, the stress at such a point of intersection is zero.

It should be noted that the invention can be practiced in alternate embodiments having neither an extension **27** nor a U-shaped reinforcement **17.** In such embodiments, the blades would be sandwiched between reinforcement strips and the arms.

DETAILED DESCRIPTION OF ALTERNATE EMBODIMENTS

FIG. **4** illustrates an alternate embodiment in which the radially inner edge **47** of the blade has an edge **49** where a semi-circular portion of the blade is removed. The edge **49** approaches the trailing edge **51** of the reinforcement substantially tangentially at point **53.**

FIG. **5** illustrates a third embodiment in which a portion **54** of the radially inner edge **55** of the blade intersects the trailing edge **57** of the reinforcement at an acute angle rather than tangentially. The acute angle intersection approximates a tangential approach.

FIG. **6** illustrates a fourth embodiment in which the radially inner corner **59** of the trailing edge **61** of the reinforcement is curved. The rounded corner **59** reduces the stress concentration in the blade **60** at point **63** over that of a square corner on the reinforcement.

Further modifications and alterations will occur to those skilled in the art which are included within the scope of the following claims.

We claim:

1. A fan structure including a spider having arms extending generally radially outwardly from a central hub portion,

a reinforcing member overlying one face of each of said arms,

flexible fan blades having portions underlying said reinforcing members,

fasteners securing said reinforcement members and said blades to said arms,

each of said blades having at least a leading edge, a trailing edge and a radially inner edge,

said reinforcing members overlying the portions of said blades adjacent said leading edges,

the portions of said blades trailing said reinforcing members when viewed in a radial direction being simple curves curving in a single direction,

each said reinforcing member having a trailing edge extending generally parallel to the arm to which it is secured,

said inner edge of said blade including a concave curved portion tangentially approaching said trailing edge of said reinforcing member.

2. A fan structure according to claim 1,

a reinforcement extension overlying a leading portion of each of said blades,

said reinforcing member overlying said reinforcement extension.

3. A fan structure including a spider having arms extending radially outwardly from a central hub portion,

reinforcing members overlying one face of each of said arms and extending beyond the ends of said arm,

flexible fan blades having leading portions underlying at least portions of said reinforcing members, said fan blades having portions trailing said reinforcing members, said trailing portions when viewed in a radial direction being simple curves curving in a single direction,

and fastening means spaced along the length of each arm to rigidly join the arm, reinforcing member and blade,

each of said fan blades having a leading edge, a trailing edge and a radially inner edge interconnecting the leading edge and the trailing edge,

the leading edge of each of said fan blades having a greater radial length than the trailing edge of each of said fan blades,

said radially inner edge including a first edge portion and a second edge portion, said reinforcing member overlying said first portion, said first portion and said second portion being interconnected by a curved edge tangentially approaching an edge of said reinforcing members.

4. A fan structure including a spider having arms extending generally radially outwardly from a central hub portion,

a reinforcing member overlying one face of each of said arms,

flexible fan blades having portions underlying said reinforcing members,

fasteners securing said reinforcing members and said blades to said arms,

each of said blades having at least a leading edge, a trailing edge and a radially inner edge,

said reinforcing members overlying the portions of said blades adjacent said leading edges,

the portions of said blades trailing said reinforcing members when viewed in a radial direction being simple curves curving in a single direction,

each said reinforcing member having a trailing edge extending generally parallel to the arm to which it is secured,

said inner edge of said blade including a portion approaching said trailing edge of said reinforcing member at an acute angle.

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