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EP 0407159 A1 EP 0081610 A1
US 4448375 A

(58) Field of Search:
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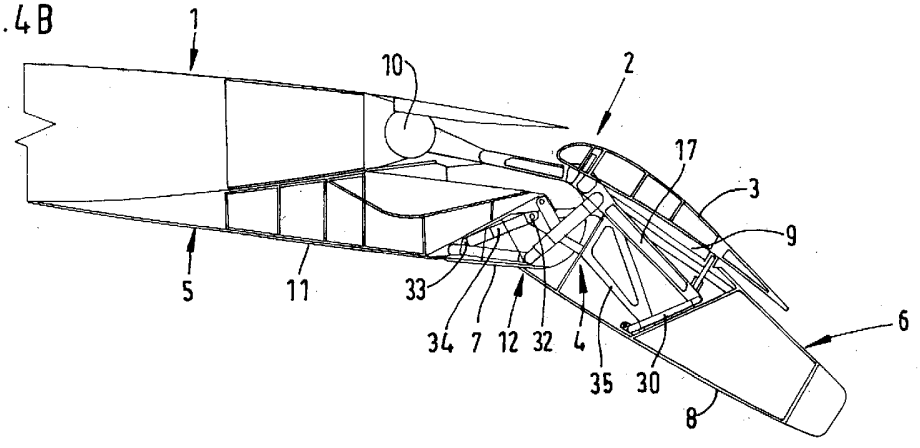
Other: EPODOC, WPI

(54) Abstract Title: **Pivotted wing flap with fairing**

(57) A wing having extendable aerodynamic pivoted flaps 3 uses a drive device 10, which powers an actuating device 4 for the flaps 3. The actuating device 4 contains a gear device 12 coupled to the drive device 10 and to the pivoted flap 3 in such a way that when the drive device 10 is actuated the pivoted flap 3 performs a combined translatory and rotary movement. The gear device 12 includes a crank mechanism, is supported on the wing 1 and is at least partially surrounded by a fairing housing 6 pivotally mounted on the wing 1, the fairing housing 6 being coupled to the gear device 12 in such a way that an actuation of the drive device 10 causes a swivelling movement of at least a portion of the fairing housing 6. Preferably the housing is in two parts 7, 8 each capable of pivoting.

FIG.4B



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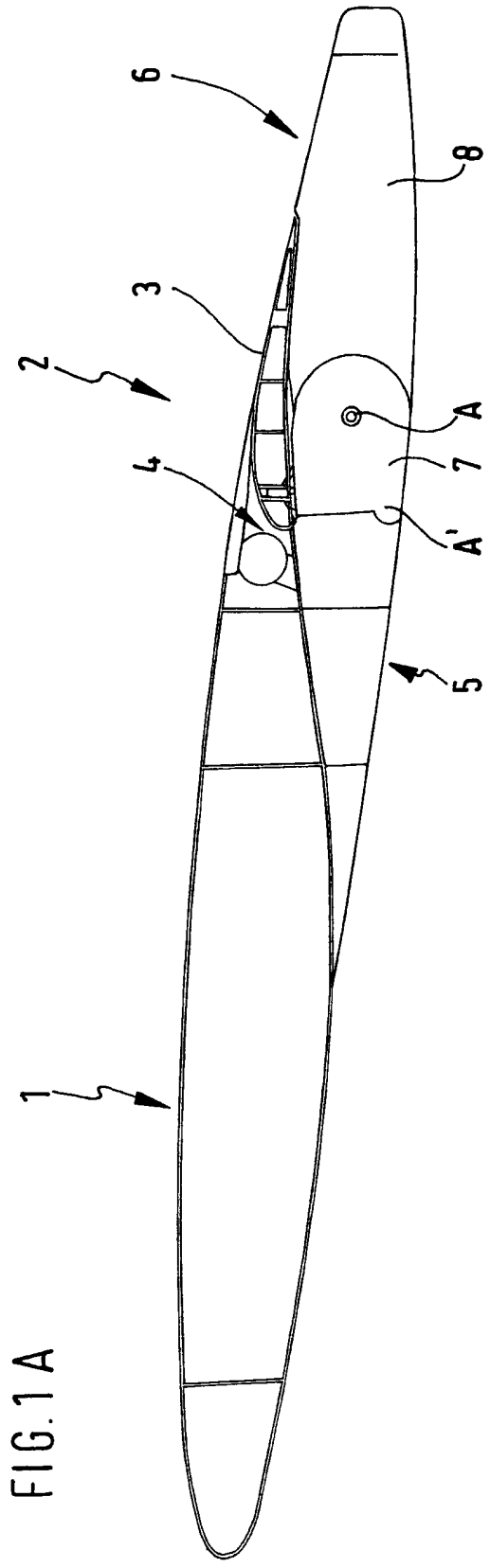

FIG.1A

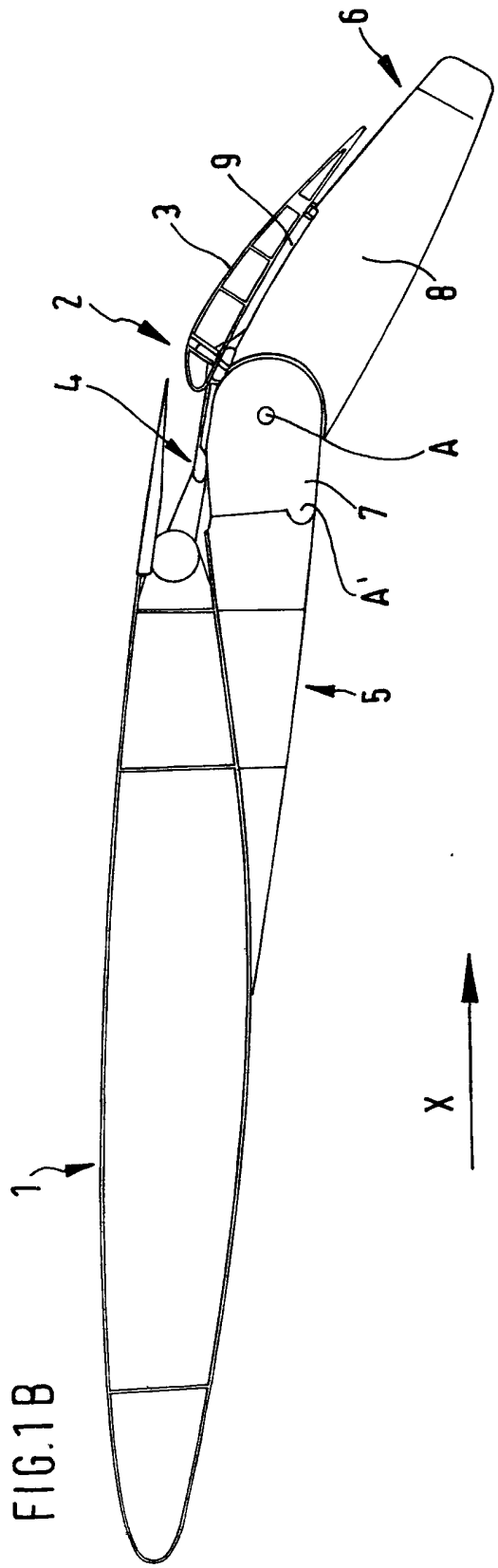

FIG.1B

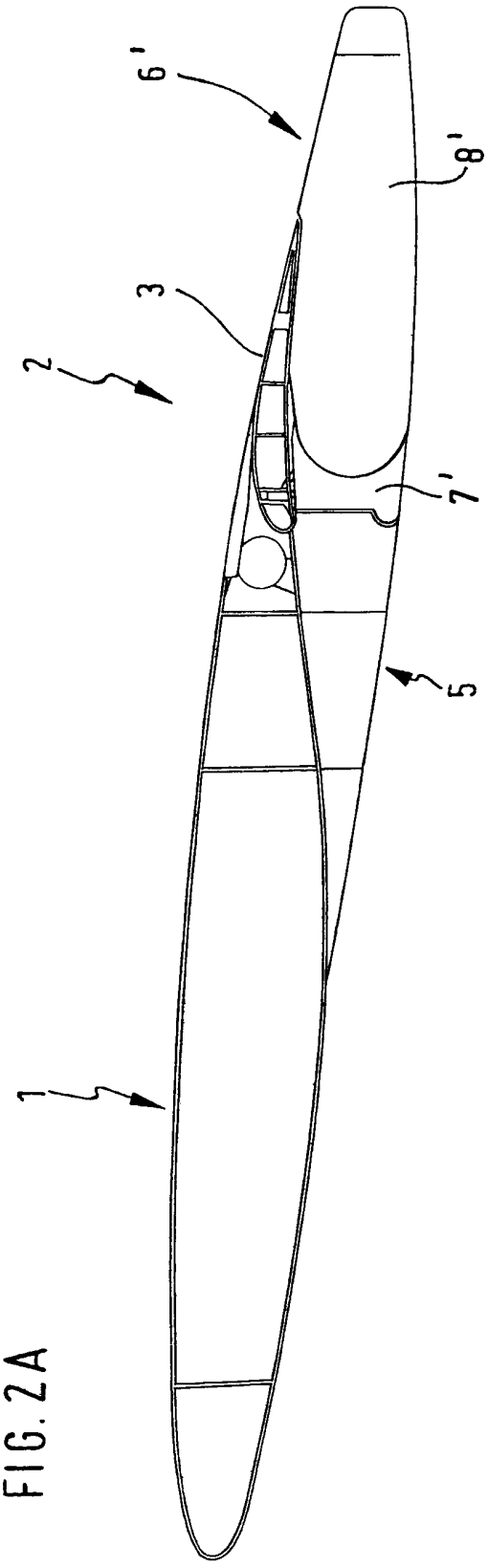

FIG. 2A

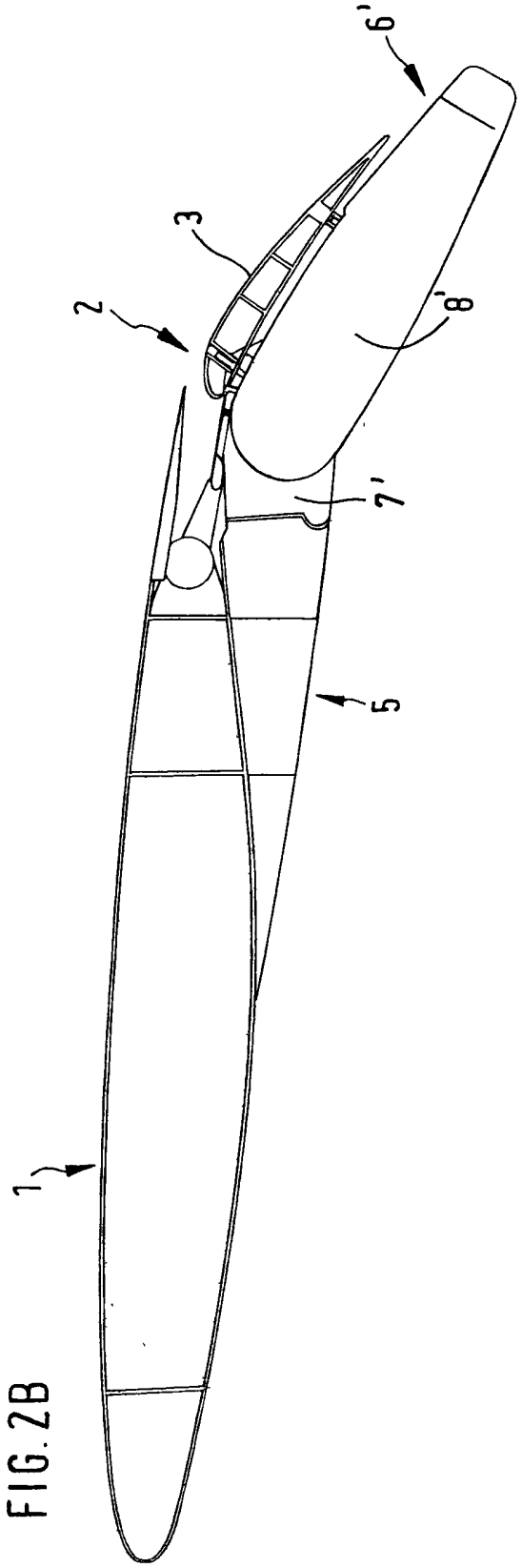

FIG. 2B

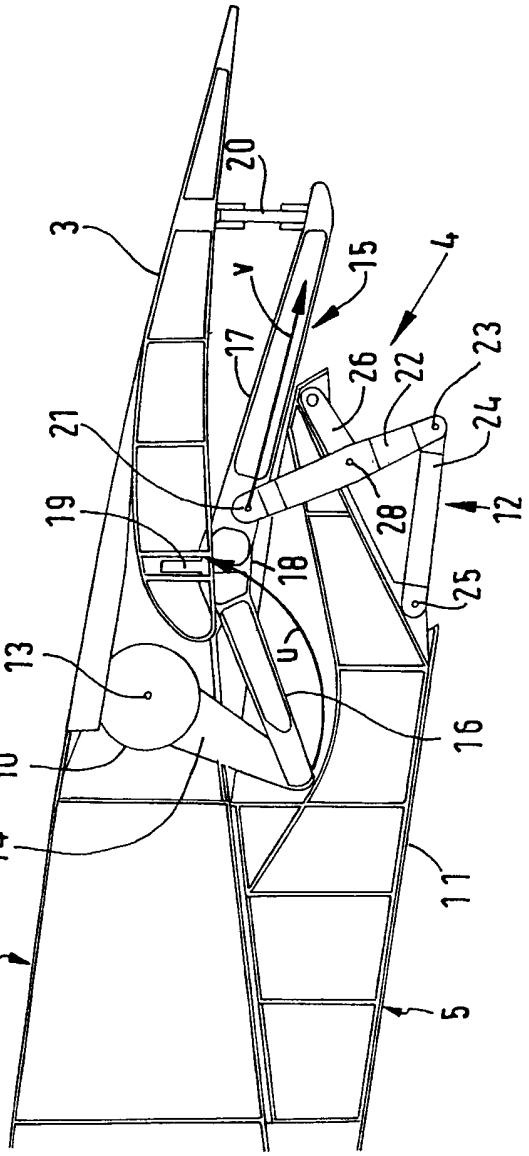
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FIG.3A

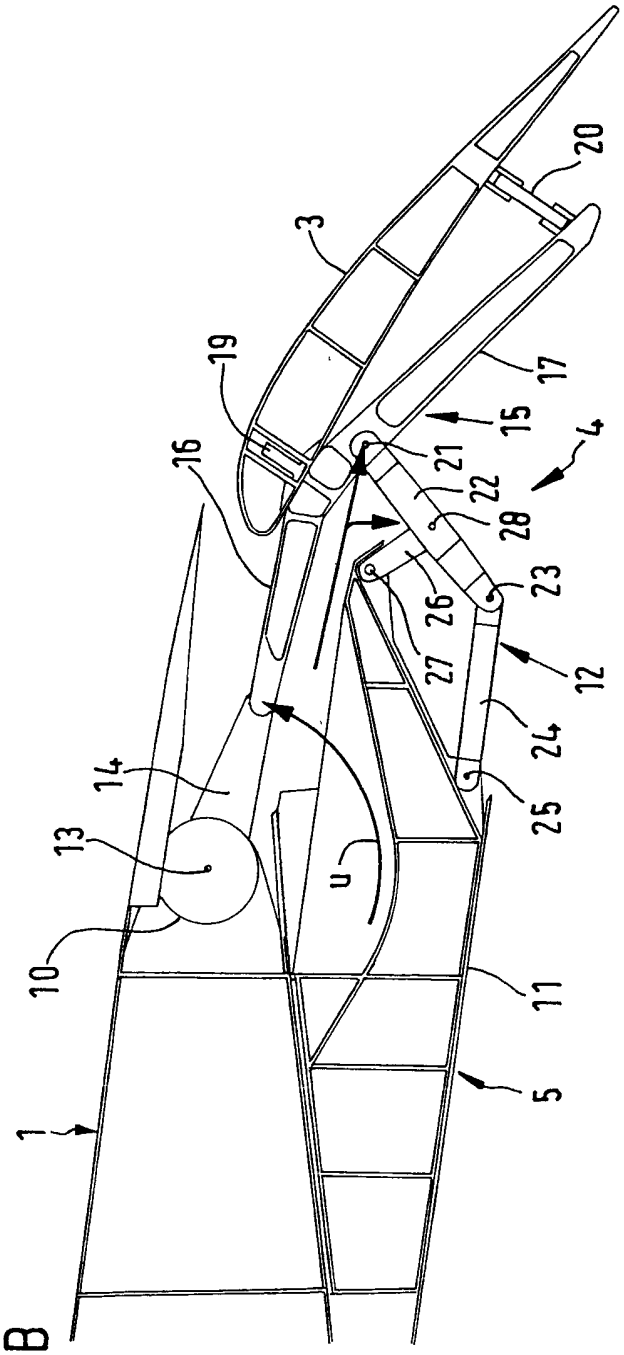
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FIG.3B

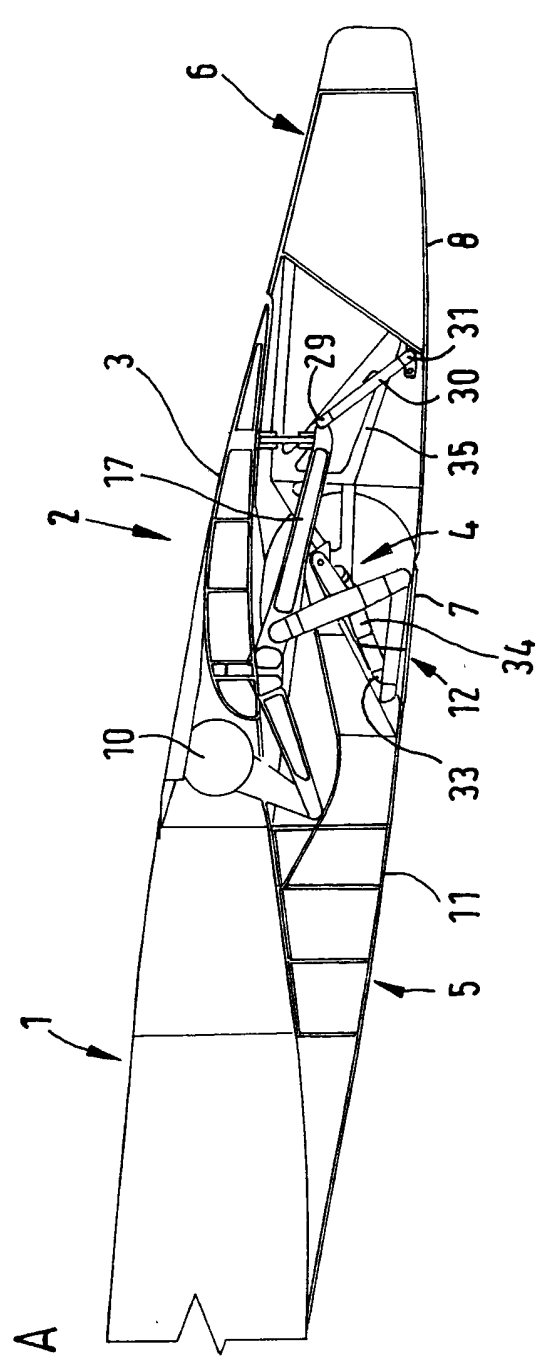
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FIG. 4A

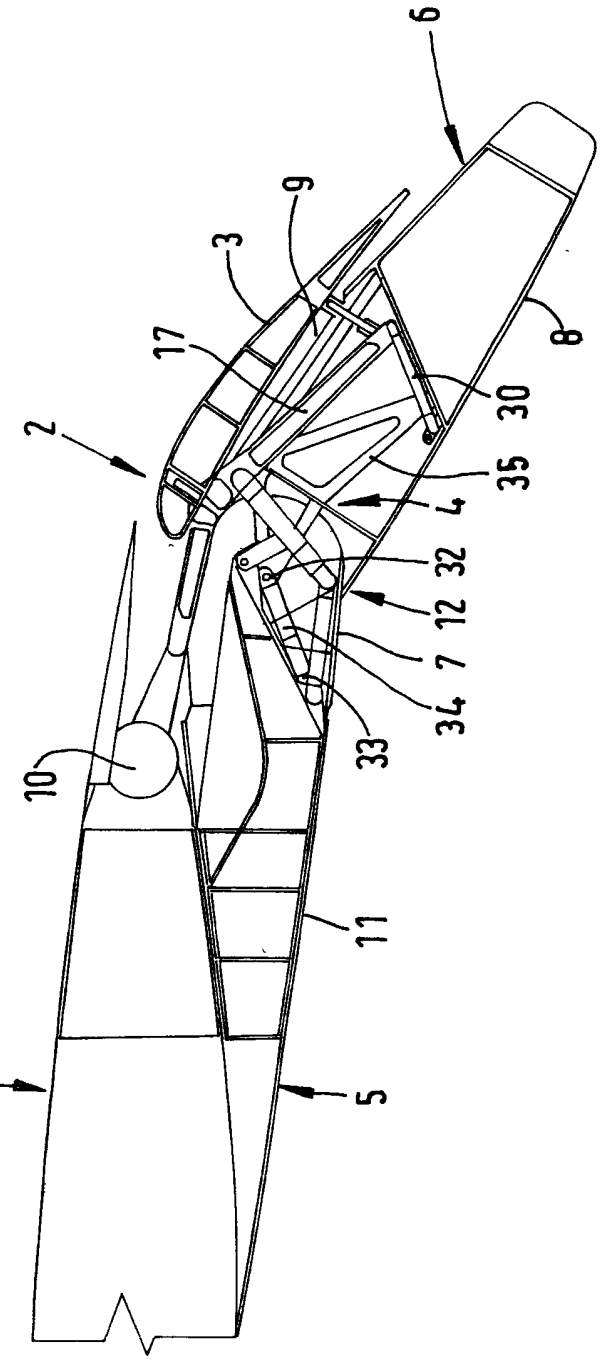
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FIG. 4B

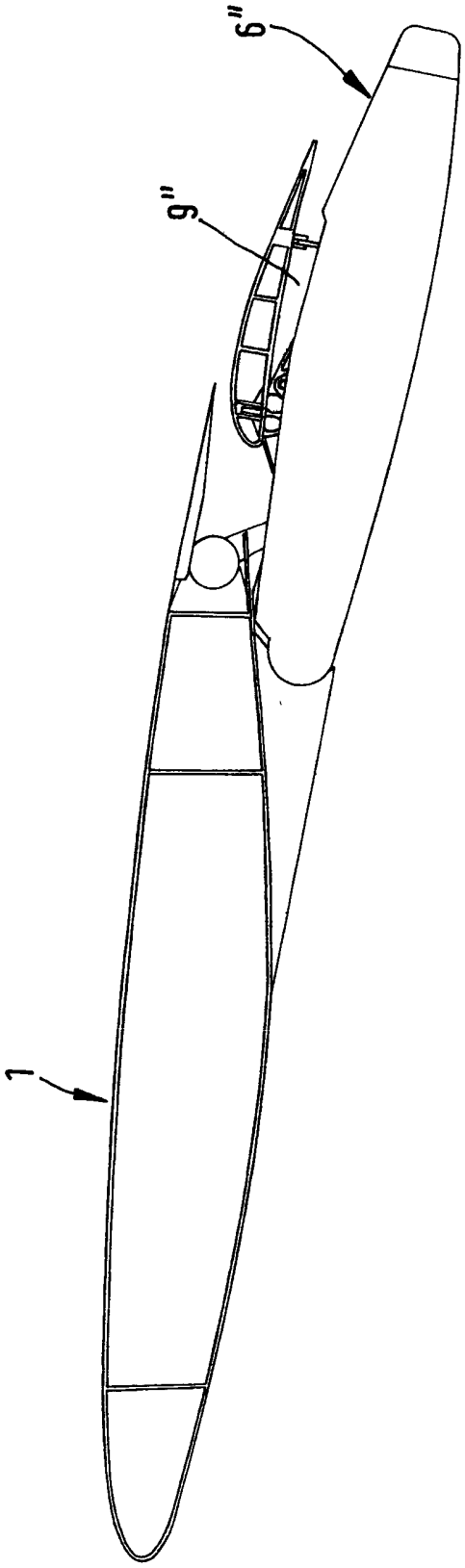

FIG.5A

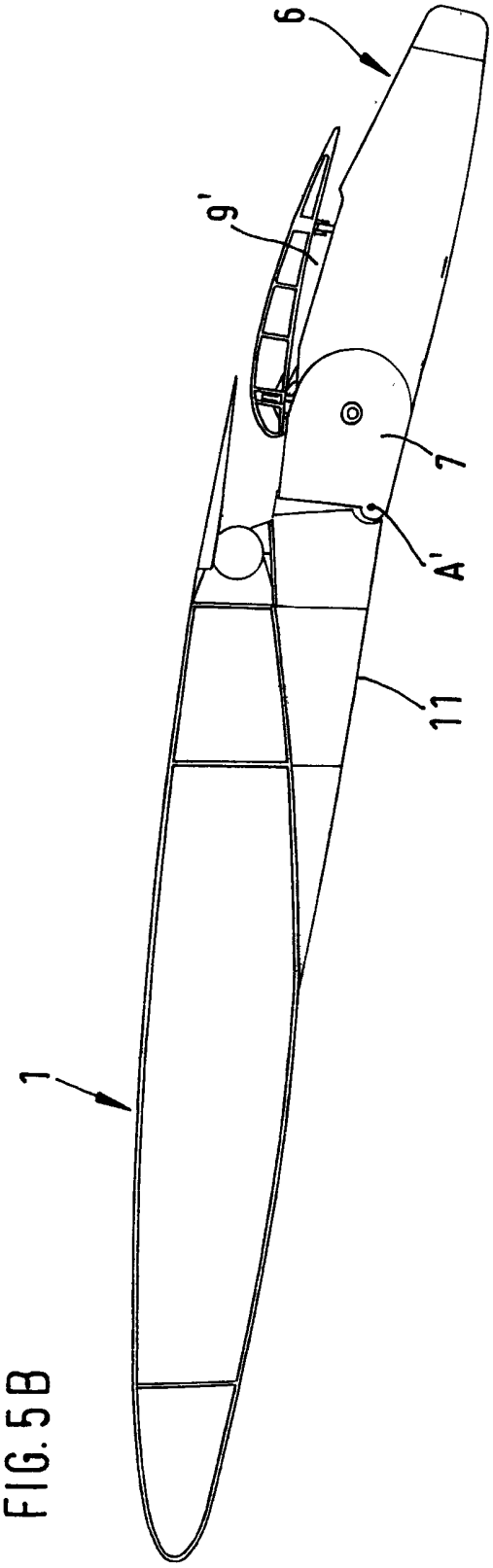

FIG.5B

Wing having extendable flaps

BACKGROUND

The present invention relates to a wing comprising extendable aerodynamic pivoted flaps, in particular lift flaps for an aircraft.

In previous known wings the lift flaps comprise at least one roller carriage which is provided with rollers which are guided in the manner of a connecting link in a C-shaped rail provided on the structure of the wing. This connecting link guide predetermines the movement path of the lift flaps. Since all of the aerodynamic forces acting on a lift flap have to be supported on the rail via the rollers it is necessary to make the rail extremely robust, which in turn makes it heavy. The reason for this that very high loads concentrated across the rollers cause bending stress in a rail flange, so that the rail flange must have a high material thickness to withstand the loads.

Each actuating device for the pivoted flaps and containing the roller carriage is encased by what is known as a fairing or fairing housing which is swivelled downwards during extension of the pivoted flaps. The fairing housing is open at the side in the region of the roller carriage to allow the rollers to cooperate with the rail secured to the wing. This means that in the region of the roller carriage the walls of the fairing housing must be reinforced with special structural elements, so that the weight is additionally increased.

A wing of the type at issue is known from DE 101 33 920 A1. In this known wing, the lift flaps are actuated by a lever mechanism, a leading region of the pivoted flap, connected to the lever mechanism, being guided on a rail by means of a roller carriage. A connecting link guide is provided as an alternative to the roller carriage guide. A portion of the aerodynamic loads acting on the pivoted flap is

conducted via the lever mechanism into the supporting surface structure. Provision of fairings is not disclosed in this prior art.

DISCLOSURE OF THE INVENTION

An object of the present invention is to design a wing in such a way that a reduction in weight is achieved while improving the aerodynamic properties.

The invention concerns a wing with the features of claim 1.

In embodiments of the invention the gear device, which is coupled on the one hand to the drive device and on the other hand to the pivoted flap, forms a compact and narrow actuating device for the pivoted flaps, the device being coupled to the fairing housing in such a way that actuation of the drive device causes a swivelling movement of at least a portion of the fairing housing.

There is no need to provide the heavy roller carriage or the heavy rails in the wing according to the invention. The aerodynamic loads that occur at the pivoted flap are borne by the crank mechanism and supported on the wing via the pivots of the crank mechanism. This manner of force introduction may be achieved in a more weight-saving manner compared with the prior art in addition to being less subject to wear than the known connecting link guide. The crank mechanism may also be constructed so as to be significantly narrower than the known connecting link guide with roller carriage and rail, so that the end face of the fairing housing influencing the aerodynamic resistance may also be configured so as to be narrower and thus smaller than in the prior art. The aerodynamic resistance is thus reduced.

It is also no longer necessary for the fairing housing to have a lateral opening, so that the fairing housing can be constructed as a substantially closed box without the special structural elements required in the prior art,

whereby the weight of the fairing housing is reduced. This box construction of the fairing housing also means that the primary structural parts of the wing and the actuating device for the pivoted flaps are better protected to the outside, and this reduces the risk of projectiles penetrating down to the primary structural parts or the actuating device, in particular in military applications.

The carrier of the wing structure supporting the drive device and the actuating device can also be made shorter than the prior art carriers which have to support the rails of the connecting link guide, so that a reduction in weight is also achieved here.

In a particularly preferred embodiment the fairing housing is divided into a plurality of housing portions, wherein at least two housing portions of the fairing housing are constructed so as to be swivellable with respect to the wing. This division of it allows the fairing housing to curve in the extended state and thus minimise the gap between wing, pivoted flap and fairing housing produced on extension of the pivoted flap, whereby the acoustic emission that occurs as air flows around the wing is much reduced, in addition to the aerodynamic properties of the wing being improved.

In a preferred configuration of the divided fairing housing a first housing portion of the fairing housing is adjacent to the wing is swivellably mounted on the wing, a second housing portion of the fairing housing, on the side away from the wing is swivellably mounted on the first housing portion, and the first housing portion and the second housing portion are coupled to the gear device.

It is particularly advantageous if the crank mechanism is constructed as a four-bar or four-joint linkage. With a four-bar linkage of this type a straight-line motion gear is formed which easily allows the translatory movement and the rotary movement of the pivoted flap and in which the

loads are conducted in a defined manner across the hinge points of the pivoted flap or are supported on the wing structure.

For a better understanding of the invention, embodiments of it will now be described, by way of example, with reference to the accompanying drawings, in which:

Fig. 1 shows a first embodiment of a wing according to the invention in two positions: flap retracted (Fig. 1A) and flap extended (Fig. 1B);

Fig. 2 shows an alternative embodiment of the wing according to the invention in two positions: flap retracted (Fig. 2A) and flap extended (Fig. 2B);

Fig. 3 shows a sectional diagram of the actuating device, without the fairing housing, in two positions: flap retracted (Fig. 3A) and flap extended (Fig. 3B);

Fig. 4 shows the embodiment of Fig. 1 in a longitudinal section with a view of the actuating device in the two positions: retracted (Fig. 4A) and extended (Fig. 4B); and

Fig. 5 shows a comparison of a wing according to the invention with a one-part fairing housing (Fig. 5A) and two-part fairing housing (Fig. 5B) with the pivoted flap extended.

ILLUSTRATION OF EMBODIMENTS

Fig. 1A shows in cross-section a wing 1 which, at its wing edge trailing in the direction of flow X (on the right in the figures), is provided with a lift flap arrangement 2. The lift flap arrangement 2 including at least one pivoted flap 3, for example a lift flap or landing flap. The flap 3 is mounted by means of at least one actuating device 4, described in more detail below, on a flap mount or carrier 5 connected to the wing 1.

At least one fairing housing 6 surrounding the actuating device 4 aerodynamically is provided at the trailing end of the wing 1 below the pivoted flap 3. There would normally be several such housings along the wing. In the illustrated example the fairing housing 6 is divided into a first, leading fairing housing part 7 and a second, trailing fairing housing part 8. The two fairing housing parts 7, 8 are articulated to each other so as to be swivellable about an axis A. The axis A extends in this case transversely to the direction of flow X, generally along the wing.

Fig. 1B shows the wing of Fig. 1A with flap 3 extended backwards and swivelled downwards, the flap 3 and the trailing fairing housing part 8 connected to it being swivelled clockwise about the axis A. It can clearly be seen in Fig. 1B that the spacing between the trailing fairing housing part 8 and the flap 3 is slight and only a small gap 9 is formed. The gap 9 is constructed so as to be very narrow, in particular owing to the two-part configuration of the fairing housing 6, so that little air can flow through the gap 9. Thus both the build-up of noise and the aerodynamic resistance are reduced compared with conventional flap arrangements.

While in the embodiment of the wing 1 according to the invention shown in Figs. 1A and 1B the trailing end of the leading fairing housing part 7 is convex and the leading end of the trailing fairing housing 8 is concave, the alternative embodiment of the wing 1 according to the invention shown in **Figs. 2A and 2B** shows a leading fairing housing part 7' which is concave in the trailing region and a trailing fairing housing part 8' which is convex in the leading region. This fairing housing 6' consisting of the fairing housing parts 7' and 8' also has the same advantages as the fairing housing 6 shown in Figs. 1A and 1B.

Figs. 3A and 3B are enlarged views corresponding to Fig. 1A and Fig. 1B respectively, with the fairing housing 6 not

being shown. Consequently the actuating device 4, encased by the fairing housing 6, for the flap 3 is visible.

The actuating device 4 for the pivoted flap 3 comprises a drive device 10 provided at the trailing wing edge of the wing 1. The drive device 10 can, for example, be formed by an electric or hydraulic motor or can be a shaft driven by a motor of this sort and extending over at least a portion of the trailing edge of the wing 1. A plurality of drive devices may also be provided for driving a flap 3. As a rule, two or more actuating devices 4, each encased by a fairing housing 6, are provided for driving a flap 3. However, in the case of flaps with a small transverse extent, a single actuating device 4 may be provided in exceptional cases.

The actuating device 4 includes a gear device 12, constructed as a crank mechanism, in addition to the drive device 10. The gear device 12 comprises a plurality of levers and rods that are articulated to each other and connect the drive device 10, the flap 3 and the leading fairing housing part 7 and the trailing fairing housing part 8 to each other so that they are moveable relative to each other. A leading portion of the gear device 12 is mounted on a structural element 11, provided in the trailing region of the wing 1 and rigidly connected to the wing 1, of the flap mount 5.

The drive device 10, which is preferably constructed as a rotary actuator with a drive axis 13 parallel to the pivot axes, comprises a drive arm 14 that is movable about the drive axis 13. At its free end the drive arm 14 is articulated to the leading end of a flap support 15. The flap support 15 is constructed as a one-part generally rod-shaped carrier bent at an obtuse angle and comprising a leading flap support portion 16 pointing toward the wing 1 and a trailing flap support portion 17 pointing away and downwards from the wing 1 and slightly downwards. A carrying portion 18, which is connected by means of a pin

fastening 19 to the pivoted flap 3 in the leading portion thereof that faces the wing 1, is constructed where the leading flap support portion 16 and the trailing flap support portion 17 meet at an obtuse angle, and thus supports the pivoted flap 3 in its leading portion. A generally vertical support strut 20, which connects the trailing flap support portion 17 of the flap support 15 to the trailing region of the pivoted flap 3, is provided at the trailing free end of the trailing flap support portion 17 and thus supports the trailing portion of the pivoted flap 3 on the flap support 15.

A first link 21, by means of which a steering arm 22 - pointing away from the flap support 15 and downwards, *i.e.* facing away from the pivoted flap 3 - is mounted so as to be articulated on the trailing flap support portion 17, adjacent to the carrying portion 18. A second link 23, via which the steering arm 22 is articulated to a first end of a strut 24 forming a supporting rod, is provided at the other end of the steering arm 22, which forms an oscillating rod. The other end of the strut 24 is swivellably mounted by a third link 25 on the lower trailing end portion of the structural element 11 of the flap mount 5.

A first end of a pendulum rod 26 is also swivellably mounted on the structural element 11 of the flap mount 5 in a fourth link 27, the fourth link 27 being located above and further back than the third link 25. The second end of the pendulum rod 26 is swivellably mounted on the steering arm 22, in a middle portion thereof, by means of a fifth link 28.

The pendulum rod 26, the portion of the steering arm 22 between the fifth link 28 and the second link 23, the strut 24 and the structural element 11 of the flap mount 5 between the third link 25 and the fourth link 27 form a four-bar linkage which, with respect to the length of the individual legs of the four-bar linkage between the

respectively adjacent links, has an asymmetric construction. When the drive device 10 is rotated about the axis 13 in accordance with the arrow `u' pointing in the anticlockwise direction, the gear device 12 formed by the four-bar linkage and the flap support 15 as well as the length of the drive arm 14 are dimensioned in such a way that the first link 21, which connects the steering arm 22 to the trailing flap support portion 17, performs a substantially linear movement in the direction illustrated by the arrow `v', generally rearwards and slightly downwards, and thus forms a straight-line motion gear. The same applies to the swivelling movement of the drive device 10 in the anticlockwise direction, wherein the first link 21 moves substantially linearly in the opposite direction of arrow v. The pivoted flap 3 is thus moved from the retracted state shown in Fig. 3A into the extended position shown in Fig. 3B, or back again.

In the extended state of the pivoted flap 3, the aerodynamic loads acting on the pivoted flap 3 are conducted via the flap support 15, the steering arm 22, the strut 24 and the pendulum rod 26 and via the links connecting them into the flap mount 5. Only a small portion of the aerodynamic loads acting on the pivoted flap 3 in the extended state is supported on the wing 1 via the drive arm 14 and the drive device 10 in this case.

The aerodynamic loads introduced via the flap 3 are supported on the wing 1 via struts and link joints without the flow of force having to be guided over roller carriage joints or connecting link joints.

In the diagram shown in **Figs. 4A and 4B**, the actuating device 4 corresponds to the actuating device shown in Figs. 3A and 3B, but the fairing housing parts 7 and 8 are illustrated. The trailing fairing housing part 8 is coupled, via a trailing fairing guide rod 30, whose first end is swivellably connected to the trailing flap support portion 17 in a link 29 at the trailing free end of the

trailing flap support portion 17 and which at its other end is swivellably connected in a link 31 to the structure or framework 35 of the trailing fairing housing part 8, to the actuating device 4. A leading portion of the structure 35 of the trailing fairing housing part 8 engages in the leading fairing housing part 7 and is connected thereto, so as to be swivellable about the axis A, in a link 32. The leading fairing housing part 7 is mounted, pivotably about an axis A', in a further link 33 at the trailing lower end of the structural element 11 of the flap mount 5. A leading fairing guide rod 34, which is also mounted by its ends in an articulated manner in the links 32 and 33, supports the loads acting on the trailing fairing housing part 8, in particular the aerodynamic loads, directly on the flap mount 5. The axes A, A' and 13 and the swivelling axes of all the said links extend parallel to each other.

The illustration in Fig. 4B shows how the coupling of the trailing fairing housing part 8 via the gear device 12 to the flap 3 and to the drive device 10 causes the trailing fairing housing part 8 to swivel backwards and downwards when the flap 3 is extended, wherein the gap 9 between the upper side of the trailing fairing housing part 8 and the lower side of the flap 3 is kept to a minimum.

Figs. 5A and 5B show by comparison an embodiment of the invention with a one-part fairing housing 6'' (Fig. 5A) and a wing in accordance with the invention with a two-part fairing housing 6 (Fig. 5B). It can clearly be seen that with the two-part development of the fairing housing 6 in Fig. 5B, the gap 9 between the upper side of the fairing housing 6 and the lower side of the flap 3 produced when the flap 3 is slightly extended is much smaller than the gap 9'' in the one-part embodiment of the fairing housing 6'' shown in Fig. 5A. The two-part nature of the fairing housing means that both the leading fairing housing part 7, which is mounted on the trailing lower end of the flap support 5 so as to be articulated about the axis A' on the fixed structural element 11, which extends parallel to the

axis A, and the trailing fairing housing part 8 can be swivelled about the axis A, so that the fairing housing 6 as a whole undergoes a curvature, which the one-part fairing housing 6'' shown in Fig. 5A cannot perform, and which allows the gap 9' between the fairing housing 6 and the flap 3 to be minimised.

List of reference characters

1 wing
2 lift flap arrangement
3 pivoted flap
4 actuating device
5 flap mount
6 fairing housing
6' fairing housing
6'' fairing housing
7 first, leading fairing housing part
7' first, leading fairing housing part
8 second, trailing fairing housing part
8' second, trailing fairing housing part
9 gap
9' gap
9'' gap
10 drive device
11 structural element
12 gear device
13 drive axis
14 drive arm
15 flap support
16 leading flap support portion
17 trailing flap support portion
18 carrying portion
19 pin fastening
21 first link
22 steering arm
23 second link
24 strut
25 third link
26 oscillating rod
27 fourth link
28 fifth link
29 link
30 trailing fairing guide lever
31 link

32 link
33 link
34 leading fairing support strut
35 structure

A axis
A' axis
u arrow
v arrow
X direction of flow

Claims

1. A wing having an extendable aerodynamic pivoted flap including a drive device (10) and an actuating device (4) for the pivoted flap (3) and loaded by the drive device (10), wherein the actuating device (4) comprises a gear device (12) which is coupled on the one hand to the drive device (10) and on the other hand to the pivoted flap (3), in such a way that when the drive device (10) is actuated the pivoted flap (3) performs a combined translatory and rotary movement, the gear device (12) comprising a crank mechanism and being supported on the wing (1),

   characterised in that

   - the gear device (12) is at least partially surrounded by a fairing housing (6; 6'; 6'') pivotably mounted on the wing (1), and
   - the fairing housing (6; 6'; 6'') is coupled to the gear device (12) in such a way that an actuation of the drive device (10) causes a pivoting movement of at least a portion of the fairing housing (6; 6'; 6'').

2. A wing according to claim 1, in which the fairing housing (6; 6') is divided into a plurality of housing parts (7, 8; 7', 8'), wherein at least two housing parts of the fairing housing (6; 6') are pivotably constructed with respect to the wing (1).

3. A wing according to claim 2 in which a first housing part (7; 7') of the fairing housing (6; 6') adjacent to the wing (1) is pivot mounted on the wing (1), a second housing part (8; 8') of the fairing housing (6; 6') facing away from the wing (1) is pivot mounted on the first housing part (7; 7'), and the first housing part (7; 7') and the second housing part (8; 8') are coupled to the gear device.

4. A wing substantially as described herein with reference to the attached drawings.

For Innovation

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Application No: GB0607207.8 **Examiner:** Alex Swaffer

Claims searched: 1-3 **Date of search:** 27 July 2006

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1	EP0407159 A1 (Short Brothers plc): See figures 1 and 2 in particular.
X	1	EP0081610 A1 (The Boeing Co): See figures 1-3 in particular.
X	1	US4448375 A (The Boeing Co): See figures 1-3 in particular.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art
Y	Document indicating lack of inventive step if combined with one or more other documents of same category	P	Document published on or after the declared priority date but before the filing date of this invention
&	Member of the same patent family	E	Patent document published on or after but with priority date earlier than, the filing date of this application

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC[X]:

B7G

Worldwide search of patent documents classified in the following areas of the IPC

B64C

The following online and other databases have been used in the preparation of this search report

EPODOC, WPI