A two-piece molded fan assembly is produced having overlapping fan blades using an axial draw technique. The two halves are then removed from the mold and coupled together to form the two-piece fan. By molding the fan as two pieces, a fan blade can be produced that wraps around the outside of the housing and overlaps with each other in a quick and easy manner using a simple mold design. The two pieces are formed such that the portion of each overlapping blade is formed on both halves of the assembly so that the die casting tool can be removed along a central axis defining the fan assembly without contacting the respective portion of the fan blades, therein greatly simplifying the manufacturing techniques.
TWO-PIECE MOLDED FAN

TECHNICAL FIELD

[0001] The invention relates generally to fan drive systems and more specifically, fan drive systems with two-piece molded fans.

BACKGROUND ART

[0002] Cooling systems are used on vehicles today to provide cooling to an engine during operation. A typical cooling system comprises a water pump and a fan drive. Fan drives are typically driven by the engine crankshaft at a fixed ratio to cool engine coolant as it flows through a radiator. More specifically, a fan that is rigidly mounted to the fan drive generates the airflow as a function of engine crankshaft rotational speed for cooling the radiator.

[0003] One important consideration with fans is the ease of manufacture. In automotive applications, molded plastic parts with a minimum number of parts and assembly steps are generally most cost effective. As will be recognized by those of skill in the molding art, one of the most cost effective ways to mold plastic is by the so called axial draw technique or by pass molding technique, which uses only two molds that part along a natural axis of the component. The ultimate in fan simplicity using this technique is a one-piece fan design. In order to be moldable by that technique, the part must have a certain structural relationship relative to its central axis, such as the central axis of the fan. All “upper” and “lower” surfaces of the part must be divisible in such a way that they have no radial overlap with one another. If so designed, all part surfaces may be divided up so that some can be molded by one die, and the rest by the other die, and the pair of die (or molds) can be pushed together and pulled apart freely along the same central axis. This represents the absolute minimum in terms of molds used (two) to produce the parts, and the number of pieces (one) in the part produced.

[0004] As will be recognized by those of skill in the art, the number of fan blade configurations that can be made using a one-piece mold is thus limited to configurations that can be pulled apart freely along the same central axis. For example, overlapping blade fans cannot currently be made using the axial draw technique because the blade overlap would prevent part removal if the whole fan was cast as one piece.

[0005] It is thus highly desirable to introduce a overlapping blade fan using the axial draw technique.

SUMMARY OF THE INVENTION

[0006] The above and other objects of the invention are met by the present invention. In the present invention, a two-piece fan blade integrated with the fan drive is produced having overlapping fan blades using an axial draw technique. The two halves are then removed from the mold and bolted together to form the two-piece fan.

[0007] By molding the fan as two pieces, a fan blade can be produced that wraps around the outside of the housing and overlaps with each other. The molding can be done within one die casting tool having a front and rear section or can be done with two separate die casting tools.

[0008] Other features, benefits and advantages of the present invention will become apparent from the following description of the invention, when viewed in accordance with the attached drawings and appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. 1 is a perspective view of a two-piece fan assembly according to one preferred embodiment of the present invention;

[0010] FIG. 2 is an exploded view of the two-piece fan assembly;

[0011] FIG. 3 is a front view of FIG. 1; and

[0012] FIG. 4 is a side view of FIG. 1 indicating mold release directions.

BEST MODE(S) FOR CARRYING OUT THE INVENTION

[0013] Referring now to the drawings, which are not intended to limit the invention, FIGS. 1-4 indicates a two-piece fan assembly 10 according to a preferred embodiment of the present invention. The two-piece fan assembly 10 is generally defined about a central axis A, and also spins about the same axis in operation. The two-piece fan assembly 10 is preferably formed of die cast aluminum or molded plastic, although other materials may be used as those of skill in the art recognize.

[0014] The structural foundation of the fan assembly 10 is the central hub 12, which is basically an annular disk that extends radially outward from a center bore 14. The center bore 14 is the attachment point of a motor shaft (not shown) that spins the fan assembly 10 about central axis A. The motor shaft, and associated housing, have a conventional arrangement well known to those of skill in the art and will not be discussed further in this application.

[0015] Disposed about the central hub 12 are a plurality of circumferentially displaced, radially disposed fan blades 16 having a radially inner portion 32 of their bases integrally molded with, and supported by, the central hub 12. Also note that each fan blade 16 has a part of the front side portion 34 blocked by the next adjacent front side portion 34 when a person views the fan blade 16 from the side as in FIG. 3 (i.e. there is at least a partial overlap of the blades 16 as viewed from the front or back). This overlapping blade 16 structure, as one of skill in the art appreciates, enables the fan assembly 10 to provide increased air flow as compared with fan assemblies having non-overlapping blade structures.

[0016] The fan assembly 10 consists of a front portion 20 (left half of FIG. 4) and a rear portion 22 (right half of FIG. 4) fastened together through a coupling device known to those of skill in the art. Both the front portion 20 and rear portion 52 have a substantially flat region 50a, 50b that is defined by and corresponding to the relative positioning plane 52. As such, the central hub 12 consists of a front hub portion 12a and a rear hub portion 12b. Similarly, the fan blades 16 consist of a front fan blade portion 16a and a rear fan blade portion 16b. As best seen in FIG. 4, each front fan blade portion 16a is coupled to a rear fan blade portion 16b such that they form a relatively smooth coupling along and between each radially outward portion 30, radially inward
portion 32, front side portion 34 and rear side portion 36 when the front portion 20 is coupled to the rear portion 22.

[0017] In the preferred embodiments as shown in FIGS. 1-4, the front portion 20 and rear portion 22 are formed with a plurality of bolt holes 25a, 25b. Of course, the bolt holes 25a, 25b could also be formed in a post-casting step using a drill or similar equipment.

[0018] As best shown in FIG. 4, to couple the front portion 20 to the rear portion 22, the flat portions 30a, 30b are first aligned along either side of the relative positioning plane 52. A bolt 24 is then inserted through a corresponding bolt hole 25a and 25b to secure the front portion 20 to the rear portion 22. The bolt 30 may be secured within the respective pair of bolt holes 25a, 25b by a corresponding nut (not shown) or other methods well known in the art. While the embodiments shown in FIGS. 1-4 indicate 12 bolts 24 and 12 corresponding bolt holes 25a, 25b circumferentially placed around the hub portions 12a, 12b, the number and location of the bolts 24 and bolt holes 25a, 25b may vary as one of skill in the art would appreciate. Further, while the bolts 24 are shown with their head portions 24a, closely coupled with the front portion 20, one of skill would recognize that it is equally plausible that the bolt 24 is secured with the head portion 24a closely coupled with the rear portion 22 to secure the front portion 20 to the rear portion 22.

[0019] Referring now to FIG. 4, the fan assembly 10 is formed by die casting the front portion 20 and rear portion 22 as two separate pieces within a corresponding die casting tool separated along a relative positioning plane 52. After introduction of the molten material and die casting has occurred within the die cast tool (not shown) by conventional techniques, the die cast tool separates, as indicated by the arrows, along the axis A away from the relative positioning plane 52, thereby allowing the two portions 20, 22 to be removed from the tooling. As one of skill would recognize, the overlapping structure of the fan blades 16 would prevent part removal if the fan assembly 10 were cast as a single piece using an axial draw technique. Here, the front section of the die cast tool separates from the front portion 20 along the axis A away from the relative positioning plane 52 such that the front section of the tool does not contact the front section of the overlapping blades 16a. At the same time, the rear section of the die cast tool separates from the rear portion 22 along axis A away from the relative positioning plane 52 such that the rear section does not contact the rear section of the overlapping blades 16b.

[0020] Of course, as is appreciated by one of skill in the art, the front portion 20 and rear portion 22 could be formed within two separate die casting tools using the axial draw technique.

[0021] Thus, the present invention presents a simple, easy and efficient procedure for casting a fan assembly 10 having an overlapping fan blade 16 structure using an axial draw technique. Importantly, the technique presented in the present invention can be applied to a potentially infinite variety of overlapping fan blade designs. All that is required to incorporate this technique is to determine a relative positioning plane 52 within the fan assembly 10 cutting through the fan blades 16 and hub 12 such that the die cast tool can be pulled apart along the axis A of the fan assembly 10 after the portions 20, 22 are die cast.

[0022] While the invention has been described in connection with one embodiment, it will be understood that the invention is not limited to that embodiment. 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 method for forming a fan assembly defined by and capable of spinning about a central axis, said fan assembly having a plurality of circumferentially displaced, radially disposed overlapping fan blades coupled about a central hub, the method comprising comprising:
   - determining a relative positioning plane extending through the plurality of overlapping fan blades and central hub of the fan assembly, said relative positioning plane located such that a front portion of said plurality of overlapping fan blades are located on one side of the relative positioning plane a rear portion of said plurality of overlapping fan blades are located on the opposite side of said relative positioning plane;
   - die casting said front portion of the two piece fan assembly, said front portion having said first portion of said plurality of overlapping fan blades and a front hub portion and a substantially flat front flat portion, said front flat portion defined by said relative positioning plane;
   - die casting a rear portion of the two piece fan assembly, said rear portion having said second portion of said plurality of overlapping fan blades and a rear hub portion and a substantially flat rear flat portion, said rear flat portion defined by said relative positioning plane;
   - and coupling said front portion to said rear portion to form the two-piece fan assembly.

2. The method of claim 1, wherein die casting a front portion and die casting a rear portion comprises:
   - introducing a first quantity of molten material within said front portion of a die casting tool;
   - introducing a second quantity of said molten material within said rear portion of said die casting tool; and
   - cooling said first quantity of cast molten material to form said front portion and cooling said second quantity of cast molten material to form said rear portion.

3. The method of claim 1, wherein said front hub portion has a plurality of bolt holes formed therein and wherein said rear hub portion has a second plurality of holes formed therein.

4. The method of claim 2, wherein coupling said front portion to said rear portion comprises:
   - providing a plurality of bolts, each of said plurality of bolts having a head;
   - forming a plurality of front bolt holes on said front hub portion in a post-casting step;
   - forming a second plurality of rear bolt holes on said rear hub portion in a post-casting step;
   - coupling said front flat portion of said front portion to said rear flat portion of said rear portion;
introducing one of said plurality of bolts through a corresponding one of said plurality of front bolt holes and through a corresponding one of said second plurality of rear bolt holes, wherein at least one of said heads of said plurality of bolts is closely coupled with said front hub portion; and
securing each of said plurality of bolts.
5. The method of claim 2, wherein coupling said front portion to said rear portion comprises:
providing a plurality of bolts, each of said plurality of bolts having a head;
forming a plurality of front bolt holes on said front hub portion in a post-casting step;
forming a second plurality of rear bolt holes on said rear hub portion in a post-casting step;
coupling said front flat portion of said front portion to said rear flat portion of said rear portion;
introducing one of said plurality of bolts through a corresponding one of said second plurality of rear bolt holes and through a corresponding one of said plurality of front bolt holes such that at least one of said heads is closely coupled with said rear hub portion; and
securing each of said plurality of bolts.
6. The method of claim 4, wherein securing said plurality of bolts comprises securing each of said plurality of bolts with a corresponding nut, said corresponding nut closely coupled with said rear hub portion.
7. The method of claim 5, wherein securing said plurality of bolts comprises securing each of said plurality of bolts with a corresponding nut, said corresponding nut closely coupled with said rear hub portion.
8. The method of claim 3, wherein coupling said front portion to said rear portion comprises:
providing a plurality of bolts, each of said plurality of bolts having a head;
coupling said front flat portion of said front portion to said rear flat portion of said rear portion;
introducing one of said plurality of bolts through a corresponding one of said plurality of rear bolt holes and through a corresponding one of said second plurality of rear bolt holes, wherein at least one of said heads of said plurality of bolts is closely coupled with said front hub portion; and
securing each of said plurality of bolts.
9. The method of claim 3, wherein coupling said front portion to said rear portion comprises:
providing a plurality of bolts, each of said plurality of bolts having a head;
coupling said front flat portion of said front portion to said rear flat portion of said rear portion;
introducing one of said plurality of bolts through a corresponding one of said second plurality of rear bolt holes and through a corresponding one of said plurality of front bolt holes such that at least one of said heads is closely coupled with said rear hub portion; and
securing each of said plurality of bolts.
10. The method of claim 8, wherein securing said plurality of bolts comprises securing each of said plurality of bolts with a corresponding nut, wherein said corresponding nut is closely coupled with said rear hub portion.
11. The method of claim 9, wherein securing said plurality of bolts comprises securing each of said plurality of bolts with a corresponding nut, wherein said corresponding nut is closely coupled with said front hub portion.
12. A method for die casting a two-piece fan assembly having a plurality of circumferentially displaced, radially disposed overlapping fan blades, said fan assembly capable of rotating about a central axis, the method comprising:
determining a relative positioning face extending through the plurality of overlapping fan blades and central hub of the fan assembly, said relative positioning plane located such that a front portion of said plurality of overlapping fan blades are located on one side of the relative positioning face a rear portion of said plurality of overlapping fan blades are located on the opposite side of said relative positioning face;
die casting a front portion and a rear portion of the two piece fan assembly within a die casting tool having a front section and a rear section, wherein said front portion having said first portion of said plurality of overlapping fan blades and a substantially flat flat portion, said rear flat portion defined by said relative positioning plane,
wherein said rear portion having said second portion of said plurality of overlapping fan blades and a substantially flat rear flat portion, said rear flat portion defined by said relative positioning plane;
uncoupling said front section of said die cast tool along said central axis away from said relative positioning plane such that said front section does not contact first portion of said plurality of overlapping blades; and
uncoupling said rear section of said die cast tool along said central axis away from said relative positioning plane such that said rear section does not contact second portion of said plurality of overlapping blades.
13. The method of claim 12, wherein die casting a front portion and die casting a rear portion comprises:
introducing a first quantity of a molten material within said front section;
introducing a second quantity of said molten material within said rear section; and
cooling said first quantity of cast molten material to form said front portion and cooling said second quantity of cast molten material to form said rear portion.
14. The method of claim 12, wherein said front hub portion has a plurality of bolt holes formed therein and wherein said rear hub portion has a second plurality of holes formed therein.