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(54) METHOD OF FABRICATING A COMPOSITE AERODYNAMIC ROTOR BLADE ASSEMBLY AND THE ASSEMBLY PER SE

(71) We, BOEING COMPANY, a corporation organized and existing under the laws of the State of Delaware, United States of America, of 7755 East Marginal Way, Seattle, Washington, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a method of fabricating a composite aerodynamic rotor blade assembly, such as a helicopter rotor blade assembly, and the assembly *per se* whenever made by the method.

From the very advent of the composite aerodynamic rotor blade, those skilled in the art have sought to reduce the cost of manufacture by in some way reducing or changing the various stages of fabrication. Still, however, composite rotor blades are fabricated by joining a number of separately fabricated sub-assemblies; and, for the most part, as multicured sub-assemblies requiring separate bonding assembly jigs for each major cure sub-assembly.

For example, in a known method of fabricating a composite aerodynamic rotor blade, the following sub-assemblies are produced:—

a. blade cap member, de-icing blanket and nose block sub-assembly;

b. blade spar sub-assembly;

c. blade spar and cap member, de-icing blanket, and nose block sub-assembly.

d. blade trailing edge wedge sub-assembly;

e. blade aft fairing core, (unmachined) with one skin member sub-assembly;

f. blade aft fairing core (machined) with both skin members sub-assembly;

g. Final assembly including all sub-assemblies.

As can readily be seen, this assembly includes at least seven curing and/or bonding operations.

It would, therefore, be desirable to be able to reduce the total number of curing and/or bonding operations now required to fabricate a composite aerodynamic rotor blade and thereby reduce the cost of fabrication.

Of the various sub-assemblies mentioned above, one of the most limiting to the achievement of production economy is the, spar sub-assembly. For example, in one known method of fabrication which employs curing; it has been found that a back pressure has to be provided against the rear face of the spar to counteract the internal bag pressure acting within the spar during the curing cycle. In the past the only successful way to do this was by forming the spar separately in a mould. In another known method of fabrication which employs curing, it was decided to fabricate the spar heel separately from the spar and then to include the spar heel in assembly with the spar during the spar curing cycle. This procedure, however, did not prove satisfactory, the spar developing undesirable surface wrinkles.

Since the spar is a key element in any aerodynamic rotor blade, and since it has had to be fabricated separately it can be readily appreciated that optimization in fabrication can be achieved by providing a method in which the spar need not be fabricated as a separate sub-assembly.

It would, therefore, be desirable to provide a method of fabricating a composite aerodynamic rotor blade in which the spar need not be separately assembled and which does not develop any undesirable conditions detrimental to the proper employment of the spar.

According to the present invention we provide a method of fabricating a composite aerodynamic rotor blade assembly utilizing a single matched die mold, the assembly including: a cap member having an outer surface which defines a leading edge of the blade and an inner surface with a nose block engaging portion, a spar engaging portion and an aft fairing skin member engaging portion; a nose block having a spar engaging surface; a spar heel; a spar having a root end and an outer surface with a spar heel engaging portion; an aft fairing structure which defines a trailing edge of the blade and comprises a lightweight core having front, rear, top and bottom surfaces, and a respective skin member secured to each one of the top and bottom surfaces; and a tip cover having a surface which engages the cap member and the skin members, the method comprising the steps of:

a) machining the bottom surface of the core at an inclination relative to the top surface of the core such that the core cells assume a vertical orientation when the core is placed in a bonding assembly jig;

b) forming the aft fairing structure in a bonding assembly jig by:

(i) laying-up one of the skin members in the jig and engaging the layed-up skin member with the bottom surface of the core;

(ii) forming the layed-up skin member into a structural member by subjecting it to the heat and pressure of a curing cycle while at the same time securing it to the engaged surface of the core;

(iii) machining the top surface of the core into a contoured surface;

(iv) laying-up the other of the skin member in a jig and in engagement with the machined contoured top surface of the core;

(v) attaching with an adhesive, the spar heel to the front surface of the core and to the structuralized skin member while engaging the spar heel with the layed-up skin member; and

(vi) forming the layed-up skin member into a structural member by subjecting it to the heat and pressure of a curing cycle while at the same time securing the engaged and attached surfaces.

c) placing the spar, the cap member, the nose block, the aft fairing structure and the tip cover into the single matched die mold with:

(i) the nose block engaging portion, the spar engaging portion and the aft fairing skin member engaging portion of the inner surface of the cap member in engagement with the nose block, the spar and the aft fairing skin members, respectively;

(ii) the spar engaging surface of the nose block engaging the spar;

(iii) the spar heel engaging portion of the outer surface of the spar engaging the spar heel;

(iv) the tip cover surface engaging the cap member and the skin members; and with

(v) the engaged surfaces in (i)—(iv) being attached with an adhesive; and

d) securing the attached surfaces to each other in the single matched die mold through the application of heat and pressure to thereby form the composite aerodynamic rotor blade assembly.

The invention will now be described by way of example only with reference to the figures of the accompanying drawings in which:—

Figure 1 is a top plan view of a composite aerodynamic blade assembly for a helicopter that is fabricated according to the method of this invention.

Figure 2 is a cross-sectional view (to a larger scale than that used in Figure 1) of the rotor blade of Figure 1 taken on the section station 2—2 of Figure 1.

Figures 3 to 7 illustrate various stages of development in the fabrication of the rotor blade by the method of this invention and the tools used.

Figure 8 is a detailed illustration of the part encircled at A of Figure 2.

In Figures 1 and 2 a helicopter composite rotor blade 10 includes in its essential parts a spar 12, an aft fairing structure 14, a cap member 16, a nose block 18 and a tip cover 20.

The spar 12 is formed generally as a shaped rounded "D" like structure in cross-section with a spanwise transition to a generally rectangular root end section 22 which is fitted into a rotor hub in any conventional manner (not shown). The spar 12 is tubular and acts as the predominate load bearing member of the blade and therefore serves as a carrier to which all other elements are attached to form the composite structure. Because the spar serves as a carrier, its outer surface is shaped to accommodate the other elements of the blade so that in cross section, the blade presents an aerofoil shape.

The aft heel section of the spar 12 is fabricated as a separate spar heel 24 capable of withstanding not only the operating flight loads of the helicopter to which it is fitted but also, in the case where curing is employed, the temperature and pressure requirements of the various curing cycles to which it is subjected. The spar heel 24 is in this invention first secured to the aft fairing structure 14 and then attached to the spar 12 as part of the aft fairing structure 14.

The spar heel 24 is formed generally as a shaped C like structure in cross-section with a spanwise transition toward the root end section 22 which renders the spar heel 24 compatible with the spar 12 to form the root end section 22 of the blade 10.

The aft fairing structure 14 exclusive of the spar heel 24 includes typically a light weight core 26, made preferably of foam or honeycomb, an upper skin member 25, a lower skin member 30 and in most cases, a trailing edge wedge 32.

Preferably each of the elements comprising the aft fairing structure 14 possesses a unitary spanwise construction. Alternatively, the elements may comprise any number of discrete boxes 34 each including a core 26, upper and lower skin members 28, 30 and, in most cases, a trailing edge wedge 32. In assembly, the boxes are separated by a spacer rib 36 (shown only schematically in Figure 1). The spacer ribs 36 are preferably made of rubber.

When the aft fairing structure 14 has been assembled with the spar heel 24 it is preferably balanced. For this purpose, the spar heel 24 is provided with an extension which serves as a tip weight housing 38 adapted to accommodate the necessary balancing weights that are added during the balancing procedure, which procedure is known and is not discussed herein.

At the front end of the blade assembly there is preferably provided in addition to the cap member 16 and the nose block 18 a de-icing blanket 40. The nose block 18 has formed therein a spanwise extending bore 42 into which a counterwight (not shown) is inserted. The cap member 16 is preferably made of metal, such as titanium, although it may be made of any non-metallic material capable of protection against erosion. Whether the cap member 16 is made of metal or of a non-metallic material, it includes a non-metallic inboard portion which with the spar 12 and spar heel 24 form the root end of the blade 10. The root end of the blade 10 has the blade torsion splices (not shown) formed therein. The procedure for forming the torsion splices is known and thus not discussed herein.

The cap member 16 has an outer surface which defines a leading edge 44 of the blade 10 and an inner surface which defines a nose block engaging portion 46, a spar engaging portion 48 and an aft fairing skin member engaging portion 50. The extent of the engagement of each portion is evident from the section in Figure 2. The nose block engaging portion 46 is shown in Figure 2 to be in engagement with the de-icing blanket 40.

The nose block 18 has a spar engaging surface 51, the spar 12 has an outer surface with a spar heel engaging portion 52, while the core 26 of the aft fairing structure 14 has front, rear, top and bottom surfaces 54, 56, 55 and 60 respectively. Finally the aft fairing structure 14 define a trailing edge 76 of the blade.

As can be seen in the section of Figure 2, the outer surface of the spar 12 is so shaped that in the blade assembly it defines a recess along with the cap member 16, and a slot along with the cap member 16 and nose block 18.

In Figures 3—7 it should be noted that in forming the aft fairing structure 14, the core 26 has its bottom surface 60 cut or machined in a conventional manner so to conform it to the inclination of a jig portion 62 of a bonding assembly jig shown generally as 62A that when placed in the said jig portion 62 on a lower skin member 30, the cell walls C1. C2 of the core 26 for example are parallel to the back edge 24A of the spar heel 24 (Figure 2) when fitted thereto. Alternatively, the core 26 can be obtained with its surface 60 already cut or machined to the inclination of the jig portion 62.

The bonding assembly jig 62A also includes pressure blocks 64 with rubber pads 66 which are placed as shown in Figure 3. The remaining parts of the bonding assembly jig 62A are not shown since they are known to one skilled in this art.

The lower skin member 30 may be obtained in sheet form either in a cured or uncured condition. In either case, the lower skin member 30 is attached to the surface 60 of the core 26 using any known adhesive for the purpose. The adhesive is applied to the mating surfaces, and the attached core and skin member subjected to heat and pressure in the bonding assembly jig to secure the mating surfaces.

It is preferred that the lower skin member 30 is first layed-up in the jig portion 62, and core 26 positioned as before, the jig assembled and the contents thereof subjected to the heat and pressure of a curing cycle. As a result of the curing, the layed-up skin is formed into a structural member and simultaneously secured to the core 26.

After the lower skin member 30 is secured to the bottom surface 60 of the core 26 the top surface 55 is machined to a contoured shape 58^1 that brings it to an aerofoil shape.

Next, the upper skin member 28 is placed in a portion 68 of another bonding jig portion, shown generally at 68A but only in part in Figure 4. The spar heel 24 is now fitted and the machined core 26 and its secured lower skin member 30 also placed in said portion 68 with the machined surface 58^1 in engagement with the upper skin member 28 and with the skin members 28, 30 and core 26 in engagement with the said spar heel 24. When a trailing edge wedge 32 is to be included it can be assembiled with the machined core 26 and lower skin member 30 or it can be placed as shown in Figure 4 against the upper skin member 28 and the machined core 26 and secured lower skin member 30 then placed in the jig portion so that the trailing edge wedge 32 engages the rear surface 56 of the core 26. The placement of the trailing edge wedge 32 precedes placement of the spar heel 24. With the aft fairing structure 14 so assembled remaining parts of the jig are closed with the portion 68 preparatory to effecting the securing step. One of these jig parts is a side part 70 which includes a mandrel 72 and an inflatable bag 74 which extend into the cavity defined by the spar heel 24. Clearly the mandrel 72 lends support to the spar heel 24 during the securing step and the inflatable bag 74 insures a uniform bond along the entire surface of engagement.

The upper skin member 28, as with the lower skin member 30, may be procured either in a cured or uncured condition, and the trailing edge wedge 32 may also be cured or uncured in its desired shape. In this case, the upper skin member 28, the spar heel 24, the machined core 26 and secured lower skin member 30 and the trailing edge wedge 32 are mutually attached using any known adhesive and the two circular halves or terminal ends 66A, 66B are jointed along line AA1 Figure 4 and form the circular bead 66C. The adhesive is applied to the mating surfaces and the elements subjected to heat and pressure in the bond assembly jig 68A to secure the mating surfaces.

Preferably the upper skin member 28 and the trailing edge wedge 32 are first layed-up in the jig portion 68, the machined core 26 and secured lower skin member 30 and spar heel 24 positioned as before, the jig assembled and the contents thereof subjected to the heat and pressure of a curing cycle. As a result of the curing, the layed-up upper skin member 28 and the layed up trailing edge wedge 32 are formed into structural members and simultaneously all the engaged surfaces are secured.

In either case, however, the spar heel 24 is separately fabricated. Preferably it is also formed by first being layed-up in a mould and subjected to the heat and pressure of a curing cycle.

Where the aft fairing structure 14 is to include discrete boxes 34, the procedure is basically unchanged from that described above. The lower skin members 30 are placed in the jig portion side-by-side and secured to the bottom surface of their respective core 26 and spacer rib 36. At the same time, the engaged side surfaces of the core 26 and spacer rib 36 of each box 34 are secured while the other side surface of each spacer rib 36 is secured to the side surface of the core 26 of an adjacent box. Before this securing step is effected, the bottom surface of each core 26 and spacer rib section is cut or machined to conform them to the inclination of the jig portion 62 for the reason stated above. Thereafter the fabrication of the aft fairing structure 14 proceeds as outlined above. Preferably, the skin members 28, 30 on both the top and bottom surfaces of the core 26 and spacer ribs as well as the trailing edge wedge 32 are layed-up and cured.

As an alternative to the above, it may be desirable in both configurations first to attach a simulated skin member to the bottom surface of the core or the core and spacer rib after the core or the core and spacer rib have been cut for the purpose of machining the top surface to the desired contoured surface. Thereafter, the simulated skin memmember is removed and the top and bottom skin members, spar heel, and if desired, the trailing edge wedge are secured in accordance with the teaching discussed above.

Preferably the skin members 28, 30 and the trailing edge wedge 32 are layed-up and formed into structural members by curing while all the engaged surfaces are simultaneously secured.

The simulated skin member may be any easily manageable material of appropriate thickness.

As another alternative to the above, it may be desirable to obtain the core 26 with both surfaces 58 and 60 machined to their desired contour. In this case, the aft fairing structure 14 is fabricated by placing the core 26, the skin members 28 and 30, the spar heel 24 and the trailing edge wedge 32 into assembly as shown in Figure 4 and the engaged surfaced simultaneously secured using an adhesive and the requisite amount of heat and pressure.

It is preferred that the skin members and trailing edge wedge are layed-up in the assembly with the obtained core and spar heel and formed into structural members by curing while all the engaged surfaces are simultaneously secured.

After the aft fairing structure 14 is fabricated it is removed from jig portions 68 and 70 and assembled as shown in Figures 5—7 with the remaining parts of the rotor blade 10 in a single matched die mould 78, 80, 82.

The nose block 18, the spar 12 and the de-icing blanket 40 can be preformed or obtained members. These three members may be formed into a separate sub-assembly. Alternatively, the cap member 16, the de-icing blanket 40 and the nose block 18; or the cap member 16 and de-icing blanket 40; or the spar 12 and nose block 18 may be formed into separate sub-assemblies.

Preferably, however, the nose block 18 and spar 12 are layed-up in a fashion similar to that of the spar heel 24, the skin members 28 and 30 and the trailing edge wedge 32, and subjected to one final curing cycle in the single matched die mould at which time they are structuralized. The nose block 18 is layed-up directly in the cap member 16, while the spar 12 is layed-up on an inflatable and preferably rigidized mandrel 92 and placed into the cap member 16 in this state. In the nose block lay-up, the counterweight is included as a part thereof, while when the nose block is either performed or procured, the counterweight is inserted into the bore 42 before the nose block is placed into the cap member 16.

The final assembly is made by placing any of the sub-assemblies of the nose block 15, the spar 12, the de-icing blanket 40 and the cap member 16, mentioned above, into the forward section 78 of the single matched die mould and positioning them therein with the aid of the leading edge tooling tabs 84. When it is desired to use a metal or non-metallic cap member 16 with any sub-assembly other than that sub-assembly which includes the cap member 16, the de-icing blanket 40, the nose block 18 and the spar 12, a spreading tool 86 having spreading tongs 88 and 90 is used. The tongs 88 and 90 co-operate to spread the cap member 16 open sufficiently so that the nose block 18 and spar 12, or the nose block 18, de-icing blanket 40 and spar 12 can be inserted in place within the cap member 16 and so that the aft fairing structure 14 with the spar heel 24 can be installed into engagement with the cap member 16 and spar 12.

Once the blade is assembled and properly located in relation to the forward section 78 of the single matched die mould, the forward section of the mould is pivoted about a pin 94 by appropriate means (not shown) through the position shown in Figure 5 by arrow V to the position shown in Figure 6 and then to the position shown in Figure 7 where the aft fairing structure 14 and part of the spar 12 are brought to rest in the aft section 80 of the single matched die mould. Partially to support the assembled blade during the pivotal movement of the forward section 78 of the mould and also properly to locate the aft section 80 of the mould a locator support 96 is provided. The mould part 82 forms a strong back. The locator support 90 comprises an arm 98 and a two part receiver 100 which receives the bead 66C of the terminal end of the joined skin members 28 and 30, and which can be locked together by means not shown. The locator support 96 and receiver 100 are both pivotable.

The terminal ends 66A, 66B of the skin members 28, 30 is purposely shaped as shown in Figures 3—7 so that the blade can be safely pivoted with the forward section 78, and so that the aft fairing structure 14 can be securely held between the two halves of the receiver 100 and supported during the assembly of the aft fairing structure 14 shown in Figure 5 with any of the sub-assemblies noted above. The means for bringing the aft fairing structure into the assembly shown in Figure 5, except for the arm 98 and the receiver 100, is not shown since it is conventional.

The aft section 80 of the mould is provided with a matching recess 102 into which one half of the receiver 100 is inserted. The terminal 66C is eventually removed from the blade to form the blade trailing edge 76.

Prior to pivoting of the blade and forward section 78 the strongback 82 is secured in place between the forward section 78 of the mould and the receiver 100 (Figure 7) in a conventional manner not shown.

With the blade assembled as shown in Figures 6 and 7, according to a preferred embodiment which includes only the aft fairing structure as a sub-assembly, the following surfaces are in engagement but unsecured; the spar engaging surface 51 of the nose block 18 is in engagement with the spar 12; the nose block is engaging portion 46 of the cap member 16 is in engagement with the nose block 18 or with the de-icing blanket 40 as the case may be; the spar engaging portion 48 of the cap member 16 is in engagement with the spar 12; the aft fairing skin member engaging portion 50 of the cap member 16 is in engagement with the aft fairing skin members 28 and 30; and the spar heel engaging portion 52 of the spar 12 is in engagement with the spar heel 24.

Referring to Figure 7, the final assembly is completed by lowering the upper section 82 of the single matched die mould into its closed position and heat and pressure applied to the assembled blade. For this purpose the upper section 82 is connected to a press which is not shown.

Again, if the nose block 18, de-icing blanket 40 and spar 12 are preformed oe obtained as structural members, then the above-noted engaged surfaces are attached by using any known adhesive for the purpose. The adhesive is applied to the engaged surfaces prior to their engagement and the surfaces thus engaged are secured by the heat and pressure applied to the assembly in the single matched die mould.

It is preferred that the nose block 18, de-icing blanket 40 and spar 12 are layed-up as noted above and located in the single matched die mould. This subassembly is then subjected to the heat and pressure of a curing cycle, as a result of which the nose block 18, de-icing blanket 40 and spar 12 are structuralized and the above-noted engaged surfaces simultaneously secured.

In laying-up the de-icing blanket 40, for example, in the cap member 16, a layer of layers 104 of tape is or are applied by an adhesive to the inner surface of the cap member (Figure 8) with any known adhesive. To this tape layer or layers the grid 106 including the electrical wires 108 is attached also by an adhesive. Finally a further layer or layers 110 of tape is or are attached by an adhesive to the exposed surface of grid 106. The grid 106 may be a printed circuit board. The adhesive serves primarily to position the blanket in the cap member 14 so that the nose block 18 can be layed-up directly in the cap member 16 and thereafter the layed-up spar 12 can also be inserted into the cap member 16 and properly positioned. When properly positioned, a portion of the de-icing blanket 40 fills the slot 55 so that, when viewed in cross-section, a continuous wall is established from the outside surface of the cap member 16 to the inside surface of the spar. With such a continuous wall, an enhancement of the load carrying capability of the rotor blade is achieved in that the supporting structural material of the de-icing blanket 40 itself becomes a load carrying member.

A continuous wall is also established between the outside surface of the cap member 16 and the inside surface of the spar 12 in the spar heel region of the assembly by that portion of the secured skin members 28, 30 and spar heel 24 received within the recess 53 (Figure 2). This design, which we refer to as the tuck-in design, is very effective in firmly securing the aft fairing structure 14 into assembly with the spar 12 and cap member 16, providing thereby a fail-safe design. It is also effective from the standpoint of load transfer into the aft fairing structure 14. The greater resulting load distribution increases the load carrying capacity of the rotor blade which itself is desirable.

As noted above, one feature of the present invention resides in the provision of a spar heel 24 which together with the spar 12 and cap member 16 form the root end of the blade. A transition of the spar, the cap member and spar heel occurs so that the root end, the spar and spar heel form, preferably, a rectangular cross-section. Since the spar 12 is preferably formed as a layed-up structure which is cured in the single matched die mould, the extension of the spar heel 24 beyond the aft fairing structure 14 and to an extent equal to that of the spar 12 ensures that the spar 12 is properly formed during the curing cycle.

Certain operating parameters that are used in the manufacture of the composite aerodynamic rotor blade of the present invention are given below:—

i. A pre-impregnated mono-filament fibre is used for the lay-up members.

ii. The aft fairing structure 14 is cured at 250°F (121°C) for two hours in the pressure range of 50 to 100 pounds force/square inch.

iii. The spar heel 24 is cured at 250°F (121°C) for two hours in the pressure range of 70 to 100 pounds force/square inch.

iv. In the single matched die mould the cure cycle is two hours at 250°F (121°C) with a pressure in the range of 70 to 100 pounds force/square inch in the spar bag 74. When utilizing a cap member 16 of titanium and a de-icing blanket 40, an adhesive system requiring of 70 to 100 pounds force/square inch is needed for bonding the said de-icing blanket 40 to the said cap member 16.

Attention is directed to our co-pending applications:

35567/77 (Serial No. 1591671)
35569/77 (Serial No. 1585130)
08496/80 (Serial No. 1591673)
08497/80 (Serial No. 1591674)
08498/80 (Serial No. 1591675)
08499/80 (Serial No. 1591676)
08500/80 (Serial No. 1591677)

WHAT WE CLAIM IS:—

1. A method of fabricating a composite aerodynamic rotor blade assembly utilizing a single matched die mold, the assembly including: a cap member having an outer surface which defines a leading edge of the blade and an inner surface with a nose block engaging portion, a spar engaging portion and an aft fairing skin member engaging portion; a nose block having a spar engaging surface; a spar heel; a spar having a root end and an outer surface with a spar heel engaging portion; an aft fairing structure which defines a trailing edge of the blade and comprises a lightweight core having front, rear, top and bottom surfaces, and respective skin member secured to each one of the top and bottom surfaces; and a tip cover having a surface which engages the cap member and the skin members, the method comprising the steps of:

a) machining the bottom surface of the core at an inclination relative to the top surface of the core such that the core cells assume a vertical orientation when the core is placed in a bonding assembly jig;

b) forming the aft fairing structure in a bonding assemblyjing by:

(i) laying-up one of the skin members in the jig and engaging the layed-up skin member with the bottom surface of the core;

(ii) forming the layed-up skin member into a structual member by subjecting it to the heat and pressure of a curing cycle while at the same time securing it to the engaged surface of the core;

(iii) machining the top surface of the core into a contoured surface;

(iv) laying-up the other of the skin member in a jig and in engagement with the machined contoured top surface of the core;

(v) attaching with an adhesive, the spar heel to the front surface of the core and to the structuralized skin member while engaging the spar heel with the layed-up skin member; and

(vi) forming the layed-up skin member into a structual member by subjecting it to the heat and pressure of a curing cycle while at the same time securing the engaged and attached surfaces.

c) placing the spar, the cap member, the nose block, the aft fairing structure and the tip cover into the single matched die mold with:

(i) the nose block engaging portion, the spar engaging portion and the aft fairing skin member engaging portion of the inner surface of the cap member in engagement with the nose block, the spar and the aft fairing skin members, respectively;

(ii) the spar engaging surface of the nose block engaging the spar;

(iii) the spar heel engaging portion of

the outer surface of the spar engaging the spar heel;

(iv) the tip cover surface engaging the cap member and the skin members; and with

(v) the engaged surfaces in (i)—(iv) being attached with an adhesive; and

d) securing the attached surfaces to each other in the single matched die mold through the application of heat and pressure to thereby form the composite aerodynamic rotor blade assembly.
blade assembly.

2. The method as claimed in Claim 1, wherein the assembly further includes a trailing edge wedge, and wherein during the formation of the aft fairing structure the trailing edge wedge is engaged with the layed-up skin member and attached with an adhesive to the rear surface of the core and to the structuralized skin member, and subsequently secured to the engaged and attached surfaces during the curing cycle of the layed-up skin member.

3. The method as claimed in Claim 1, wherein the assembly further includes a trailing edge wedge, the method further comprises the step of:

e) laying-up the trailing edge wedge in the jig in engagement with the structuralized skin member the layed-up skin member and the rear surface of the core, and wherein the layed-up trailing edge wedge is formed into a structural member and secured to its engaged surfaces during the curing cycle of the layed-up skin member.

4. The method as claimed in Claim 1, wherein the assembly further includes a deicing blanket, wherein during the placement defined in step c) the deicing blanket is placed between the cap member and the nose block and spar and attached thereto with an adhesive, and wherein during the securing step defined in step d) the deicing blanket is secured at its attached surfaces to the cap member, the nose block and the spar.

5. The method as claimed in Claim 27, further comprising the step of:

e) laying-up the spar heel in a mold and forming the spar heel into a structural member by subjecting it to the heat and pressure of a curing cycle.

6. A composite aerodynamic rotor blade when ever made by the method of any one of the preceding claims.

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Agent for the Applicant.

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1591672 COMPLETE SPECIFICATION

3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

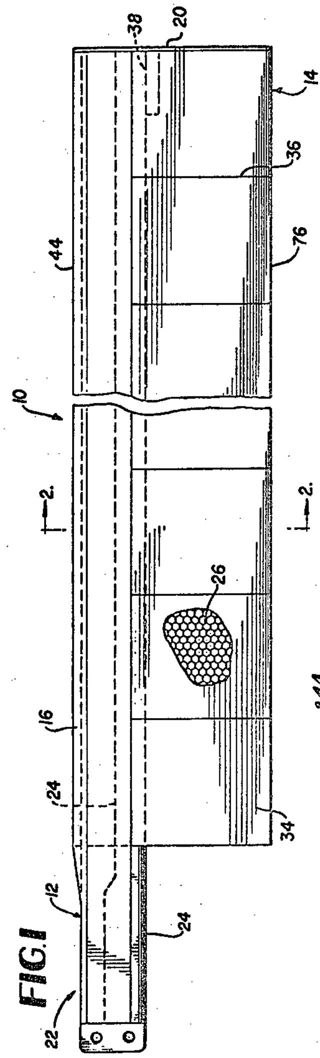


FIG. 1

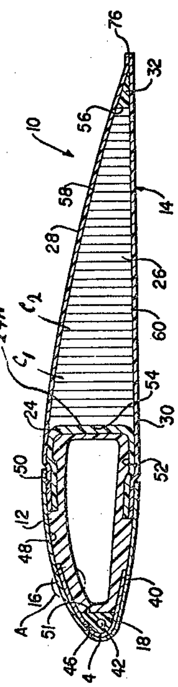


FIG. 2

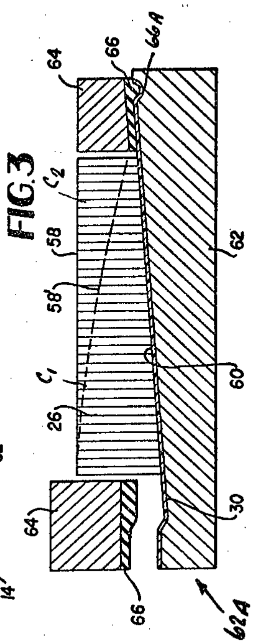


FIG. 3

1591672 COMPLETE SPECIFICATION

3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 2

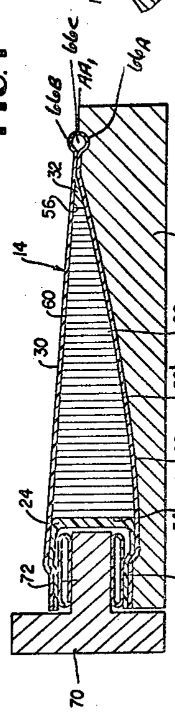


FIG.4

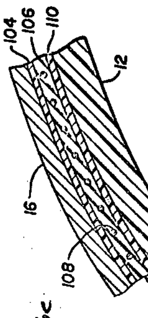


FIG.8

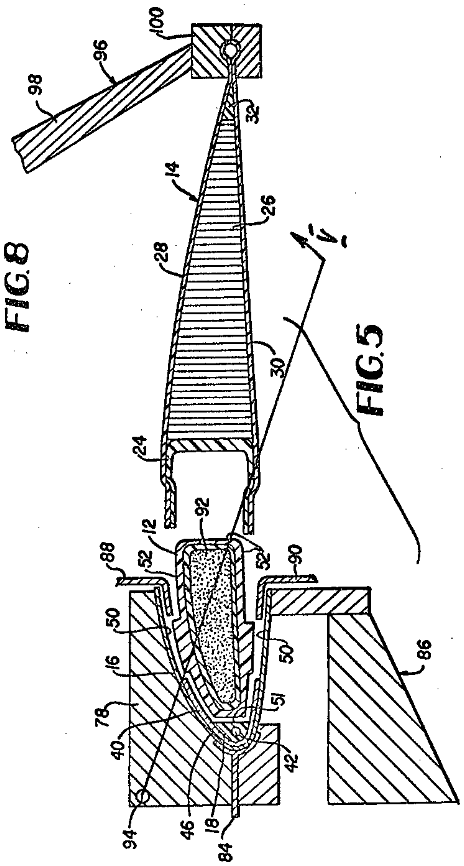
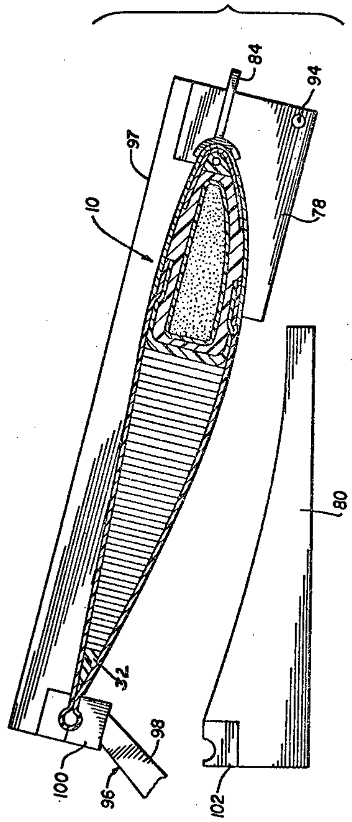


FIG.5

FIG. 6



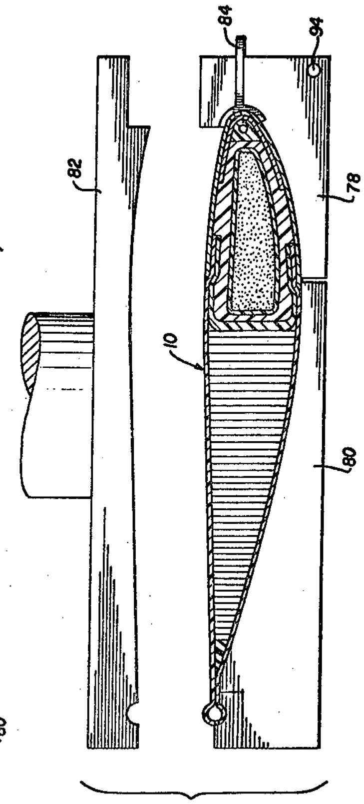


FIG. 7