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(71) Applicant *(for all designated States except US)*: **MOOG WOLVERHAMPTON LIMITED** [GB/GB]; Wobaston Road, Wolverhampton, West Midlands WV9 5EW (GB).

(72) Inventor; and
(75) Inventor/Applicant *(for US only)*: **MATTHEWS, Timothy** [GB/GB]; 1 Henney Close, Penkridge, Staffordshire ST19 5TD (GB).

(74) Agent: **WITHERS & ROGERS LLP**; Goldings House, 2 Hays Lane, London SE1 2HW (GB).

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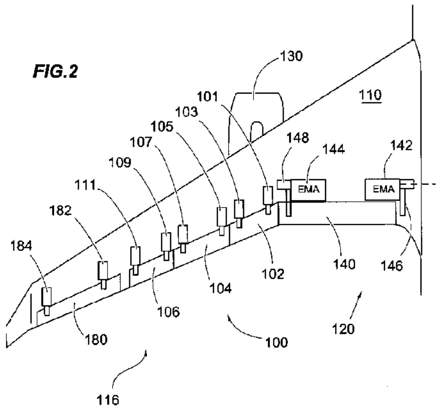
FIG.2



(57) Abstract: The present invention provides a panel device for modifying airflow about a wing (110) of an aircraft (120). The panel device may be used to provide a flap (100) or a leading edge slat. The panel device comprises a plurality of independently operable panel sub-sections (102, 104, 106). Each panel sub-section (102, 104, 106) has a panel authority lower than a predetermined critical threshold value so as to allow simple economic control of synchronisation. The panel device provides for both improved fuel efficiency as well as enhanced operational safety of the aircraft (120).

WO 2010/119280 A1

HIGH LIFT DEVICES FOR AIRCRAFT

Field

The present invention relates generally to high lift devices for aircraft. More particularly, the present invention relates to improved designs for devices that modify airflow over the wings of an aircraft.

Background

In various aircraft it is known to provide devices such as flaps or slats to enable the camber or shape of a wing to be modified temporarily to change the lift characteristics of the wing, for example, during the take-off and landing phases of a flight [1-5].

Moreover in certain relatively large aircraft, each of a port and starboard wing may be provided respectively with several separate flap panels spaced apart in a span-wise direction. For example, a small aircraft may have a single flap panel per wing, a medium aircraft two flap panels per wing and a large aircraft three flap panels per wing. The span-wise spaced flap panels on one wing may be independently operable of one another (e.g. as per a Boeing 787™ or an Airbus A350™), but are often ganged as port-starboard wing pairs [6,7] to ensure a symmetrical lift distribution across both wings when the aircraft is in flight. It is a requirement in certain jurisdictions that port and starboard flaps of a significant control authority are connected across the fuselage by mechanical or equivalent means. For example, an in-board flap on the port wing may be physically connected to a corresponding in-board flap on the starboard wing by way of a mechanical transmission system, such as a flexible carbon-fibre tube or a solid shaft linkage, to ensure the in-board flaps move together in synchronisation. Additionally, it is known to use such linked conventional flap panels to trim an aircraft, e.g. as fuel is used from the wing tanks [7] and the weight distribution changes, or during a specific phase of flight.

Connecting port and starboard flaps (in particular outboard flaps) across the fuselage via a mechanical link results in a complex system which is time consuming to manufacture. Connecting such panels across the fuselage with a control system (e.g. computerised) link is also expensive and complicated. Traditional flap panels are significant in size and as such have significant control authority. Therefore they are designed to fail free (i.e. they can move following a failure event). Because of the size of the panel, the control system for it has to be high integrity. A high integrity computer control system is very costly in terms of design, manufacture and certification.

In addition whilst conventional flap panels may be used to provide trim during the cruise phase of a flight, their inherent design limitations mean that they are not able to trim a wing profile for optimum fuel efficiency.

Summary

The present invention has thus been devised whilst bearing the above-mentioned drawbacks, and others, associated with conventional devices, such as flap panels, in mind.

According to a first aspect of the present invention, there is thus provided a panel device for modifying airflow about a wing of an aircraft, the panel device comprising a plurality of independently operable panel sub-sections, the panel sub-sections being driven by respective electro-mechanical actuators wherein each panel sub-section is configured to fail fixed.

By “mechanical actuators” we mean purely mechanical or electromechanical actuators which are not hydraulic.

Providing a plurality of fail-fixed sub-panels by providing an appropriate mechanical actuation system or an arresting mechanism (brake or no-back) to prevent movement after a failure limits the possible failure scenarios and / or the influence of a failed or hard over panel. Therefore the control system is simpler and easier to certify. The panel sub-sections can be configured to be fail-fixed by ensuring that they have panel authority lower than a predetermined critical value. Preferably the panel device can be designed such that the effect of one of the sub-sections failing fixed when hard over can be counteracted or offset by at least one of the other sub-panels (i.e. no sub-panel has a maximum lift-altering capability more than half of the combined lift-altering capability of the panel device).

The use of electromechanical actuators provides easier control by computer.

According to a second aspect of the present invention, there is thus provided a panel device for modifying airflow about a wing of an aircraft, the panel device comprising a plurality of independently operable panel sub-sections. The panel sub-sections may be synchronised or operated independently under computer control rather by mechanical means.

According to a third aspect of the present invention, there is provided a method of improving the fuel efficiency of an aircraft in flight. The method comprises trimming at least one aircraft wing by deflecting the position of at least one of a plurality of independently operable panel sub-sections forming a panel device provided on the aircraft.

According to a fourth aspect of the present invention, there is provided a high lift system for an aircraft comprising a port wing and a starboard wing. Each wing comprises at least one respective panel device, and the panel devices are each formed of a respective plurality of panel sub-sections that are paired such that panel sub-sections of a port wing panel device may usually operate symmetrically with corresponding panel sub-sections of the starboard wing in tandem. The port and starboard wing panel devices and/or various of the panel sub-sections may be mechanically connected together through the fuselage of the aircraft.

A panel device may, for example, be used to provide a flap or leading edge slat. Each of the panel sub-sections has a panel authority lower than a predetermined critical threshold value.

By providing a plurality of independently operable panel sub-sections that can act together, e.g. as a single flap panel or slat equivalent, various embodiments of the present invention can be used to provide fine trim control.

Additionally, since no single panel sub-section has overall panel authority, embodiments of the present invention are inherently safer than conventional devices as the mechanical failure of any single panel sub-section will not ordinarily prevent the operation of the remaining panel sub-section(s), thereby enabling any remaining functional panel sub-sections to be operated in a manner that compensates for any panel sub-section failure(s).

Various embodiments of the present invention provide particular benefit for medium and large aircraft having, for example, a plurality of flap panels and/or slats provided on respective wings.

Brief description of the drawings

Various aspects and embodiments of the present invention will now be described, along with certain associated advantages and benefits thereof, in connection with the accompanying drawings, in which:

Figure 1 shows a partial schematic plan view of the port wing of a conventional Airbus™ A380 aircraft;

Figure 2 shows an aircraft wing including a flap according to an embodiment of the present invention;

Figures 3A to 3C show the deployment of a panel sub-section of the flap shown in Figure 2 shown in cross-sectional view in accordance with an example embodiment of the present invention; and

Figure 4 shows a method of improving the fuel efficiency of an aircraft in flight according to an embodiment of the present invention.

Detailed description

Figure 1 shows a partial schematic plan view of the port wing 10 of a conventional Airbus™ A380 aircraft. The wing 10 includes a high lift system that incorporates a slat system 12 provided at the leading edge 14 of the wing 10 and a flap system 50 provided at the trailing edge 16 of the wing 10. Both the slat system 12 and the flap system 50 are controlled by a common flap/slat control computer 18. A similar high lift system is symmetrically disposed on the starboard wing of the aircraft (not shown) and is driven through compliant shafts 22, 52 by motors 24, 54 that are controlled by the flap/slat control computer 18. The motors 24, 54 are connected to different power supplies to ensure availability of the systems and may be electrically or hydraulically driven.

The compliant shaft 22 of the slat system 12 drives a first slat transmission shaft 26. The first slat transmission shaft 26 is coupled to a second slat transmission shaft 36 through a kink bevel gearbox 28 and a transmission gearbox 30. The series of slat transmission shafts 26, 36 is operable to drive a plurality of geared rotary actuators, one of which only is numbered 32 in Figure 1 for the sake of clarity. On the slat system 12 there is nominally one shaft provided between each geared rotary actuator; three being provided in the wing roots and over the engines. The actuators 32 are in turn operable to drive various lever link tracks 34 or rack and pinion tracks 38 to move various of the slats 40 into a desired position.

The flap system 50 includes motor 54 for driving the compliant shaft 52. The compliant shaft 52 in turn drives a first flap transmission shaft 56. The first flap transmission shaft 56 is coupled to a second flap transmission shaft 66 through a bevel gearbox 58. The bevel gearbox 58 also drives track_1 torque shaft input gearbox 59 that in turn drives station1 centre hinge geared rotary actuator 60. The centre hinge geared rotary actuator 60 is coupled to a first inboard flap panel 80a and is operable to move the flap panel 80a into various conventional discrete flap-down stage positions (e.g. -8°, -17°, -22°, -26°, -30° with respect to an unextended, or neutral flap-up, position).

The second flap transmission shaft 66 is coupled to a right angle gearbox 62 that drives a third series of flap transmission shafts 76. The third series of flap transmission shafts 76 connects to a first down drive gearbox 64, and a kink gearbox 68 through which it drives a fourth set of flap transmission shafts 86. Third flap transmission shafts 76 drive down drive gearbox 64 that in turn drives track_2 torque shaft input gearbox 69. Together both track_1 torque shaft input gearbox 59 and track_2 torque shaft input gearbox 69 drive the flap panel 80a via the geared rotary actuators, thereby providing built-in redundancy for the flap system 50.

Various steady bearings are provided along the lengths of the third flap transmission shafts 76 and the fourth series of flap transmission shafts 86 for support. One such steady bearing only is numbered 77 in Figure 1 for the sake of clarity. Additionally, it is noted that there are about one hundred transmission shafts used for an Airbus A380™, with three such shafts being provided between mid-flap down drive gearboxes 72 and 74.

The flap transmission shafts 86 drive two mid-span flap down drive gearboxes 72, 74. In turn the mid-flap down drive gearboxes 72, 74 drive respective of a mid-span flap track_3 torque shaft input gearbox 73 and a mid-flap track_4 torque shaft input gearbox 75. Both mid-span flap input gearboxes 73, 75 are used to drive a mid-span flap panel 80binto various flap stage positions via respective geared rotary actuators.

Flap transmission shafts 86 also drive two outboard flap down drive gearboxes 82, 84. In turn the outboard flap down drive gearboxes 82, 84 drive respective of an outboard flap track_5 torque shaft input gearbox 83 and an outboard flap track_6 torque shaft input gearbox 85. The fourth flap transmission shaft 86 is connected between the outboard flap down drive gearboxes 82, 84 through a wing tip brake 88. The wing tip brake 88 is a safety device that can be triggered by the flap/slat control computer 18 to lock the flap system 50 in a failed position. Both outboard flap input gearboxes 83, 85, along with respective geared rotary actuators, are used to drive an outboard flap panel 80c into various flap stage positions.

The flap panels 80a, 80b, 80c each have 100% panel authority: i.e. a single respective panel generates all of the respective lift altering forces (e.g. of ΔN Newtons) that can be generated by each of the three respective inboard, mid-span and outboard flaps when they are moved into various of the permitted flap stage positions.

Figure 2 shows schematically an aircraft wing 110 including a flap 100 according to an embodiment of the present invention. Those skilled in the art will be aware that the embodiment of Figure 2 may incorporate various conventional elements whilst providing a flap that operates in accordance with certain aspects of the present invention. For example, various of the components described above in connection with the high lift system shown in Figure 1 may be used.

The wing 110 is the port wing of an aircraft 120, and is shown in plan view. The wing 110 supports inboard flap 140, an aileron 180 and the flap 100 at its trailing edge 116. The wing 110 also supports a conventional aircraft gas turbine engine 130. Inboard flap 140 may be conventional in design whereby it is connected through to the starboard wing (not shown) by a shaft (not shown). The aileron 180 is normally provided as a separate primary flight control. Such primary flight controls are usually designed to fail free. In various embodiments using fly-by-wire they may be allowed to be drooped on take-off and landing in order to augment the flap system.

Inboard flap 140 may be driven conventionally, or as shown by a first electro-mechanical actuator 142 through a first mechanical track 146 and simultaneously by a second electro-mechanical actuator 144 through a second mechanical track 148. The aileron 180 is driven jointly by outer actuators 182, 184.

The flap 100 is composed of three independently operable panel sub-sections 102, 104, 106. An innermost panel sub-section 102 is redundantly driven by two actuators 101, 103. Mid panel sub-section 104 is redundantly driven by two actuators 105, 107. An outermost panel sub-section 106 is redundantly driven by two actuators 109, 111. The panel sub-sections 102, 104, 106 may all be independently rotateable about a common hinge line. Various, or all, of the actuators 101, 103, 105, 107, 109, 111 may be electro-mechanical actuators (EMAs).

Transmission may be omitted from between the panel sub-sections 102, 104, 106 to allow independent movement and reduced panel authority. Transmission may however be provided respectively between the actuators 101 and 103, the actuators 105 and 107, and the actuators 109 and 111 in a configuration that would enable simplification of the EMAs and/or respective local control systems.

At least one flap is thus composed of m individual panel sub-sections (wherein the integer value $m = 3$ in the embodiment of Figure 2) each having a respective maximum lift altering capability of Δn_x Newtons, for $x = 1$ to m. The total combined lift altering capability of the flap is thus ΔN Newtons, such that:

$$\Delta N = \sum_{x=1}^{m} |\Delta n_x| \qquad \text{- Equation (1)}$$

where Δn_x may be a positive or negative lift altering value. Alternatively, ΔN may be defined as the maximum of the modulus of the sum of all negative lift maximum values and of the sum of all positive lift maximum values for all of the panel sub-sections.

For example, where $|\pm n_x|$ is the same for each individual panel, panel authority for each panel may be defined as:

$$|\Delta n_x| \leq \frac{\Delta N}{m} \qquad \text{- Equation (2)}$$

the value $\frac{\Delta N}{m}$ corresponding to a predetermined critical threshold value.

Alternatively, for example, the maximum lift altering capability of any single panel sub-section Δn_{max} may be set such that:

$$\Delta n_{\max} \leq \frac{\Delta N}{2} \qquad \text{- Equation (3)}$$

the value $\frac{\Delta N}{2}$ corresponding to an alternative predetermined critical threshold value.

Various other schemes are also possible for determining panel authority and predetermined critical threshold value settings.

By providing a flap 100 in which each panel sub-section 102, 104, 106 has a panel authority lower than a predetermined critical threshold value, various advantages arise.

For example, this avoids the computing overhead associated with controlling panels that have critical authority, since should a panel sub-section fail the effects can be compensated by other panels. This also enables simplified, more reliable and less expensive control computers to be used to used to drive the panel sub-sections.

Additionally, the panel sub-sections can be designed such that they fail fixed, in contrast to the primary control surfaces which are designed to fail free. For example, various mechanisms such as actuators/locks/sprung pins etc. may be used.

Furthermore, various embodiments of the present invention can enable the removal of some spoilers and/or enable reduction or removal of under-wing flap fairings providing a cleaner more efficient wing with lower weight that can be rigged automatically.

Various embodiments may be provided that also use fewer parts than conventional designs, thus providing for quicker and cheaper build and servicing, as well as for lighter devices having improved operational reliability.

Various aspects of the present invention also allow for full control flexibility that enables in-flight trim as well as full flap and spoiler functionality.

Figures 3A to 3C show the deployment of the panel sub-section 102, in accordance with an embodiment of the present invention, presented in cross-sectional view.

The panel sub-section 102 is coupled to the trailing edge 116 of the wing 110 by a linkage mechanism 120. The linkage mechanism 120 comprises an actuator 101 coupled to a trapezoidal frame 130 by a mechanical linkage 142. The actuator 101 is fixed to the wing 110 at the trailing edge 116. Activation of the actuator 101 is operable to raise and lower the relative position of the panel sub-section 102 with respect to the wing 110.

For example, the panel sub-section 102 may, in conjunction with the other panel sub-sections 104, 106 that form the flap 100, be positioned in order to act as a conventional flap when moved to one of the flap stage positions (e.g. -5°, -10°, -15°, -25°, -40°, etc., the negative sign denoting a downward deflection relative to the wing 110). Additionally, the panel sub-section 102 may be independently operable about a hinge line by a relatively small amount, e.g. a finesse amount of ±1°, ±2°, ±3°, ±4°, ±5°, etc. This enables trimming to be provided, e.g. during cruise flight, and thereby provides improved fuel use efficiency.

The trapezoidal frame 130 comprises substantially parallel outboard arm 132 and inboard arm 138. The trapezoidal frame 130 also comprises substantially parallel upper arm 136 and lower arm 134.

The outboard arm 132 and inboard arm 138 are connected at an upper end by upper arm 136 and at a lower end by lower arm 134. The outboard arm 132 is provided within panel sub-section 102 and is pivotally connected to the upper arm 136 by way of a rearwardly positioned first connection pin 131. The upper arm 136 is also housed within the panel sub-section 102 and is pivotally connected to the inboard arm 138 by a second connection pin 137 positioned forwardly of the first connection pin 131 and housed within the panel sub-section 102. Inboard arm 138 is pivotally connected to lower arm 134 by a third connection pin 135 also positioned forwardly of the first connection pin 131. In turn the lower arm 134 is further pivotally connected to the outboard arm 132 by way of a rearwardly positioned fourth connection pin 133.

The actuator 101 is mechanically coupled to the lower arm 134 of the trapezoidal frame 130 by the mechanical linkage 142. The third connection pin 135 is mechanically attached to the trailing edge 116 of the wing 110 to provide support to the panel sub-section 102 and linkage mechanism 120, preferably using the same mount (not shown) that supports the actuator 101.

Figure 3A shows the panel sub-section 102 in an upwardly deflected position. The panel sub-section 102 is deflected by an angle α_+ with respect to the neutral position shown in Figure 3B.

Figure 3C shows the panel sub-section 102 in an downwardly deflected position. The panel sub-section 102 is deflected by an angle α_- with respect to the neutral position shown in Figure 3B.

It is noted that the maximum magnitude of the deflection angles α_+ and α_- may be, but are not necessarily, the same, i.e.:

$$|\alpha_+| < |\alpha_-| \text{ or } |\alpha_+| > |\alpha_-| \text{ or } |\alpha_+| = |\alpha_-| \qquad \text{- Equations (4)}$$

A similar arrangement to the embodiment of Figures 3A-3C may be provided for the panel sub-sections 104, 106.

The actuation ranges (α_+ to α_-) for each of the panel sub-sections 102, 104, 106 in the same flap 100, or between any of the flaps, for modifying the span-wise camber distribution of the wings (e.g. varying the camber profile from wing tip to wing root) may or may not be the same.

Figure 4 shows a method 400 of improving the fuel efficiency of an aircraft in flight. The method 400 may, for example, be used in connection with the embodiments depicted in Figures 2 and 3 of the present disclosure.

The method 400 comprises trimming at least one aircraft wing by deflecting the position of at least one of a plurality of independently operable panel sub-sections.

A first step 402 involves determining the flight phase of the aircraft. This is done in order to ensure that over-riding aircraft performance characteristics are applied for any panel sub-section movements that are to be made. For example in cruise flight, wing efficiency is important for saving the maximum amount of fuel and the panel sub-section may be used to provide fuel-saving trim during this phase. During landing, for example, panel sub-section movements may be made in order to dump lift from the wings by spoiler action.

The wing may also be optimised for climb cruise and/or descent, and being able to trim the trailing edge means that it can be optimised for substantially the whole duration of the flight. For example, an aircraft designed for short flights, with a relative large proportion of the flight envelope occupied by climb in take-off and descent in landing phases, may be provided with dynamic trimming profile that is optimised for all of the take-off, climb/descent cruise, approach and landing phases. Various embodiments of the present invention may thus be flexibly provided with trim profiles tailored to a specific end-use flight envelope. Additionally, various of these optimised profiles can be re-programmed or modified for various different flight envelopes, for example, either automatically or manually as desired by an end user.

At step 404 the optimal configuration for all panel sub-sections of both wings is calculated for the determined flight phase. E.g. for a landing configuration, various panel sub-sections may be required to adopt a lift-dumping or spoiler position to aid in the descent phase of the aircraft.

Finally, at step 406 the individual panel sub-sections are actuated such that both wings adopt the best configuration determined in step 404. In various embodiments, synchronisation logic and/or mechanisms similar to those used for conventional ailerons may be used to ensure symmetrical lift distribution between port and starboard wings.

Such a process 400 may be continually applied for the entire duration of a flight so that, for example, the configuration of the panel sub-sections is adjusted during cruise in order to optimise wing efficiency as fuel is used from the wing tanks.

Those skilled in the art will be aware that conventional aircraft are often provided with two flap panels that are separated due to the kink in the trailing edge of the wing. The Airbus 380™ is provided with three, however, as it is so large. Generally, conventional teaching in the art is thus away from splitting individual panels into sub-panels since this would required complex control synchronisation and a dual load path structure.

Various aspects of the present invention therefore go against such conventional thinking in the art by providing various flaps, slats, etc. comprised of a plurality of sub-panels having panel authority lower than a critical threshold value. Additionally, by reducing the panel authority of individual sub-panels, it is possible to provide a certifiable device that uses simple computing control.

Whilst various aspects and embodiments of the present invention are described herein, those skilled in the art will be aware of many modifications that may be made within the scope of the invention. These variations and equivalents are intended to fall within the scope of the appended claims.

For example, various inboard and/or outboard flaps, slats, etc. and/or panel sub-sections may be provided that are slotted e.g. double-slotted or triple-slotted. Conventional slats (e.g. provided at a wing leading edge) may also be provided.

In certain embodiments, the panel sub-sections may driven by a common actuator. For example, the common actuator may additionally be operable to move an aileron provided on the wing to which the flap is attached. Such embodiments enable a weight and/or cost saving to be provided by using the common actuator, with the additional benefit that part of the transmission system for an outboard panel device might be removed. Various "through fuselage" transmission mechanisms might be retained however, e.g. linking port and starboard inboard flaps, if total removal is not certifiable by various relevant aviation authorities.

Various embodiments of the present invention may also be provided in which flaps and/or panel sub-sections are mechanically connected to a "next track" via an inboard flap surface.

Certain embodiments may also be provided in which panel sub-sections are together operable to provide a flap having combined spoiler and flap functionality. For example, such embodiments may be used to replace a conventional outboard spoiler further simplifying the overall wing systems.

In any particular flap, slat, etc. all panel sub-sections may moveable together (i.e. in tandem) so they act as a conventional device when they are moved, for example to one of the flap stage or slat deployment positions. Often such devices are further operated together as a port/starboard pair, however, by providing panel sub-sections, certain embodiments of the present invention may not only be used to trim in-flight but may also be used to compensate for flight force asymmetries, if present, by moving one or more of the panel sub-sections. This ability is particularly useful in abnormal situations, e.g. should any primary or secondary flight surfaces fully or partially fail or should any of the engines lose power.

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Where permitted, the content of the above-mentioned references are hereby also incorporated into this application by reference in their entirety.

CLAIMS:

1. A panel device for modifying airflow about a wing of an aircraft, the panel device comprising a plurality of independently operable panel sub-sections, the panel sub-sections being driven by respective mechanical actuators wherein each panel sub-section is configured to fail fixed.

2. The panel device according to claim 1, wherein each panel sub-section has a panel authority lower than a predetermined critical value.

3. The panel device according to claim 2 in which the panel device is configured such that the aerodynamic effect of one of the panel sub-sections can be offset by the aerodynamic effect of one or more of the other of the panel sub-sections.

4. The panel device according to any preceding claim in which the electro-mechanical actuators are configured to fail in a fixed position.

5. The panel device according to any of claim 1 to 3 comprising an arresting mechanism arranged to prevent movement of at least one panel sub-section upon failure of the panel device.

6. The panel device according to claim 5 in which the arresting mechanism is a brake.

7. The panel device according to any preceding claim, wherein the panel device forms part of a flap or a slat.

8. The panel device according to any preceding claim, wherein the panel sub-sections are all independently rotateable about a design hinge line.

9. The panel device according to any preceding claim, wherein the panel sub-sections are independently operable about a hinge line to raise and/or lower the panel sub-sections by a finesse amount less than a first stage actuation angle.

10. The panel device according to any preceding claim, wherein the panel sub-sections are provided as an outboard flap.

11. The panel device according to any preceding claim, further comprising a mechanical connection to a respective next track via an inboard panel device surface.

12. The panel device according to any preceding claim, wherein different panel sub-sections in the same panel device have different deflection ranges.

13. The panel device according to any preceding claim, wherein the panel sub-sections are together operable to provide a flap having combined spoiler and flap functionality.

14. A high lift system for an aircraft, comprising:

a port wing and a starboard wing, each wing comprising a panel device according to any preceding claim, wherein the panel devices are controlled by a controller such that sub-panel sections of the port wing panel device can operate symmetrically with corresponding sub-panel sections of the starboard wing in tandem.

15. The high lift system of claim 14, wherein the panel device is an outboard flap.

16. The high lift system of claim 14 or 15, wherein the panel device is operable under computer control.

FIG.1 (PRIOR ART)

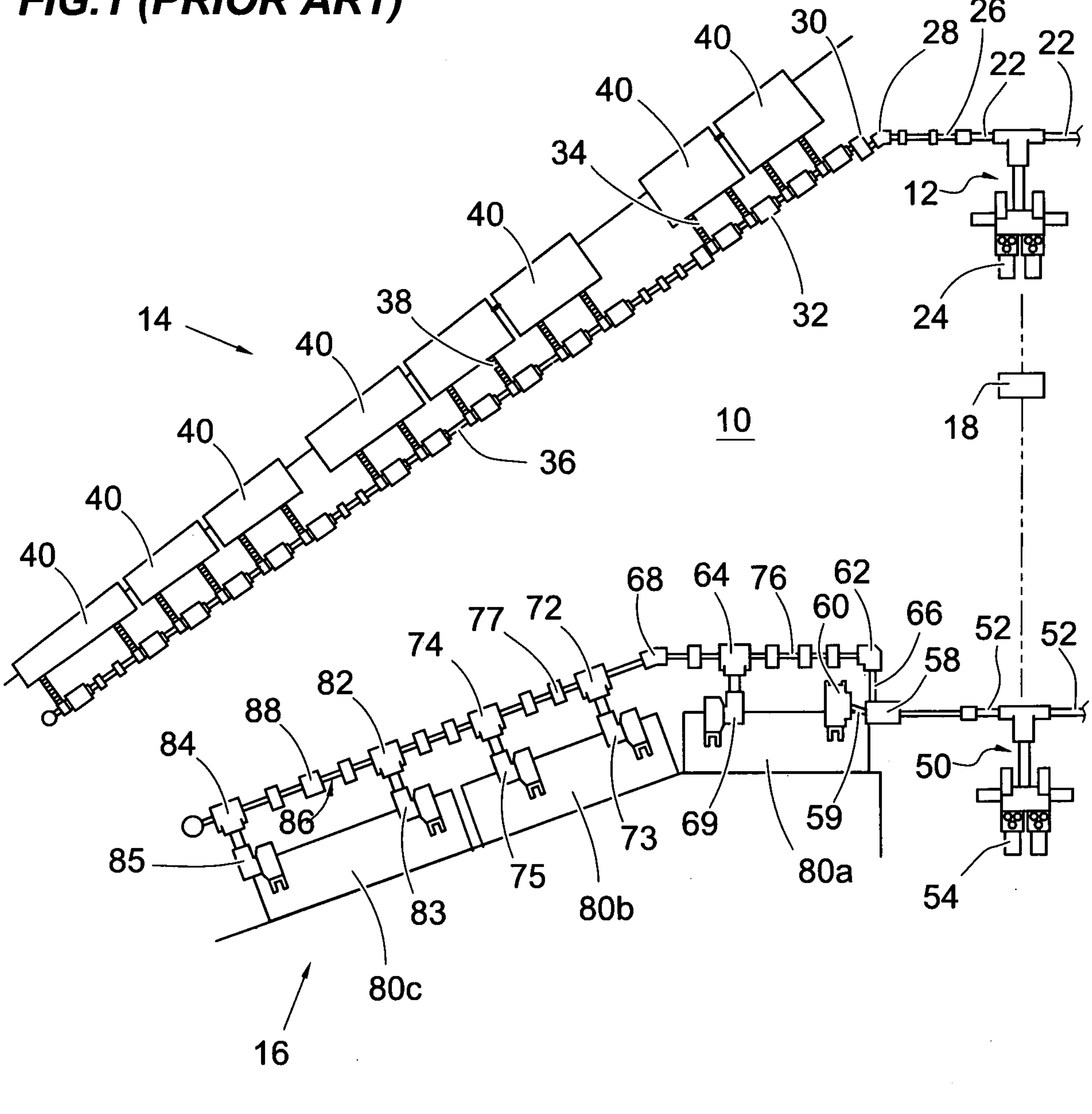

FIG.2

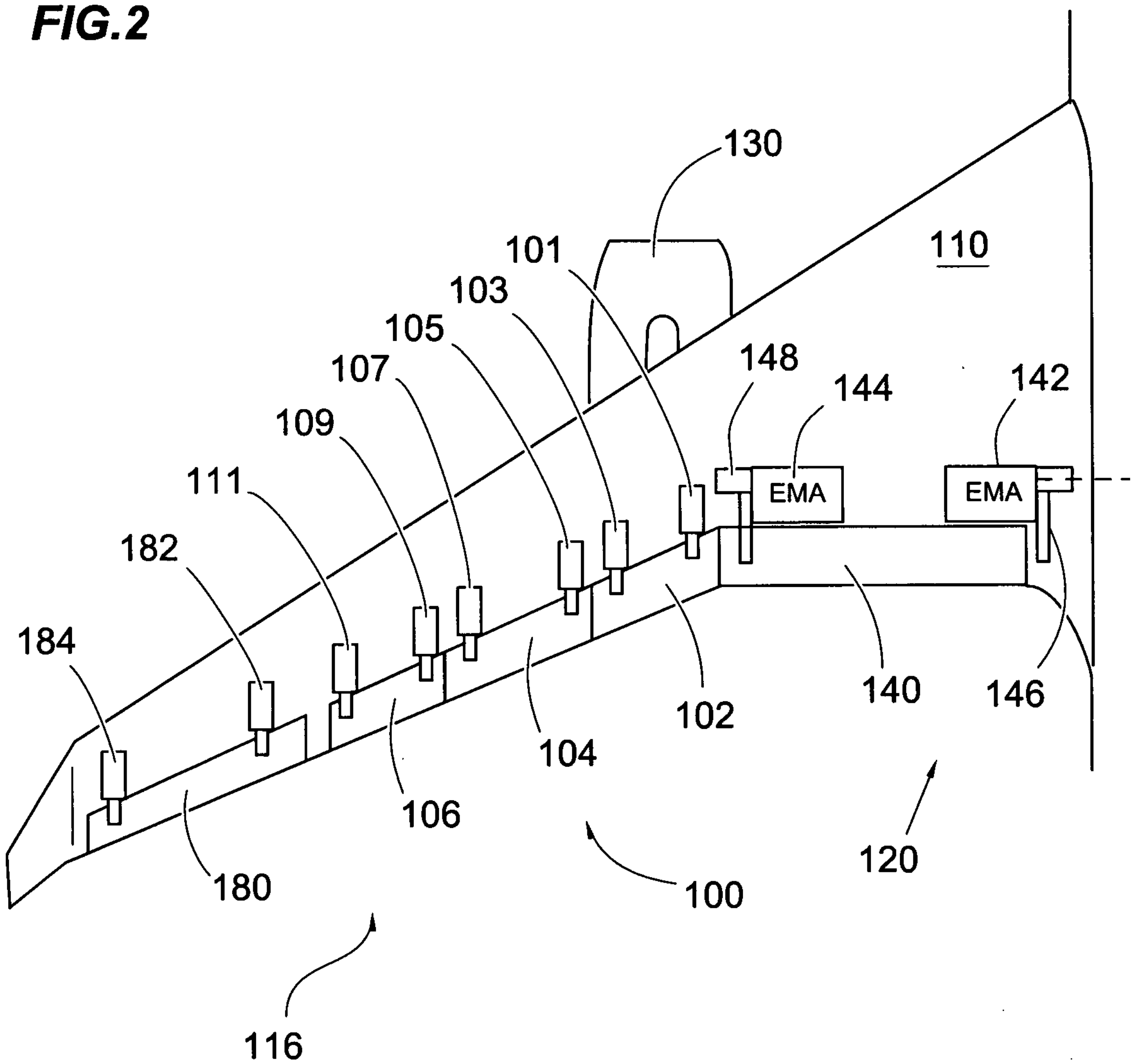
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FIG.3A

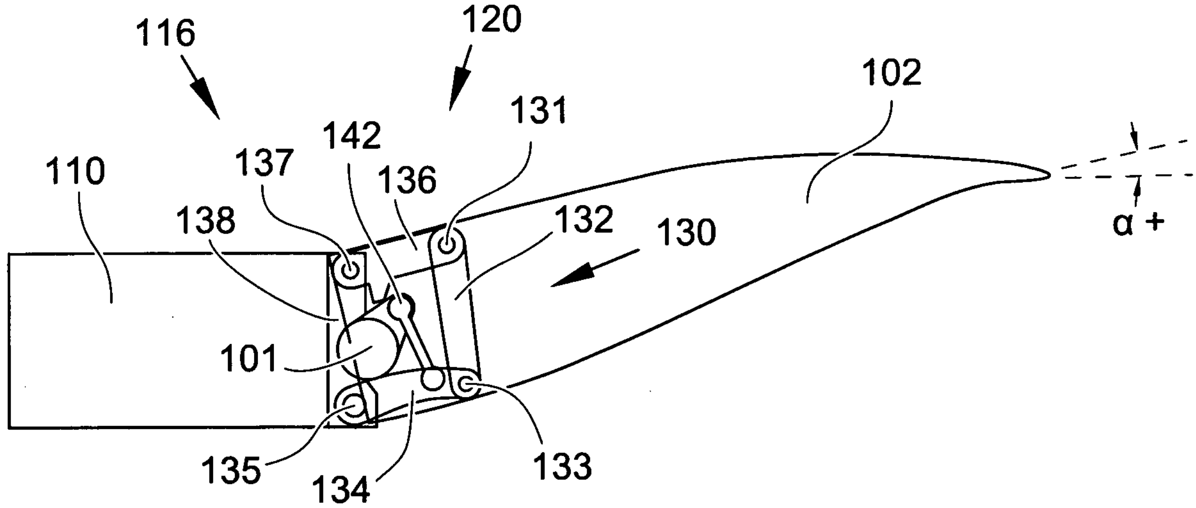


FIG.3B

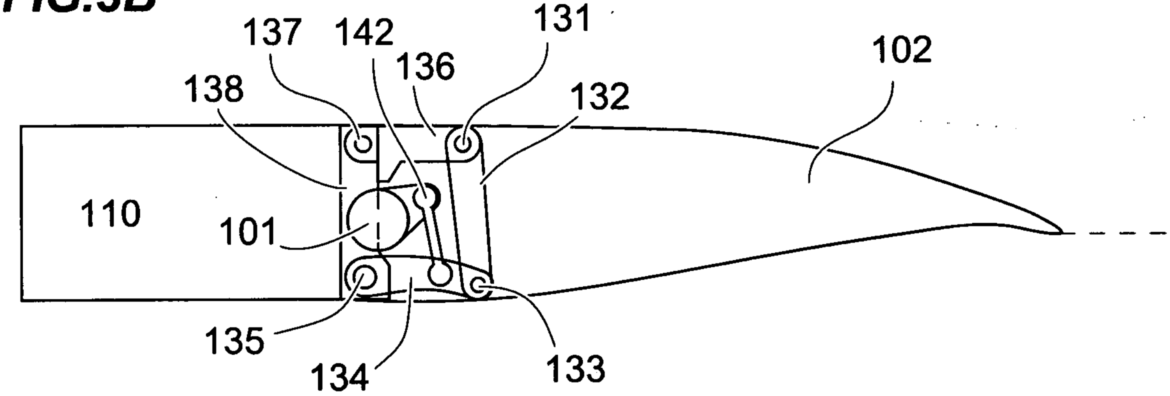


FIG.3C

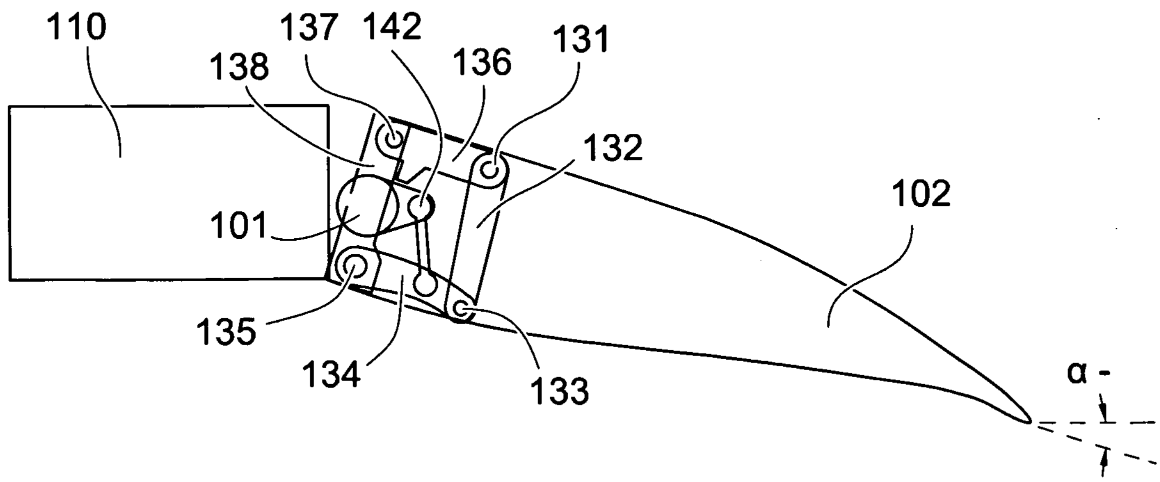
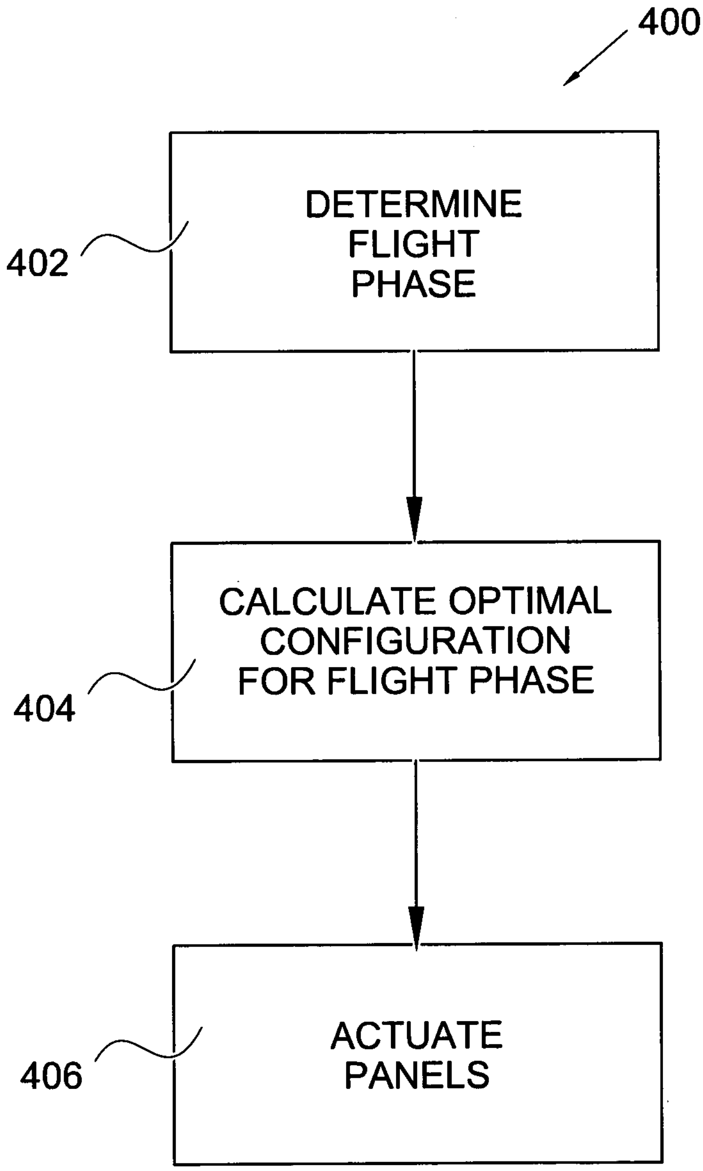


FIG.4


400
402
DETERMINE FLIGHT PHASE
404
CALCULATE OPTIMAL CONFIGURATION FOR FLIGHT PHASE
406
ACTUATE PANELS

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2010/050612

A. CLASSIFICATION OF SUBJECT MATTER
INV. B64C9/06 B64C9/20 B64C9/26 B64C13/50
ADD.

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)
B64C

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 practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	EP 1 462 361 A1 (AIRBUS GMBH [DE]) 29 September 2004 (2004-09-29) paragraphs [0002], [0014], [0018], [0019], [0028], [0030], [0035], [0036], [0038]; figures 3-7	1,2,4-16 3
X	DE 10 2005 017307 A1 (AIRBUS GMBH [DE]) 26 October 2006 (2006-10-26) paragraphs [0002], [0014], [0015], [0041], [0043], [0046], [0049], [0050], [0052], [0062]; figures 1-4	1,2,4-16
A	EP 0 726 201 A1 (BOEING CO [US]) 14 August 1996 (1996-08-14) column 2, line 24 - line 34; figures 2-4	1
	-/--	

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 August 2010	24/08/2010

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Kaysan, Rainer

1

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 470 923 A (JOSEPH KSOLL) 24 August 1937 (1937-08-24) page 1, line 15 - line 28; figures 2a-2d	1
A	WO 98/00334 A1 (SUNDSTRAND CORP [US]) 8 January 1998 (1998-01-08) page 6, line 7 - line 13; figures 1a-4	1

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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