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FLEXIBLE BLADE ENGINE COOLING FAN

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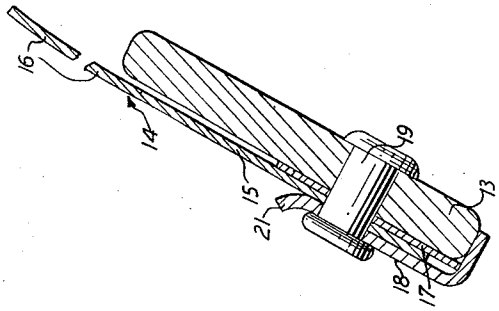

FIG. 3

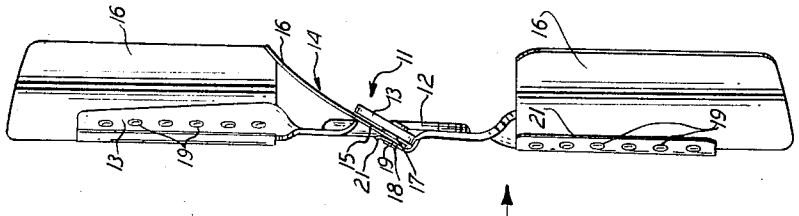

FIG. 2

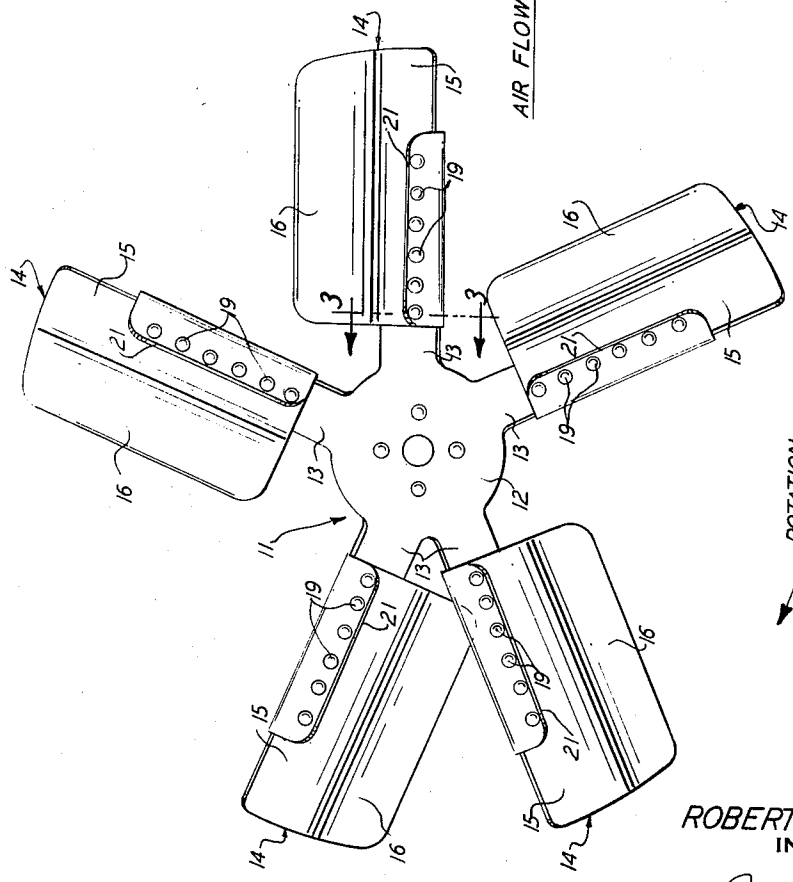

FIG. 1

ROBERT L. CASSIDY
INVENTOR

BY John A. Faulkner
John J. Koechel
ATTORNEYS

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FLEXIBLE BLADE ENGINE COOLING FAN

Robert L. Cassidy, Westland, Mich., assignor to Ford Motor Company, Dearborn, Mich., a corporation of Delaware

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ABSTRACT OF THE DISCLOSURE

The present invention relates to a flexible cooling fan assembly of the type comprising a hub having asymmetrically disposed arms extending outwardly therefrom, the arms being twisted so as to have an angle of attack with respect to the air flow. The arms are combined with flexible curved blades which are mounted thereon by rivets or the like and suitable laminated reinforcements. The reinforcements are constructed and arranged to provide stress relief for the blades as they attempt to attain planar relationship with the hub upon high speed rotation of the fan.

This invention relates to a flexible blade engine cooling fan.

Summary of the invention

It has long been recognized that engine cooling fans in which the blades are of a fixed pitch decrease in air moving efficiency and therefore engine cooling efficiency as the speed of the engine and the speed of the vehicle is increased. At high vehicle speeds, the cooling efficiency is relatively low because the ram effect of the air flowing through the radiator passages and over the engine block is more than sufficient to provide the necessary cooling effect. There have been several proposals made in the prior art of means for reducing engine cooling fan drag as the speed of the engine and the vehicle increases. Among these, has been a proposal to provide an engine cooling fan having flexible blades, the pitch of the blades being responsive to air and centrifugal forces which cause the pitch of the blades to decrease as the speed of the fan is increased. U.S. Patent 2,149,267 to Bouvy et al. and 3,044,557 to Posh are representative of this type of fan.

Flexible fans have not achieved commercial success because the designs available have not been able to achieve optimum production design and optimum fan endurance. It is an object of the present invention to provide a flexible cooling fan which meets both of the necessary criteria for commercial acceptability.

The foregoing has been accomplished by providing an engine cooling fan having a central planar hub and a plurality of rigid arms extending outwardly of the hub. Each arm has mounted thereon a flexible blade. Each blade has a flat leading portion overlying the arm with the plane of the flat portion intersecting the plane of the hub at an angle. Each blade has a curved trailing portion extending laterally of its flat portion and curved away from the plane of the hub. An important feature of the present invention is the provision of lamina means for mounting the blade on the arm, the lamina means comprising an insulation plate interposed between each arm and blade flat leading portion and a cap plate overlying the blade flat leading portion. Securing means, such as rivets or the like, secure each arm, insulation plate, blade flat portion and cap plate in the laminated relationship. A further important feature is that each cap plate is provided with a curved trailing edge laterally spaced from the securing means and extending longitudinally of the cap plate. The cap plate is curved at its trailing edge to provide for stress concentration relief as the blade curved portion is flexed toward the plane of the planar hub upon rotation of the fan.

Other objects, advantages and features of the present invention will become more apparent as this description proceeds particularly when considered in conjunction with the accompanying drawings, wherein:

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

FIG. 2 is a side elevational view of FIG. 1; and

FIG. 3 is an enlarged sectional view taken along line 3—3 of FIG. 1.

Detailed description

Referring now in detail to the drawing, there is shown generally at **11** an engine cooling fan adapted for use on a motor vehicle engine. The fan comprises a spider or central planar hub **12** and a plurality of rigid arms **13** extending outwardly of the hub. The arms **13** are preferably asymmetrically disposed and in this respect follow conventional design practice.

Each arm **13** has mounted thereon a flexible or resilient blade **14** having a substantially flat portion **15**, see FIG. 3, overlying the arm. The blade **14** has a curved trailing portion **16** extending laterally of the flat portion **15** and curved rearwardly away from the plane of the hub, see FIG. 2.

The flexible blades **14** are mounted on their respective arms **13** by lamina means comprising an insulation plate **17**, which may be a pressure sensitive aluminum foil tape, and a cap plate or reinforcement member **18**, which may be formed of sheet metal.

Securing means, such as rivets **19**, or the like, secure each arm **13**, insulating plate **17**, blade flat portion **15** and cap plate **18** in laminated relationship. As best seen in FIG. 3, each cap or reinforcing plate **18** has a curved trailing edge **21** laterally spaced from the rivets **19** and extending longitudinally of the cap plate. This is an important feature, as will be explained.

Each arm **13** has a twisted base section **22** adjoining the arm to the hub **12** so that the plane of each arm is at an angle to the plane of the hub. This means that the leading edge of each arm in the direction of rotation of the fan as indicated by the arrow in FIG. 1, is forward of the trailing edge of the arm so as to to form an attack angle relative to the direction of air flow as indicated by the arrow in FIG. 2. A flat portion of each blade **15** lies adjacent the forward face, again with reference to the direction of relative air flow as shown by the arrow in FIG. 2, of the arm **13**. The direction of curvature of the curved portion **16** of each blade is rearwardly of the plane of rotation of the fan or of the fan hub.

As a result of the foregoing construction and arrangement, the blades **14** will by the action of the air pressure and centrifugal forces acting on the flexible portions of the blades, have tendency to flatten out as the rotational speed of the fan is increased. In effect, the pitch of the fan blades is decreased as the speed increases which has the effect of decreasing the amount of air pumped per fan revolution as the speed increases. This has the further effect of decreasing the drag of the fan on the engine at the higher rate of fan rotation, thus making more horsepower available for propelling the vehicle.

The importance of the curved trailing edges **21** on the cap plates **18** is that as the fan blades flex away from the arm **13**, the portions of the blades adjacent the curved edges **21** roll around the edges **21** thereby shifting the point of stress concentration outwardly from the rivets **19** as the fan speed is increased. This prevents the buildup of metal fatigue on the blades at any single line of contact with the cap or reinforcing plates and results in much greater fan endurance.

It will be understood that the invention is not to be limited to the exact construction shown and described, but that various changes and modifications may be made without departing from the spirit and scope of the invention as defined in the appended claims.

I claim:

1. An engine cooling fan having a central planar hub and a plurality of rigid arms extending outwardly of said hub,

a plurality of flexible blades each having a flat leading portion overlying an arm with the plane of the flat portion intersecting the plane of the hub at an angle thereto,

each blade having a curved trailing portion extending laterally of its flat portion and curved away from the plane of said hub,

a spacer plate interposed between each arm and blade flat leading portion and an outermost cap plate overlying said blade flat leading portion,

securing means securing each arm, spacer plate, blade flat portion and cap plate in laminated relationship,

and each cap plate having a curved trailing edge closely adjacent to said securing means extending longitudinally of said cap plate and away from the plane of the blade therebeneath,

said cap plate curved trailing edge providing stress relief for said blade curved portion adjacent said securing means as the latter is flexed about said curved trailing edge toward the plane of said planar hub upon rotation of said fan.

2. An engine cooling fan according to claim 1 in which the arms are asymmetrically positioned around said hub.

3. An engine cooling fan having a central planar hub and a plurality of rigid flat arms extending asymmetrically of said hub,

each arm having a twisted base section joining the arm to the hub so that the plane of each arm is at an angle to the plane of said hub,

a plurality of flexible blades each having a flat portion at the leading edge thereof and a curved trailing portion extending laterally of its flat portion,

a first plate member interposed between the blade flat portion and an adjacent surface of an arm and an outermost cap plate overlying said blade flat portion,

securing means securing each arm, first plate member, blade flat portion and cap plate in laminated relationship,

and each cap plate having a curved trailing edge closely adjacent to said securing means,

said blade curved trailing portions upon rotation of said fan seeking a parallel planar relationship to the plane of said hub,

said cap plate curved trailing edges providing stress relief for said blades adjacent said securing means as the latter bend around said cap plate curved trailing edges upon said blades seeking parallel planar relationship to said hub.

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EVERETTE A. POWELL, JR., *Primary Examiner.*

EDGAR W. GEOGHEGAN, *Examiner.*

Disclaimer

3,356,154.—*Robert L. Cassidy*, Westland, Mich. FLEXIBLE BLADE ENGINE COOLING FAN. Patent dated Dec. 5, 1967. Disclaimer filed Sept. 17, 1970, by the assignee, *Ford Motor Company*.

Hereby enters this disclaimer to claims 1, 2 and 3 of said patent.

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