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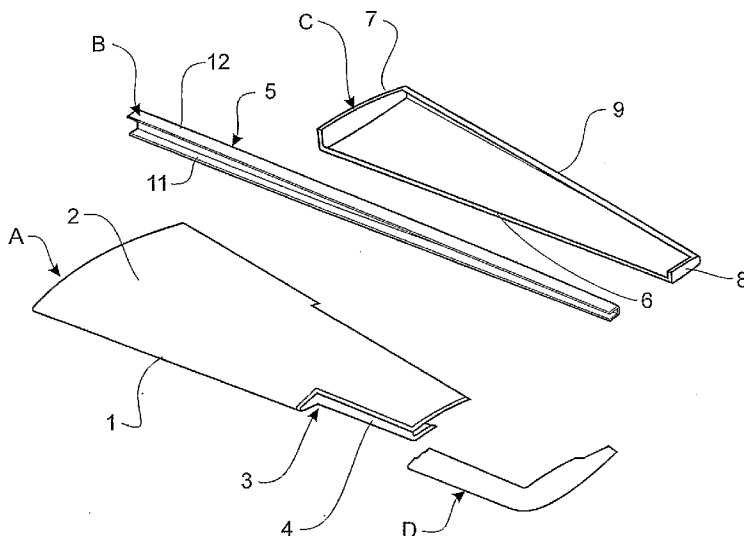


FIGURE 7

(57) Abstract: An aircraft with (I) a wing assembly primary each of three moulding, one providing a spar, a second most of the exterior including the leading edge, and a third at least most of the rear under surface and (II) a compatible fuselage. The wing assembly and its components also constitute the invention.

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“AIRCRAFT COMPONENT MANUFACTURE AND ASSEMBLY”

The present invention relates to aircraft component manufacture and assembly.

More particularly and without wishing to be restrictive the present invention relates to aircraft assemblies or subassemblies, or components for such assemblies or sub assemblies,
5 (formed from composite materials).

In the context of aircraft “composite materials” refers to a matrix or binder that binds together a reinforcement material or materials. Reinforcement materials include fibres of for example glass, a polymeric material such as KEVLAR™ and carbon. Suitable matrix materials include thermosetting plastics (but can be thermosoftening plastics in some instances). Ceramics,
10 carbon and metals have also been used in special applications as a matrix material.

Without wishing to be limited, any suitable moulding process can be used, but our preference is for a resin infusion moulding process with a thermosetting resin about a fibre reinforcement. It can be a sandwich composite of any suitable form.

Modern aviation, both military and civil would be much less efficient without composites. In fact, the demands made by that industry for materials that are both light and strong has been the
15 main force driving the development of composites. It is common now to find wing and tail sections, propellers and rotor blades made from advanced composites, along with much of the internal structure and fittings. The airframes of some smaller aircraft can be made entirely from composites, as are the wing, tail and body panels of large commercial aircraft.

Much of modern aircraft such as the Boeing 77 and F-22 are of mouldings of composite
20 material(s).

US Patent 5476704 of Kohler discloses that small aircraft such as gliders, motorised gliders or light motorised aircraft can be of components built almost exclusively of fibre reinforced plastics. He says this applies particularly in respect of the wings. He discloses that a wing can be
25 constructed of a wing shell which provides the profile ie, the profile which generates the lift.

US 5476704 discloses a plastics composite profile which permits wing spars with a tapering cross section and constructional height. Kohler discloses a requirement for at least two pre-manufactured flanges and at least one pre-manufactured web interconnecting the flanges, the flanges being manufactured by pultrusion of thermo plastic resin impregnated rovings and having
30 adhesive bonded flanges protruding from the surface of the flanges over part of the height of the web and defining a hollow gap there between. The web is manufactured of cured thermoplastic resin impregnated woven or non woven fabrics inserted in the hollow gap of the adhesive bonded flanges of both of the flanges of the wing spar and fixed therein by means of an appropriate adhesive.

PCT/GB2005/004710 (published as WO2006/061617) of Airbus UK Limited discloses that composite materials (such as carbon fibre composites) can provide a saving in weight. They disclose aircraft wings of composite material(s) are made by attaching struts directly to the wing skin which acts as an outer frame. This attachment has metal fittings. They disclose a variation of such wing truss structures for use in an aircraft where the exterior frame is of composite material and includes integral sockets for the struts.

PCT/US2004/011516 (published as WO2005/002961) of Adam Aircraft Industries, Inc refers to the manufacture of composite material aircraft and the requirement for a great number of moulds. They disclose the composite parts generally are manufactured by laying up uncured composite material in a mould or tool, drawing a vacuum on the uncured material, curing the material in the mould at controlled conditions of temperature and humidity, and then removing the part from the mould. They refer to the challenge faced by the composite aircraft designer to reduce the parts to reduce manufacturing and assembly costs and the need for flexibility to change features of parts whilst avoiding large retooling costs.

In this specification where reference has been made to patent specifications, other external documents, or other sources of information, this is generally for the purpose of providing a context for discussing the features of the invention. Unless specifically stated otherwise, reference to such external documents is not to be construed as an admission that such documents, or such sources of information, in any jurisdiction, are prior art, or form part of the common general knowledge in the art.

It is an object of the present invention to provide alternative procedures for the manufacture of aircraft fuselage subassemblies and/or aircraft wing foil subassemblies.

The present invention also relates to a desire to provide alternative assemblies and subassemblies (preferably using one shot) moulded components of a composite material to provide shape and/or structural strength. Preferably such components are to provide the structure of the resulting assembly ie, both required shape and require structural strength.

The present inventions has as a further or alternative object the provision of wing components able to be manufactured and to be assembled with savings in labour. To this end preferably one-shot (eg resin infusion) moulding techniques are to provide readily assemble wing structures.

The present invention also is directed to novel wing assemblies, combinations of components for wing assemblies, wing skin mouldings and related aircraft and/or their compatible fuselages.

Preferably at least most are to be of, or primarily of, one-shot (preferably resin infusion) moulded components but optionally with optional localised reinforcement and/or modification post mould and/or during assembly.

It is to these aims that some of various aspects of the present invention as now defined are directed.

In an aspect the invention is a **wing assembly**, the assembly comprising or including: a first moulding or composite material form ("moulding") that provides an elongate spar of the wing assembly,

a second moulding or composite material form ("moulding") which provides at least in part a front, top and bottom of the wing assembly thereby to define respectively, at least in part the leading edge, at least in part the fore and rear regions of the upper surface and at least in part the fore region of the under surface, and

a third moulding or composite form ("moulding") defining at least most of the rear under surface.

Preferably at least one, two or all three of said mouldings is a one shot moulding.

Preferably said third moulding provides a web bounded proximally, distally and rearwardly by upstands from the web, the underside of the web defining at least most of said rear under surface, and the upstands defining a proximate bulkhead, a distal bulkhead and the rear edge.

Preferably the rear edge upstands from the web of said third moulding and extends between the proximate and distal bulkheads thereby in effect providing a second spar.

Preferably in the bonded wing assembly:

the proximate region of the first moulding projects beyond the proximate bulkhead, each of the proximate and distal bulkheads and the rear edge upstands of the third moulding underlie the top of the second moulding; and

the first moulding is bonded to the forward most surface of the web and the proximate and distal bulkheads as well as directly to the under surface of the top and the top surface of the bottom of said second moulding.

Preferably save for the third moulding provided bulkheads, the assembly is ribless or at least substantially ribless.

Preferably said third moulding is pan like.

Preferably said second moulding defines the leading edge save near the distal region.

The present invention in an aspect is also comprises in combination, two or more mouldings for an assembly as previously defined.

In another aspect the invention is a wing skin moulding having proximal and distal regions and for use in a wing assembly, said moulding providing a front, top and bottom exterior surface to

define respectively the leading edge, the fore and rear regions of the upper surface and the fore region of the under surface of the wing assembly.

Preferably said moulding does not define the distal region of the leading edge.

Preferably said a wing skin moulding is substantially herein described with reference to any one or more of the accompanying drawings.

In another aspect the invention is an aircraft being an assembly of components of composite material, the components being or including:

a fuselage right side,

a fuselage left side bonded to said right side,

a wing support moulding or component ("moulding") bonded to both of said sides and supporting a leading edge and top surface of stub wings in part defined by each side, the wing support moulding having a pan form with an upstanding perimeter,

a right wing leading edge, top surface and front of bottom surface moulding or component ("moulding"),

a left wing leading edge, top surface and front of bottom surface moulding or component ("moulding"),

a right wing spar leading edge, top surface and front of bottom surface moulding or component ("moulding"),

a left wing spar leading edge, top surface and front of bottom surface moulding or component ("moulding"),

a right wing rear under surface moulding or component ("moulding") having a pan form with an upstanding perimeter,

a left wing rear under surface moulding or component ("moulding") having a pan form with an upstanding perimeter,

wherein each spar at its proximate end bonds to at least the wing support moulding and at its further out region(s) to each of its two wing mouldings,

and wherein each wing leading edge et al moulding bonds to both its spar moulding and the wing rear undersurface et al moulding to define fully the wing foil.

Preferably at least a majority of said mouldings are one-shot mouldings.

Preferably the wing support moulding transits under the cockpit opening defined by the mated fuselage side mouldings.

Preferably each wing foil is or can be ribless save for bulkheads (proximate and distal) provided by the upstanding perimeter of the wing rear et al mouldings.

Preferably the spars are channels that taper from their proximate region.

Preferably the base of the spar channels on its channel exterior bonds to the fore upstanding perimeter of its associated wing rear et al moulding.

In another aspect the invention is **a method of wing assembly manufacture** which involves the assembly of one-shot mouldings to provide a wing assembly as previously defined.

5 In another aspect of the invention preferably there is provided **a wing assembly of at least three mouldings**, defining respectively :

a first one shot moulding that provides an elongate spar of the wing assembly,

10 a second one shot moulding which provides a front, top and bottom thereby to define respectively the leading edge (save optionally near the distal region), the fore and rear regions of the upper surface and the fore region of the under surface, and

a third one shot moulding (preferably pan-like) providing a web bounded proximally, distally and rearwardly with upstands from the web thereby defining the rear under surface, a proximate bulkhead, a distal bulkhead and the rear edge, the rear edge upstanding from the web and extending between the proximate and distal bulkheads providing a second spar,

15 **wherein** in the bonded wing assembly

- the proximate region of the first moulding projects beyond the proximate bulkhead,
 - each of the proximate and distal bulkheads and the rear edge upstands of the third moulding underlie the top of the second moulding, and
 - the first moulding is bonded to the forward most surface of the web and the
- 20 proximate and distal bulkheads as well as directly to the under surface of the top and the top surface of the bottom of said second moulding.

In another aspect the invention consists in **a wing of or for an aircraft** substantially as herein described with reference to any one or more of the accompanying drawings.

In still another aspect the invention is **an aircraft having multiple one-shot mouldings of composite material**, the mouldings being or including:

25 a fuselage right side,

a fuselage left side bonded to said right side,

a wing support moulding bonded to both of said sides and supporting a leading edge and top surface of stub wings in part defined by each side, the wing support moulding having a pan form with an upstanding perimeter,

30 a right wing leading edge, top surface and front of bottom surface moulding,

a left wing leading edge, top surface and front of bottom surface moulding,

a right wing spar leading edge, top surface and front of bottom surface moulding,

a left wing spar leading edge, top surface and front of bottom surface moulding,

35 a right wing rear under surface moulding having a pan form with an upstanding perimeter,

a left wing rear under surface moulding having a pan form with an upstanding perimeter, **wherein** each spar at its proximate end bonds to at least the wing support moulding and at its further out region(s) to each of its two wing mouldings,

and wherein each wing leading edge et al moulding bonds to both its spar moulding and the wing rear under surface et al moulding to define fully the wing foil.

Traditional aerofoil, wing or other foil forms affected of substantial transverse section have involved the use of beams or spar like members that locate at least substantially transverse ribs. It is on to this form that the foil surface is defined by cladding (e.g. aluminium sheeting or composite material sheeting) that is affixed adhesively, by rivets and/or otherwise. It is this cladding material which provides the periphery to provide the pressure differential transverse to the general flow to the foil form(s).

We have determined that much of a wing can efficiently be fabricated from three single shot mould components, each of a composite material. If desired a wing tip can be provided by a fourth component also of a composite material.

If desired, a rib can be added to reinforce the hinge point at the assembly of the flap and aileron, if it is to have both. No rib is needed particularly when only an extended aileron is used or the wing span is smaller.

In another aspect the invention consists in **a wing structure** suitable but not necessarily only for association with a fuselage of the type herein described which has stub wing structures.

In another aspect the invention relates to **a fuselage of composite material** where two single shot moulded large components of the fuselage (a right and left side, whether exactly halved, or not, and whether mirror imaged, or not) are mated and are associated with a single shot moulded twin spar moulding (preferably of a pan-like form) so that with essentially the three components, in an assembled condition, a fuselage with a twin spar stub wing structure results, part of each of the left and right mouldings providing part of the outer surface of the wing stub (preferably a leading edge and at least most, if not all, of the top surface).

In another aspect, the invention is **an aircraft fuselage** having or being (at least primarily) of:

a one-shot moulded right side of a composite material and providing at least part of the exterior surface of a right wing stub,

a one-shot moulded left side of a composite material and providing at least part of the exterior surface of a left wing stub, the right and left half has been bonded to each other, and

a one-shot moulded sparred component of a composite material located transversely through the joined right and left sides and bond attached to at least part of the right and left sides.

Optionally the right and left sides can be of a mirror image one of the other. Optionally the right and left sides can be of the same size but not necessarily so ie, there can be some greater encroachment by one relative to the other they do not need to constitute necessarily a part line 50/50 down the centre of the structure and also they may lap.

5 Preferably each of said right and left sides includes part of the tail.

Preferably each of the right and left sides includes a bulkhead in advance of a cockpit recess.

10 Preferably each bulkhead in advance of the cockpit opening includes a return back towards the cock pit recess, such a return to provide when the right and left halves are mated a channel extending rearwardly from the bulkhead in front of the cockpit mated recesses.

Preferably each of said right and left sides defines the leading edge of a stub wing and at least all of the upper surface of a stubbed wing.

Preferably said one-shot sparred component has at least twin spar-like members provided with bulkheads at each end and having a web there between.

15 Preferably the web in conjunction with the spar-like members and bulkheads defines a pan-like form.

Such a web can include openings or gaps. Preferably each side includes part of a bulkhead to be positioned as the rear of the cockpit space.

20 Preferably each side includes a channel when viewed in transverse section adapted to receive at least part of a tail foil structure.

In another aspect the invention is **an aircraft fuselage** substantially as herein described with reference to any one, some or all of the accompanying drawings.

A preferred wing form (ignoring control surfaces and any wing tip structures or structure) is essentially an assembly of a three single shot mouldings.

25 Preferably the wing, save for component provided bulkheads as partial ribs, is ribless.

In another aspect the invention is **a kitset** of components and/or subassemblies of an aircraft as herein described.

In another aspect the present invention is **a component or tooling for a component** of an aircraft fuselage and/or aircraft wing of the present invention.

30 As used herein the term "and/or" means "and" or "or", or both.

As used herein the term "(s)" following a noun includes, as might be appropriate, the singular or plural forms of that noun.

35 As used herein "comprising" [or derivatives thereof], even when used in association with other words such as including or having, has the meaning of consisting only of or including or having.

As used herein derivatives of the term "mould" includes a stable component from any shaped component forming process that does not require fabrication nor excessive machining.

It may or may not involve hand or wet lay up techniques. Preferably most, if not all, of the composite components are mouldings involving fibres (eg as mats or series or sandwiches of mats of glass) fibre, carbon fibre, kevlar fibre, or mixtures thereof) and compatible resin systems (eg epoxy, polyester or the like). Such components are to be bond **assemblable** with suitable adhesive systems (eg epoxy, polyester or the like). Most preferably carbon fibre/epoxy resin infusion moulding techniques are used (eg SCRIMP, VARTM, or other).

To those skilled in the art to which the invention relates, many changes in construction and widely differing embodiments and applications of the invention will suggest themselves without departing from the scope of the invention as defined in the appended claims. The disclosures and the descriptions herein are purely illustrative and are not intended to be in any sense limiting.

A preferred form of the present invention will now be described with reference to the accompanying drawings in which:

Figure 1 shows an aircraft such as might be manufactured using components, subassemblies and assemblies of the present invention,

Figure 2 shows in an exploded view of some components of the structure of an aircraft as shown in Figure 1, there being shown the three essential components of the main part of the fuselage and there being shown the three or four main components of each wing, the view also showing engine cowling forms, cockpit forms and control surfaces and tail assembly features,

Figure 3 shows the three main components of a fuselage, ie; the left and right sides and (in a pan-like form) a wing support structure with its upstanding periphery to define bulkheads, a through fuselage pair of spars plus the cockpit pan, if and when fitted, to support any connection to a wing as hereinafter described,

Figure 4 shows the two fuselage sides bonded together optionally along a centre line,

Figure 5 shows the sub assembly of Figure 4 with the pan-like spar including form shown in Figure 4 bonded to the top side leading edge and fore region of stub wings and other parts of the fuselage,

Figure 6 shows a left hand wing in its final foil form when manufactured from four components, ie; the three components of the broadest aspect of the present invention plus an optional wing tip, the proximal region of the one shot moulded spar being visible to the left,

Figure 7 is an exploded view of the three one shot component mouldings A, B and C embodied in the assembly of Figure 6 as well as the wing tip moulding or sub assembly D,

Figure 8 is a plan view showing a bolted right wing attachment to the fore spar of the pan-like fuselage component, and

Figure 9 is a frontal perspective view of the association of Figure 8.

In the preferred form of the present invention the components hereinafter described are all preferably formed from a single one shot moulding process in a composite material.

Shown in Figure 6 is a wing moulding A of a composite material defining a leading edge 1, a top surface 2, and the fore part of an under surface 3. Also shown at the distal region 4 is a rebate to accommodate the wing tip optional fitting D which itself preferably is a single one shot moulding.

Shown in Figure 7 as B is a channel form spar of a one shot composite moulding which tapers to its distal end region to the right. Spar B is adapted to have the base of the channel bonded at the base of the channel 5 on its outer surface bonded to the face 6 of the fore part of the other main wing moulding C with its proximate end upstand 7 in the form of a bulkhead, its distal end upstand 8 in the form of a bulkhead and its trailing or rear edge upstand 9 as a secondary spar to co-act with the spar like role of the member B.

In the assembled form, as shown in Figure 6, the proximate region 10 extends from the assembly of components A + B + C + D and the flanges 11 and 12 of the spar B have been bonded to the inside of the component A so as to offer strength as well as a front region to accommodate the passage of utilities and the like outwards along the wing.

The members co-act in the assembled form, as shown in Figure 6, to enclose a cavity between the members A, B and C. This can be used for a number of functions including, if desired, a fuel bladder.

The left wing as a foil form is similar to that shown in Figure 6 but is a mirror image of it.

The fuselage itself comprises essentially three one shot mouldings E, F and G.

It can be seen that the right side of the fuselage E mirrors essentially the left side of the fuselage F. Each of the components E and F defines a top surface 13, a leading edge 14 and a fore region of the under surface 15 of a stub wing. Each also defines a cockpit cavity 16, part of the tail 17, a forward bulkhead 18, a return underside flange 19 and another return 20 which can, in the assembled form, define a pathway for control, fuel, monitoring utilities and/or the like. It can be seen that there is also a part 21 which acts as the rear of the cockpit recess 16.

Also shown is a recess 22 adapted to accommodate the fitment of the tail foil 23 (see Figure 2).

The through fuselage pan or tray like member G defines the central wing spar 23 to which the proximate end region 10:

of each wing spar is held (but not in overlapping relationship one wing spar with the other) thereby to allow a small gap between the proximal end regions 10 of the mirror imaged wing spars.

The member G preferably defines bulkheads 24 and 25 as upstands from the web 26.

There is also a trailing edge upstand 27 which acts as a secondary central wing spar.

Preferably each of the upstands 23 and 27 is provided with an inwardly turned flange 28 and 29 respectively. Likewise optionally flanges 29 and 30 respectively of the bulkhead 25 and the distal bulkhead 24.

In the bonded assembly as shown in Figure 5, preferably after fitment of each of the wings thereto a pan or other one shot moulding 31 (see Figure 2) is positioned to better define the floor and other essential support surface of the cockpit structure.

As shown in Figure 6 each wing assembly as shown in Figure 6 (and its mirror image) has the proximal regions of the wing spars associated with the fuselage position central wing spars 23. They are associated in the assembled form as shown in Figures 1, 6, 8 and 9.

In Figures 8 and 9 bolts (shown exploded on their lines of action) hold a wing spar region 10 to the fuselage fore spar 23. Other bolting and/or bonding can be employed eg; bulkhead to bulkhead.

The present invention with one shot carbon fibre composites and/or other composites defines shape and provides structural integrity of the resultant assemblies with savings in labour and related costs.

By way of example, a test aircraft (ZK LLG) with components substantially as depicted in the drawings has been constructed of carbon fibre/epoxy resin/epoxy adhesive and successfully been flown.

Typical carbon fibre cloths used

- CDB200
- CDB290
- CDB400
- CU300

Typical E-glass cloths used

- EDB430
- EDB600
- EB600
- EB850
- EU450

Typical epoxy systems (eg of Adhesive Technologies Ltd, Auckland, New Zealand)

- ADR246TG (Resin)
- ADR280 (Resin)

- ADR243 (Resin)
- ADH28 (Hardener)
- ADH26 (Hardener)
- ADH140

5 **Typical epoxy adhesives**

- Adhesive Technologies Ltd HPR25
- Huntsman Araldite 2015

Typical steps in the infusion process:

- Release agent to moulds.
- 10 ▪ Layup of necessary cloths and core panels.
- Covering with a resin transfer medium.
- Covering with a peel ply cloth.
- Positioning of resin inlet pipes and vacuum system.
- Covering whole with an airtight plastic sheet to seal to the mould.
- 15 ▪ Pull at least 99.8% vacuum on part ensuring all fibres and cores are correctly located.
- Check vacuum is maintained with vacuum pump(s) turned off.
- Let resin flow through part until it is saturated.
- Allow resin to cure partially.
- Post cure part in oven.
- 20 ▪ Release part from mould.

Assembly process for wings

- Place lower wing box (LWB), centre wing section (CWS) and spar in a first jig.
- Cut wing bolt holes in Spar and CWS.
- Bond LWB to spar with epoxy adhesive.
- 25 ▪ Bond in wing rib.
- Place LWB/spar with upper wing skin (UWS) in a second jig.
- Bond LWB/Spar to UWS.
- Bond in wing rib.
- Post cure of assembled piece.
- 30 ▪ Bond wing tip to assembled piece with epoxy adhesive.

Assembly process of fuselage

- Place left side of fuselage in mould.
- Bond right side of fuselage to left side with epoxy adhesive.
- Place bonded fuselage in a jig.

- Align and bond central wing section to fuselage with epoxy adhesive.
- Post cure of fuselage Bond Stabiliser into fin section of fuselage with epoxy adhesive.

The assembly of the plane (after the above is complete) consists primarily of bolting things together in a conventional way.

- 5 With fewer than 30 airframe structural components assembly is simpler and faster and no specialist knowledge or tools are necessary.

This test aircraft has the following characteristics:

SPECIFICATIONS

Length	6.8m
Wingspan	8.02m
Height	2.4m
Cabin width (interior)	1.1m
Wing area	10.2sq m
Aspect ratio	6.4
Empty weight*	580kg
MTOW (Utility)	980kg
MTOW (Aerobatic)	792kg
Std fuel capacity	200L
Useful load (Utility)*	400kg
Baggage capacity	Very Large
Trailer width	2.4m

PERFORMANCE

Engine	XP-10_360 (180HP)
Maximum speed	190 kts 219 mph
Cruise speed (75% at 7000 ft)	175 kts 201 mph
Cruise speed (65% at 9000 ft)	168 kts 193 mph
Stall (clean)	59 kts 68 mph
Stall (full flap)	50 kts 58 mph
VNE	215 kts 247 mph
Takeoff distance (50 ft obst.)	1000 ft 305 m
Landing distance (50 ft obst.)	1100 ft 335 m
Rate of climb	2000 fpm 610 mpm
Aerobatic flight load limits	+6, -4 Gs
Range	787 nm + 30' reserve @ 65% @ 9000ft

Such a test aircraft is merely one of a multiple of aircraft types that can benefit from the inventive aspects of the present invention.

CLAIMS

1. A wing assembly, the assembly comprising or including:
a first moulding or composite material form ("moulding") that provides an elongate spar of the wing assembly,
5 a second moulding or composite material form ("moulding") which provides at least in part a front, top and bottom of the wing assembly thereby to define respectively, at least in part the leading edge, at least in part the fore and rear regions of the upper surface and at least in part the fore region of the under surface, and
a third moulding or composite form ("moulding") defining at least most of the rear under
10 surface.
2. An assembly of claim 1 wherein all three mouldings is an actual moulding and at least one, two or all three of said mouldings is a one shot moulding.
3. An assembly of claim 1 or claim 2 wherein said third moulding provides a web bounded proximately, distally and rearwardly by upstands from the web, the underside of the web defining
15 at least most of said rear under surface, and the upstands defining a proximate bulkhead, a distal bulkhead and the rear edge.
4. An assembly of claim 3 wherein the rear edge upstands from the web of said third moulding and extends between the proximate and distal bulkheads thereby in effect providing a second spar.
- 20 5. An assembly as claimed in claim 3 or claim 4 wherein, in the bonded wing assembly:
the proximate region of the first moulding projects beyond the proximate bulkhead,
each of the proximate and distal bulkheads and the rear edge upstands of the third moulding underlie the top of the second moulding; and
the first moulding is bonded to the forward most surface of the web and the proximate and
25 distal bulkheads as well as directly to the under surface of the top and the top surface of the bottom of said second moulding.
6. An assembly as claimed in any one of the preceding claims which, save for the third moulding provided bulkheads, the assembly is ribless or at least substantially ribless.
7. A wing assembly as claimed in any one of the preceding claims wherein said third moulding
30 is pan like.
8. An assembly as claimed in any one of the preceding claims wherein said second moulding defines the leading edge save near the distal region.
9. A **wing assembly** as claimed in any one of the preceding claims substantially as herein described with or without reference to any one, some or all of the accompanying drawings.

10. **A wing assembly** of or for an aircraft substantially as herein described with reference to any one or more of the accompanying drawings.

11. **In combination**, two or more mouldings for an assembly of any one of the preceding claims.

5 12. **A wing skin moulding** having proximal and distal regions and for use in a wing assembly, said moulding providing a front, top and bottom exterior surface to define respectively the leading edge, the fore and rear regions of the upper surface and the fore region of the under surface of the wing assembly.

10 13. A wing skin moulding is claimed in claim 13 wherein said moulding does not define the distal region of the leading edge.

14. A wing skin moulding of claim 12 or 13 substantially is herein described with reference to any one or more of the accompanying drawings.

15. **An aircraft being an assembly of components of composite material**, the components being or including

15 a fuselage right side,

a fuselage left side bonded to said right side,

a wing support moulding or component ("moulding") bonded to both of said sides and supporting a leading edge and top surface of stub wings in part defined by each side, the wing support moulding having a pan form with an upstanding perimeter,

20 a right wing leading edge, top surface and front of bottom surface moulding or component ("moulding"),

a left wing leading edge, top surface and front of bottom surface moulding or component ("moulding"),

25 a right wing spar leading edge, top surface and front of bottom surface moulding or component ("moulding"),

a left wing spar leading edge, top surface and front of bottom surface moulding or component ("moulding"),

a right wing rear under surface moulding or component ("moulding") having a pan form with an upstanding perimeter,

30 a left wing rear under surface moulding or component ("moulding") having a pan form with an upstanding perimeter,

wherein each spar at its proximate end bonds to at least the wing support moulding and at its further out region(s) to each of its two wing mouldings,

35 **and wherein** each wing leading edge et al moulding bonds to both its spar moulding and the wing rear undersurface et al moulding to define fully the wing foil.

16. An aircraft of claim 15 wherein at least a majority of said mouldings are one-shot mouldings.
17. An aircraft of any one of claims 15 to 16 wherein the wing support moulding transits under the cockpit opening defined by the mated fuselage side mouldings.
18. An aircraft of any one of claims 15 to 17 wherein each wing foil is or can be ribless save for bulkheads (proximate and distal) provided by the upstanding perimeter of the wing rear et al mouldings.
19. An aircraft of any one of claims 15 to 18 wherein the spars are channels that taper from their proximate region.
20. An aircraft of claim 19 wherein the base of the spar channels on its channel exterior bonds to the fore upstanding perimeter of its associated wing rear et al moulding.
21. **A fuselage of composite material** where two single shot moulded large components of the fuselage (a right and left side, whether exactly halved, or not, and whether mirror imaged, or not) are mated and are associated with a single shot moulded twin spar moulding so that with essentially the three components, in an assembled condition, a fuselage with a twin spar stub wing structure results, part of each of the left and right mouldings providing part of the outer surface of the wing stub
22. A fuselage of claim 21 wherein said outer surface of the wing stub defines a leading edge and at least most, if not all, of the top surface.
23. **An aircraft fuselage** having or being at least primarily of
a one-shot moulded right side of a composite material and providing at least part of the exterior surface of a right wing stub,
a one-shot moulded left side of a composite material and providing at least part of the exterior surface of a left wing stub, the right and left half has been bonded to each other, and
a one-shot moulded sparred component of a composite material located transversely through the joined right and left sides and bond attached to at least part of the right and left sides.
24. A fuselage of claim 23 wherein each of said right and left sides includes part of the tail.
25. A fuselage of claim 23 wherein each of the right and left sides includes a bulkhead in advance of a cockpit recess.
26. A fuselage of claim 25 wherein each bulkhead in advance of the cockpit opening includes a return back towards the cockpit recess, such a return to provide when the right and left halves are mated a channel extending rearwardly from the bulkhead in front of the cockpit mated recesses.

27. A fuselage of any one of claims 23 to 26 wherein each of said right and left sides defines the leading edge of a stub wing and at least all of the upper surface of a stubbed wing.
28. A fuselage of any one of claims 23 to 27 wherein said one-shot sparred component has at least twin spar-like members provided with bulkheads at each end and having a web there between.
- 5 29. A fuselage of claim 28 wherein the web in conjunction with the spar-like members and bulkheads defines a pan-like form.
30. A fuselage of any one of claims 23 to 29 wherein each side includes part of a bulkhead to be positioned as the rear of the cockpit space.
31. A fuselage of any one of claims 23 to 30 wherein each side includes a channel when viewed
10 in transverse section adapted to receive at least part of a tail foil structure.
32. **An aircraft fuselage** substantially as herein described with reference to any one, some or all of the accompanying drawings.
33. **An aircraft** being at least in part an assembly of a fuselage of any one of claims 21 to 32 and wing assemblies of any one of claims 1 to 10.
- 15 34. **A method of wing assembly manufacture** which involves the assembly of one-shot mouldings to provide a wing assembly of any one of claims 1 to 10.
35. **A kitset** of components and/or subassemblies of an aircraft as claimed or described herein.

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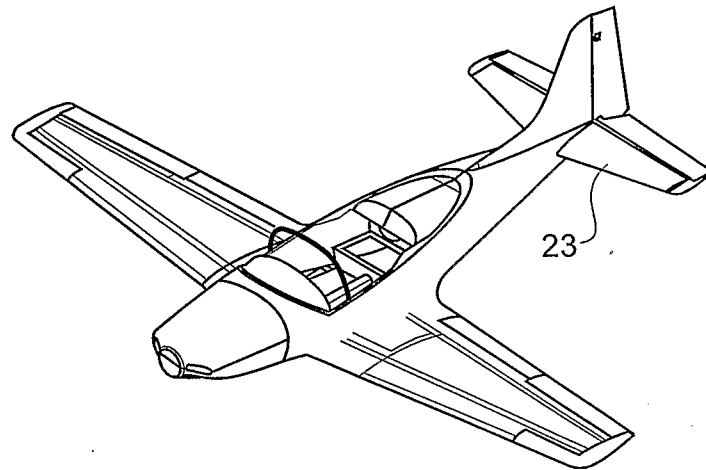


FIGURE 1

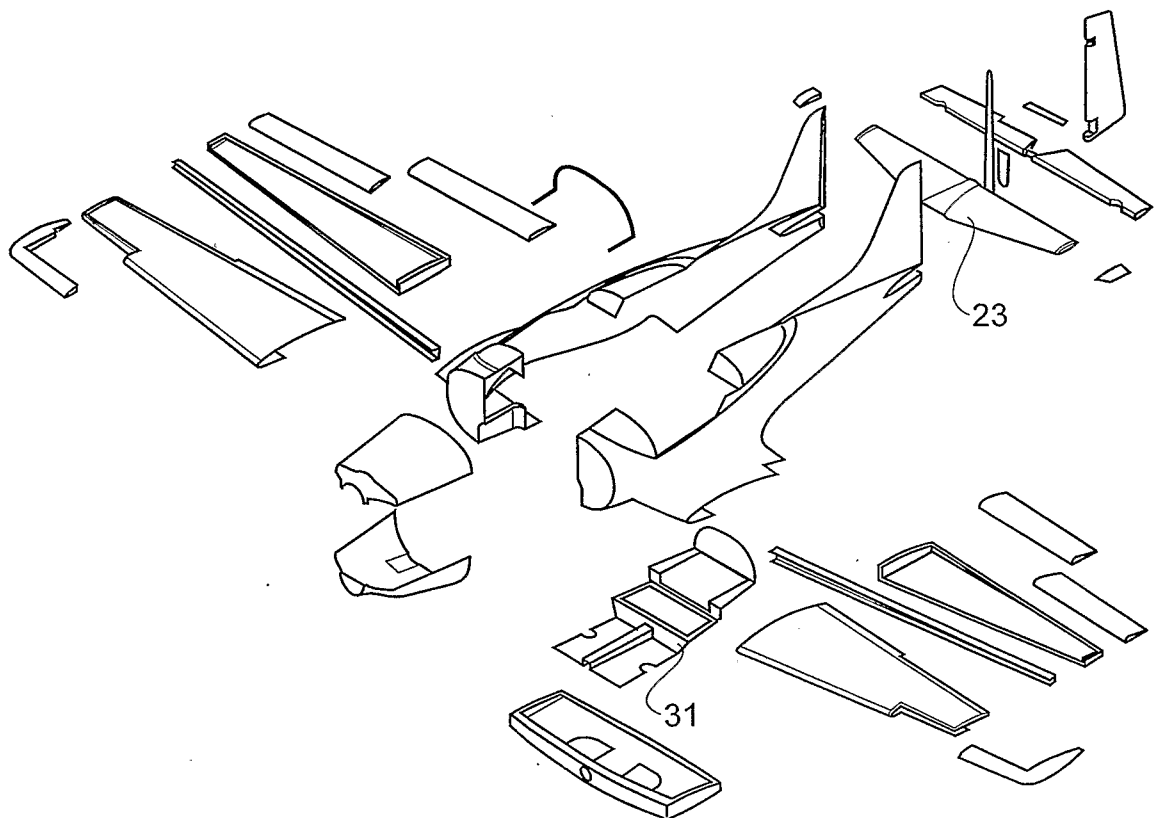


FIGURE 2

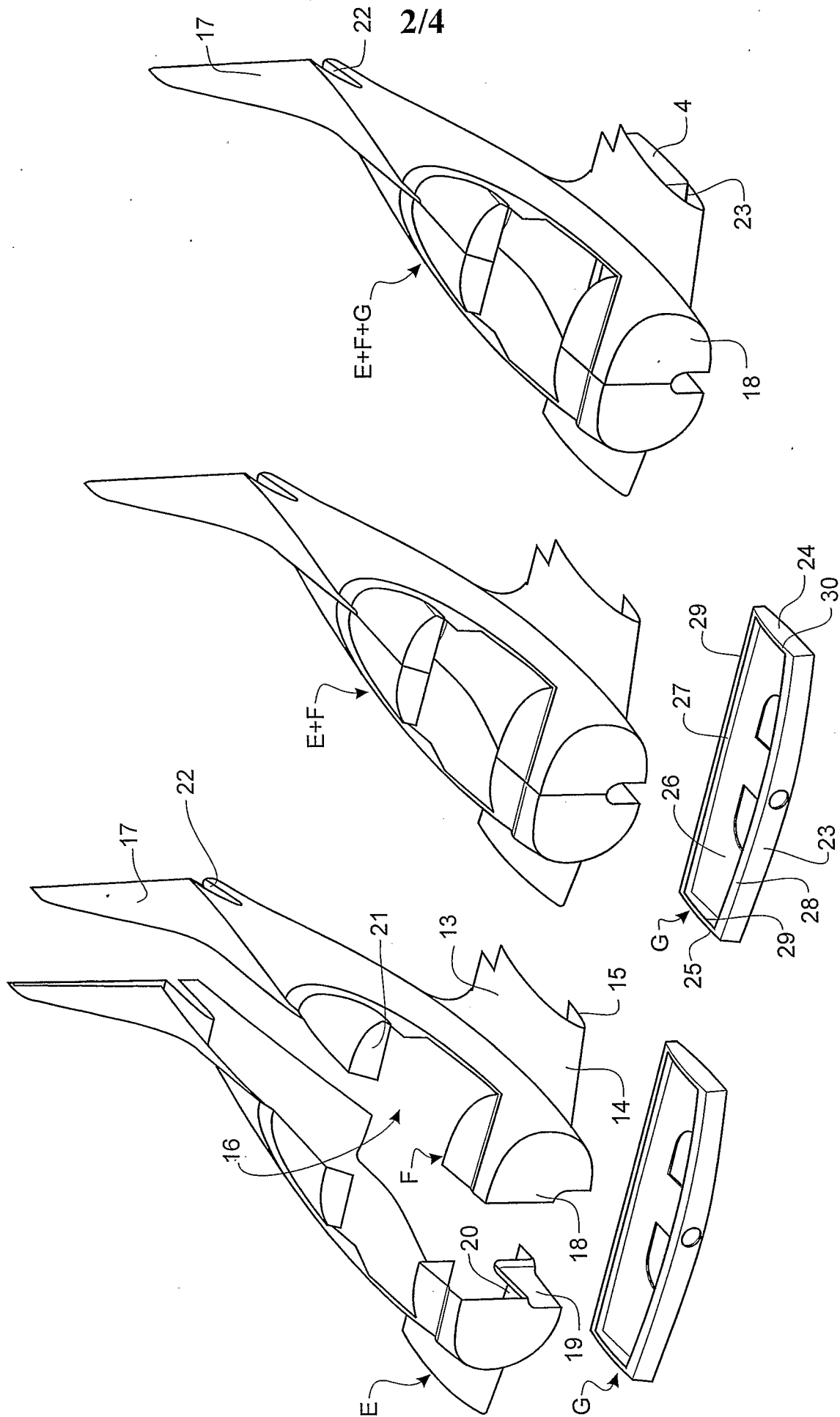


FIGURE 3

FIGURE 4

FIGURE 5

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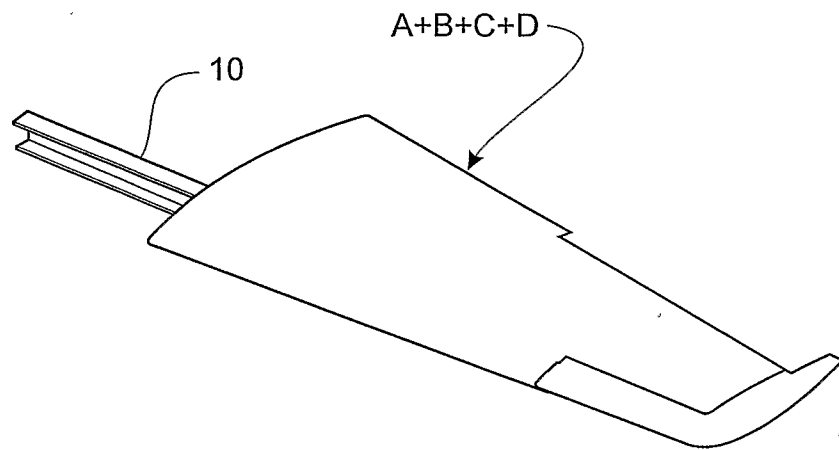


FIGURE 6

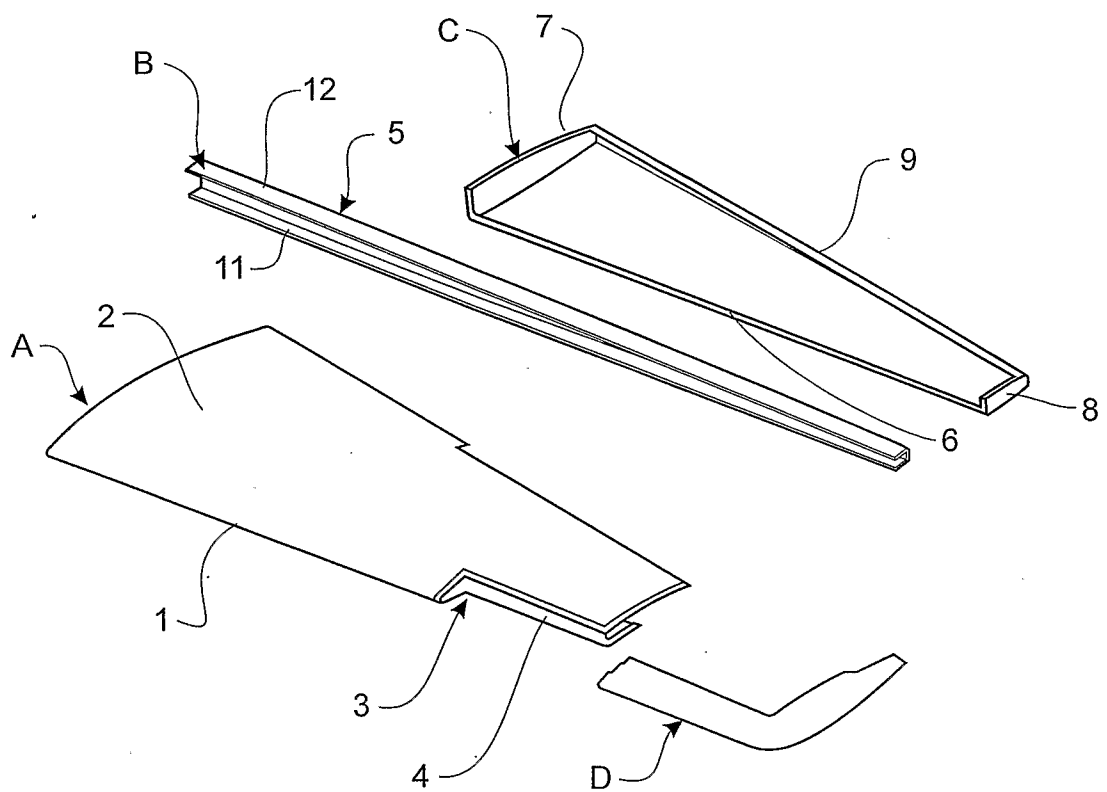


FIGURE 7

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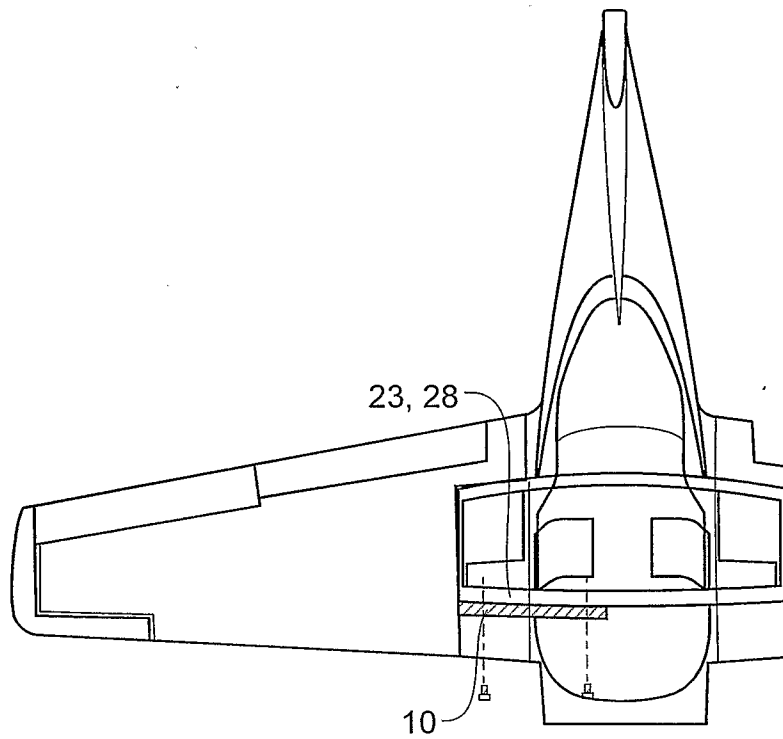


FIGURE 8

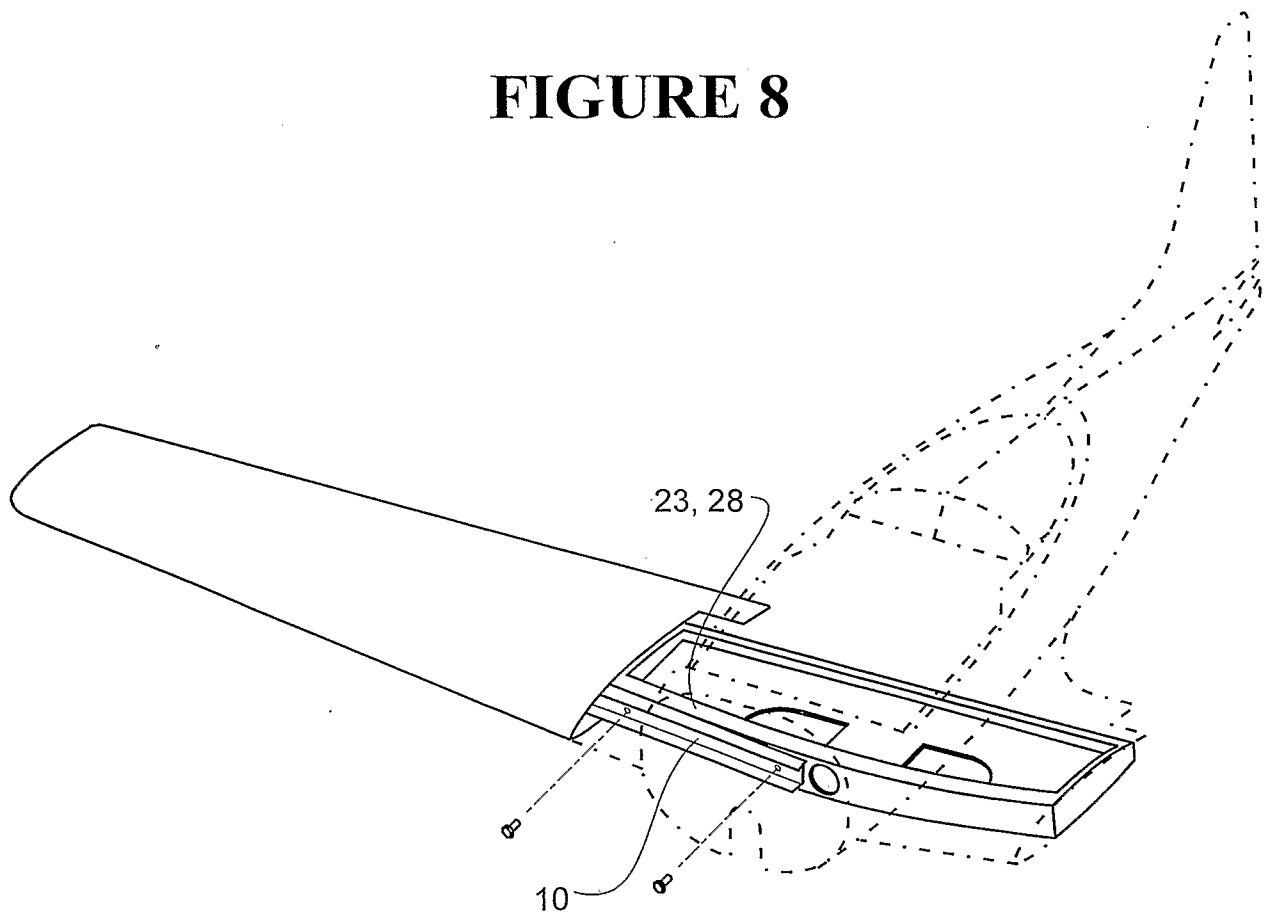


FIGURE 9

INTERNATIONAL SEARCH REPORT

International application No.

PCT/NZ2008/000065

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.

B64C 3/24 (2006.01) *B64C 3/18* (2006.01) *B64C 3/28* (2006.01)
B64C 1/06 (2006.01) *B64C 3/20* (2006.01) *B64F 5/00* (2006.01)
B64C 1/26 (2006.01) *B64C 3/26* (2006.01)

ACTION DATE: 05 June 2008

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
 DWPI, EPO, USPTO IPC B64C-003/IC, B64C-005/IC, B64C-011/IC, B64C-027/IC, B64F-005/IC, A63H-027/IC AND
 KEYWORDS composite, fibre, structure, assembly, element, configuration, topology, layout, component, spar, surface, cover, skin,
 panel, top, bottom, upper, lower, trailing, rear, and similar terms. AU design database classification 21-01C, USPTO designs
 database classification D21-447/-449.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2003/0192990 A1 (SIMPSON et al) 16 October 2003 Whole of document, in particular paragraph 27 – 38 and figure 1	1, 2, 6, 7, 11, 12, 34
X	FR 2846939 A1 (SOCIETE DE CONSTRUCTION AERONAUTIQUE AUVERGNATE) 14 May 2004 Whole of document, in particular page 2 line 7 – page 5 line 14 and figure 2 and 3	1, 2, 11, 12, 34

☒ Further documents are listed in the continuation of Box C☒ See patent family annex

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier application or patent but published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search
 05 June 2008

Date of mailing of the international search report

18 JUN 2009

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/NZ2008/000065

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4739954 A (HAMILTON) 26 April 1988 Whole of document, in particular: column 4 line 35 – 60, column 5 line 1 – 3, column 5 line 42 – 45, and figure 1	1, 2, 11, 12, 34
X	US 6116539 A (WILLIAMS et al) 12 September 2000 Whole of document, in particular column 5 line 5 – column 7 line 9 and figure 2	1, 2, 7, 11, 12, 34
X	US 1808842 A (FEDOR) 9 June 1931 Whole of document, in particular page 1 line 72 – 82 and figure 2, and 3	1, 2, 11, 12, 34
X	US 2560742 A (REDER) 17 July 1951 Whole of document, in particular column 2 line 40 – column 4 line 34 and figures 3, 4, and 10	1, 2, 6, 7, 11, 12, 34

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See supplemental box.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.: 1 – 14 & 34

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

Supplemental Box

(To be used when the space in any of Boxes I to IV is not sufficient)

Continuation of Box No: III Observations where unity of invention is lacking

This International Application does not comply with the requirements of unity of invention because it does not relate to one invention or to a group of inventions so linked as to form a single general inventive concept.

In assessing whether there is more than one invention claimed, I have given consideration to those features which can be considered to potentially distinguish the claimed combination of features from the prior art. Where different claims have different distinguishing features they define different inventions.

This International Searching Authority has found that there are two different inventions as follows:

1. Claims 1 – 9, and 34 are directed to a wing assembly comprising 1) a first moulding or composite material form that provides an elongate spar of the wing assembly, 2) *a second moulding or composite form which provides at least in part a front, top, and bottom of the wing assembly thereby to define respectively, at least in part, the leading edge, at least in part the fore and rear regions of the upper surface and at least in part the fore region of the under surface of the under surface*, and 3) a third moulding or composite form defining at least most of the rear under surface. It is considered that the feature in italics comprises a distinguishing feature.
2. Claim 10 is directed to *a wing assembly of or for an aircraft described with reference to any one or more of the accompanying drawings*. It is considered that the features in italics comprises a distinguishing feature and consequently includes the features of independent claim 1 in the specific embodiment as described.
3. Claim 11 is directed to *two mouldings for an assembly of any one of the preceding claims*. It is considered that the features in italics comprises a distinguishing feature and consequently includes the features of independent claim 1 in the specific embodiment as described.
4. Claims 12 – 14 are directed to a wing skin moulding having proximal and distal regions and for use in a wing assembly, said moulding *providing a front, top, and bottom exterior surface to define respectively the leading edge, the fore and rear regions of the upper surface and the fore region of the under surface of the wing assembly*. It is considered that the feature in italics comprises a distinguishing feature.

Claim sets 1- 4 share the distinguishing feature of a composite moulding that defines, at least in part, a wing *leading edge, top surface, and front bottom surface*. It is considered that this feature comprises a first distinguishing feature.

Continued in Supplemental Box

Supplemental Box

(To be used when the space in any of Boxes I to VIII is not sufficient)

Continuation of Box No: III Observations where unity of invention is lacking*(continued)*

5. Claims 15 – 20, & 33 are directed to an aircraft being assembled of components of composite material including amongst other components *a fuselage left side and a fuselage right side both of which supports a leading edge and top surface of stub wings*. It is considered that the feature in italics comprises a distinguishing feature.
6. Claims 21 – 22 are directed to a fuselage of composite material where *two single shot moulded large components of the fuselage (a right and left side, whether exactly halved or not, and whether mirror imaged or not)* are mated and associated with a single shot moulded twin spar moulding, *where part of each of the left and right moulding provides part of the outer surface of the wing stub*. It is considered that the feature in italics comprises a distinguishing feature.
7. Claims 23 – 32 are directed to an aircraft fuselage having a *one shot moulded right side of a composite material providing at least part of the exterior surface of a right wing, one shot moulded left side of a composite material providing at least part of the exterior surface of a left wing, the left and right sides bonded together*, and a one shot moulded spared component of a composite material located transversely through the joined left and right sides. It is considered that the feature in italics comprises a distinguishing feature.
8. Claim 35 is directed to *a kitset of components and/or subassemblies of an aircraft as claimed or described herein*. It is considered that the features in italics comprises a distinguishing feature and consequently includes the features of independent claim 15 in the specific embodiment as described.

Claim sets 5 - 8 share the distinguishing feature of two composite fuselage mouldings that each define at least part of the exterior surface of the respective wing. It is considered that this feature comprises a second distinguishing feature.

PCT Rule 13.2, first sentence, states that unity of invention is only fulfilled when there is a technical relationship among the claimed inventions involving one or more of the same or corresponding special technical features. PCT Rule 13.2, second sentence, defines a special technical feature as a feature which makes a contribution over the prior art.

Claim set 1-4 when considered together and claim sets 5-8 when considered together each have a different distinguishing feature and they do not share any feature which could satisfy the requirement for being a special technical feature. Because there is no common special technical feature it follows that there is no technical relationship between the identified inventions. Therefore these claims do not satisfy the requirement of unity of invention *a priori*.

Claim set 1-4 has been identified as the first invention, and as such the search and examination will be carried out based upon claims 1 –14, and 34.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/NZ2008/000065

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
US	2003/0192990	AU	2003245544	AU	2003251537	CN	1662696
		CN	1819947	EP	1540059	EP	1585664
		US	6482497	US	6889937	US	2003/0186038
		US	2004/0074592	US	2004/0079838	US	2006/0249626
		WO	2004/000643	WO	2004/001115		
FR	2846939	NONE					
US	4739954	NONE					
US	6116539	AU	37371/00	WO	2000/056599		
US	1808842	NONE					
US	2560742	NONE					
Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.							
END OF ANNEX							