A fan member particularly for use in a vehicle cooling system. A formed metal hub member with a plurality of plastic polymer blade members. The blade members are overmolded on the hub member, preferably individually. The plastic polymer material is molded through openings in the hub member to help securely hold the blade members in place.

**FIG. 1**
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FAN WITH OVERMOLDED BLADES

TECHNICAL FIELD
The present invention relates to fans and more particularly to cooling fans with a metal hub and overmolded fan blades.

BACKGROUND OF THE INVENTION
The use of fans to move air through heat exchanges is well known, especially in the fields of air conditioning and motor vehicle cooling. In motor vehicles, the fans are typically used adjacent radiators in order to either push air or pull air through the radiator in order to cool liquids which are circulating through the engine and/or other accessories. The fans are typically driven by an electric motor or via a transmission from an associated engine in motor vehicles. The fans are usually disposed so that the radial plane of the fan extends parallel to a face portion or surface of the associated heat exchanger, such as a radiator. Fans of this type are commonly referred to as "axial flow fans".

When the systems or vehicles are sold in substantial quantities, cooling fans made with plastic components or made entirely of plastic materials are designed and manufactured for each of the systems or vehicles - and are designed specifically for the particular air flow or that particular system or vehicle. The fans are provided of particular size and shape in order to optimize the air flow through the particular system or vehicle. Due to the large quantities in which the fans are provided, the cost of molds for even large fans are easily absorbed or amortized over the life of the vehicles and fan products. It is uneconomical, however, to provide large fans with molded plastic components for a particular system or vehicle (such as large trucks) which are not made or sold in substantial quantities.

Thus, it is an object of the present invention to provide an improved fan with molded plastic components which is less expensive to make and provide for systems and vehicles which are typically not sold in substantial quantities. It is another object of the present invention to provide a fan with a metal hub member and polymer fan blades which can be manufactured more easily and less expensively.
SUMMARY OF THE INVENTION

A fan, particularly used for use in a vehicle cooling system is provided, in a preferred embodiment, the fan includes a central hub member and a plurality of polymer blade members. The hub member is preferably made from a metal material, such as steel, while the blade members are made from a thermoplastic material, such as glass-filled nylon. The number of blade members is not critical.

The hub member has a central area used for mounting the fan adjacent a radiator or vehicle engine. The hub member has a peripheral flange member with a flared outer rim. One or two groups of openings are provided in the hub member where the blade members are to be positioned. One of these groups of openings can be provided in the peripheral flange member. The blade members are preferably individually overmolded onto the hub member. The thermoplastic material passes through the openings which securely affixes the blade members to the hub member. The blade members can be molded onto the hub member by a rotational molding process.

Other features, benefits and advantages present invention will become apparent from the following description of the invention, when viewed together with the accompanying drawings and appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a perspective view of a cooling fan according to an embodiment of the present invention.

FIGURE 2 is a front view of a fan embodiment in accordance with the present invention.

FIGURE 3 is a rear view of the fan shown in Figure 2.

FIGURE 4 is a cross-sectional view of the fan shown in Figure 2, the cross-section taken along line 4-4 in Figure 3.

FIGURE 5 is an enlarged partial cross-sectional view of the hub member and fan blade as shown in Figures 2-4.
FIGURES 6-8 depict a hub member for use with the present invention, with Figure 7 being a cross-sectional view.

DESCRIPTION OF PREFERRED EMBODIMENTS

The present invention provides a unique and inventive cooling fan with plastic (or polymer) blade members that can be used in a wide variety of applications, such as air conditioning and motor vehicle cooling. For purposes of the description herein, the present invention will be described only with reference to a preferred use in cooling systems for motor vehicles. However, the invention is not to be limited by this description and the inventor is entitled to all of the benefits and scope of the invention which involves use of the disclosed fan in any cooling system application.

The present invention has particular use for fans in large truck cooling systems. These fans can have diameters of 20-40 inches or more and are typically not produced in large quantities.

The fan member is described generally by the reference numeral 10 in the drawings. The fan 10 has a central hub member 20 and a plurality of blade members 30. The blade members extend radially outwardly, as is typical with fans used in cooling systems.

The configuration and number of fan blade members are not critical with respect to the present invention. Any number of blade members can be utilized. The example disclosed in the drawings herein has nine blade members. The blade members also can have any configuration and shape, such as being curved as shown in the example illustrated in the drawings.

The hub member 20 is preferably made of a metal material, such as steel. Other materials could also be used, depending on the strength and durability requirements of the desired use of the fan 10.

The blade members 30 are preferably made of a plastic polymer material, such as glass filled nylon. One acceptable glass filled nylon material is Nylon 6. Other thermoplastic polymer or resin materials, thermo setting polymer materials, and other engineered resins could also be used, depending on the air flow and durability requirements of the desired use of the fan 10. For convenience of the present
description, all of these materials will be referred to generally by the term "plastic polymer materials."

A preferred hub member 20 is shown in Figures 6-8. The hub member has a circular outer perimeter 32 and a formed disk-shaped cross-section. Providing the hub member with a non-flat formed cross-section increases the strength of the hub member. It allows the entire hub member to share loads more evenly and uniformly.

The hub member 20 has a raised central portion 34 with a central opening 36 and a plurality of mounting holes 38. The opening 36 saves weight and allows the fan to be positioned on or over a protruding mount or portion of an engine. The holes 38 are used to mount the fan member on a vehicle engine or component. Preferably fasteners such as bolts (not shown) are used to secure the fan member in place through the use of the holes 38.

The hub member also has a first formed conical portion 40 and a second formed conical portion 42 positioned radially outwardly from the central opening 36 and central portion 34. A generally axial extending flange member 44 is positioned radially outwardly of formed portion 42. A rim member 46 is positioned adjacent the outer periphery 32 of the hub member. The flared outer rim member 46 increases the stiffness and strength of the hub member during rotation, and prevents localized high stresses.

A first series of holes or openings 50 is positioned in an annular ring on the second formed portion 42. The openings 50 are circular in shape in the drawings, but they can be any shape, such as oval, square, triangular, etc. In the example shown, these openings are arranged in groups of four openings. The number of groups preferably corresponds to the number of blade members 30 provided on the fan member 10.

A second series of holes or openings 60 is positioned in an annular ring on the outer flange member 44. Again, although the openings 60 are shown as being oval shaped in the drawings, the openings 60 can have any shape. The openings 60 are also arranged in groups of four openings. Again, the number of groups preferably corresponds to the number of blade members 30 on the fan 10.
The openings 50 and 60 extend through the hub member (as shown in the drawings). This allows the plastic polymer material to flow through them when the blade members are formed, as described in more detail below.

The number of openings 50 and 60 in each grouping is not critical. The purpose of the openings is to securely affix and attach the blade members onto the hub member. Even a single hole or opening could be provided if it was of sufficient size to fixedly secure the blade members to the hub member. A larger number of openings could also be provided, although they should be of sufficient size to form a strong attachment of the plastic polymer material to the hub member. There also cannot be too many openings in each grouping which might cause the hub member to be weakened.

Thus, the strength of the hub member is dependent on many factors, such as the type of material utilized, the thickness of the material, the amount of forming performed on the hub member, and the number of openings provided in it. In this regard, the holes or openings 50 and 60 can be formed in any way in the hub member (shaping, stamping, drilling, cutting, etc.) and at any time in the forming process utilized.

The blade members 30 each have a base portion 70 and an outwardly extending blade portion 72. The blade members are overmolded onto the hub member. The plastic polymer material is provided in a molten form and each blade member is molded onto the edge of the hub member to form the complete fan 10 as shown. Preferably, the blade members are molded individually onto the hub member. This can be accomplished in many ways known in the art, such as by use of a rotational molding system in which the hub member is mounted on a fixture and rotated in an indexed manner through a blade forming mold in order to allow each blade member to be separately formed on the hub member. Such a process also allows the size and shape of the blade member to be customized depending on its design, purpose, and air flow requirements of the cooling fan.

As shown particularly in Figure 5, the plastic polymer forming each blade member flows through (or passes through) each of the openings 50 and 60 forming a tight and secure attachment when the plastic polymer cools and solidifies. In this
regard, as noted above, each of the base portions of each of the blade members flows through all of the openings in one of the groups of openings 50, 60. This provides a stronger and more secure attachment of the blade members to the hub member.

The openings 50 and 60 are preferably formed in aligned pairs of groupings such that a load path 80 exists through the base portion of each blade member and up through the blade portion. Such a centripetally-induced load path 80 is shown in Figure 5. This assists in overcoming loads due to centripetal forces.

Although the hub member as described herein has two series or rings of openings, it is also possible to provide only one ring of openings in the hub member - or even more than two rings of openings. The openings in each ring of openings also do not have to be arranged in groupings as discussed. Instead, a ring of equally spaced openings could be provided in the hub member for attachment of the blade members, and all of the openings would not necessarily have to be utilized for attaching the blade members. Some of the openings could be left exposed.

It is also conceivable in another embodiment to provide holes or openings for the blade members which do not extend entirely through the hub member. Such "blind holes" would not secure the blade members to the hub member as securely or as tightly as through-holes, however.

A series of reinforcing ribs 90 can be positioned on the back side of the base portions of the blade members. These are shown in Figure 3. Preferably, the ribs 90 are aligned with pairs of aligned openings in the hub members. This assists in carrying the loads experienced by the fan members when they are rotated in use.

Embodiments of the invention can have a wide variety of dimensions and specifications. For example, the hub member if made of a metal material can be formed by a deep-drawing process. The angle of the flared outer rim 46 can be from 70°-90°. The number of holes 50 and 60 can be from 2-6 holes per group. As indicated above, the holes can be any shape, such as circular, elliptical, oval, etc., and can be formed as blind-holes or through-holes by a stamping process. The outer substantially cylindrical drawn conical annular ring 44 can have a half-angle of from 0-20°.
The conical formed annular surface 42 which connects the outer drawn ring 44 to the inner raised surface 34 can have a half-angle of 60-80°. The depth of the draw is 50-100% of the depth of the outer drawn ring 44.

The inner raised surface (form) 34 can have a depth of draw of about 25-100% of the depth of the draw of the outer drawn ring 44. The radial clearance between the circle of bolts (fastener) holes 50 and the raised form 34 is about 6-50 mm.

While the invention described in connection with various embodiments, it will be understood that the invention is not limited to those embodiments. On the contrary, the invention covers all alternatives, modifications, and equivalents as may be included within the spirit and scope of the appended claims.
What is claimed is:

1. A fan comprising:
   a central hub member; and
   a plurality of blade members attached to said hub member;
   wherein said hub member has a first plurality of groups of openings located adjacent the outer periphery thereof;
   wherein said blade members are molded individually onto said hub member and positioned with one of said blade members covering one of said groups of openings; and
   wherein said blade members are securely attached to said hub member by being molded with a portion thereof passing through said openings in said groups of openings.

2. The fan as described in claim 1 wherein a second plurality of groups of openings are provided adjacent said outer periphery of said hub member, said blade members being molded onto said hub members and having portions passing through one of said groups of openings in each of said first and second plurality of groups of openings.

3. The fan as described in claim 1 wherein said hub member is made of a metal material and said blade members are made of a plastic polymer material.

4. The fan as described in claim 1 wherein nine blade members are provided.

5. The fan as described in claim 1 wherein the number of groups of openings corresponds to the number of blade members.

6. The fan as described in claim 2 wherein the number of groups of openings in said secure plurality of groups of openings correspond to the number of blade members.

7. A cooling fan assembly comprising:
   a metal hub member having a central opening, a flange member positioned on the outer periphery, and at least one plurality of equally spaced first groups of openings adjacent the outer periphery and flange member; and
a plurality of blade members attached to said hub member;
said blade members being made of a plastic polymer material and being individually molded onto said hub member;
said blade members being molded over said flange member and attached through at least one of said first groups of openings.

8. The cooling assembly as described in claim 7 wherein the number of first groups of openings correspond to the number of blade members.

9. The cooling assembly as described in claim 7 further comprising a second plurality of groups of openings, said second plurality of groups of openings being positioned on said flange member and being equally spaced around the periphery thereof, wherein each of said blade members is also attached to said hub member through at least one of said groups of openings in said flange member.

10. The cooling fan assembly as described in claim 7 wherein the number of blade members and the numbers of groups of openings are the same.

11. A cooling fan assembly as described in claim 9 wherein the number of groups of openings in said first plurality of groups of openings and said second plurality of groups of openings correspond to the number of said blade members.

12. A method of making a cooling fan member comprising:
providing a hub member, said hub member having a central opening, a flange member on the outer periphery, and a first plurality of groups of openings adjacent said flange member;
individually molding a plurality of blade members onto the outer periphery and flange member of said hub member, said blade members being secured to said hub member by having a portion molded through at least one of said first plurality of groups of openings.

13. The method of making a cooling fan member as described in claim 12 wherein said hub member is made of a metal material and said blade members are made of a plastic polymer material.

14. The method of making a cooling fan member as described in claim 12 wherein said hub member has a second plurality of groups of openings positioned in
said flange member, and wherein each of said blade members are further molded through at least one of said second plurality of groups of openings.