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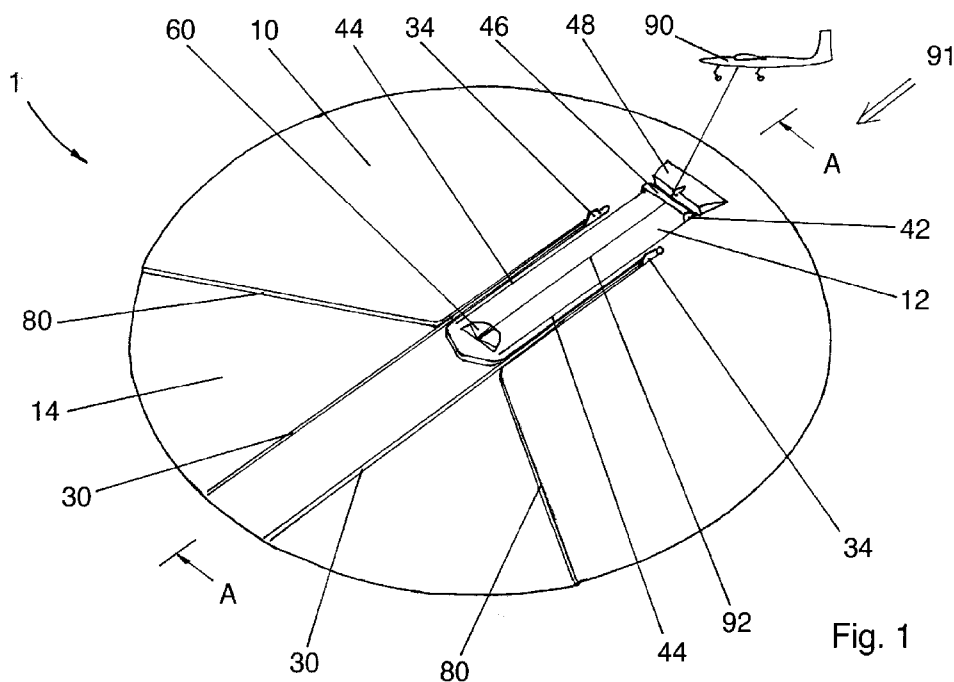
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(54) Title: METHOD FOR LANDING A TETHERED AIRCRAFT AND LAUNCH AND LAND SYSTEM



(57) Abstract: Method for landing a tethered aircraft and launch and land system The invention relates to a method for landing a tethered aircraft (90), comprising the steps of · - approaching a ground site with said aircraft, thereby shortening free length of tether (92) between the aircraft and the ground site until said free length of tether reaches a predetermined value, · - further approaching the ground site with said aircraft, thereby keeping free length of tether fixed at said predetermined value, · - retaining the tether to form a loop, wherein the loop is tensed and tightened by the moving aircraft, and · - damping said tightening of said loop in order to decelerate the aircraft until it stands at the ground site. The invention further relates to a launch and land system (1) for a tethered aircraft comprising a runway (12) for the aircraft, a winch (62) for the tether, and a retention system (42,46) for forming a loop of the tether between the winch and the aircraft approaching the runway, wherein said retention system features a damping device (41) for damping a tightening

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5 Method for landing a tethered aircraft and launch and land system

Description

10

The invention relates to a method for landing a tethered aircraft. The invention further relates to a launch and land system for a tethered aircraft.

15 Tethered aircrafts are for instance known from airborne wind energy production. An example for a respective system by the applicant is described in detail in EP 2 631 468 A1.

20 For efficient and economic operation of such systems, a high degree of automation is desirable, in particular during launching, landing, and ground handling of the aircraft. It is thus an object of the invention to provide for a high degree of automation during launching and/or landing and/or ground handling of a tethered aircraft.

25

According to the invention, this object is achieved by a method for landing a tethered aircraft, comprising the steps of

- approaching a ground site with said aircraft, thereby shortening free length of tether between the aircraft and the ground site until said free length of tether reaches a predetermined value,
- further approaching the ground site with said aircraft, thereby keeping free length of tether fixed at said predetermined value,
- 35 - retaining the tether to form a loop, wherein the loop is tensed and tightened by the moving aircraft, and
- damping said tightening of said loop in order to decelerate the aircraft until it stands at the ground site.

- 2 -

It is an aspect of the invention to decelerate the aircraft by use of the tether. This allows the aircraft to be decelerated prior to and after touch down alike or, in other terms, both in flight and when rolling on the ground. The aircraft thus can
5 approach with released constraints on flight path, enabling completely autonomous flight of the aircraft during approach without any need for supervision and/or intervention by a human operator .

10 In case of deceleration in flight, it might happen that the aircraft gets decelerated below stall speed and thus drops the remaining distance to the runway. Preferably, the aircraft is equipped with a landing gear designed for such load conditions in order to fully explore the benefits provided by the
15 invention .

It is another aspect of the invention that the majority of kinetic energy of the aircraft is dissipated by damping the tightening of a loop formed in the tether, which beneficially
20 can be achieved by use of ground-based equipment. This allows maintenance of such equipment anytime, even when the aircraft is flying. Maintenance of such equipment thus does not compromise availability of the aircraft, for instance for airborne wind energy production.

25 It is yet another aspect of the invention that the aircraft is decelerated depending on its position. In particular, deceleration starts when the tether with fixed free length is tensioned and the loop in the tether starts to get tightened.
30 Deceleration then continues until the aircraft does not move any further .

Since the length of tether has been fixed to a predetermined value or amount, the aircraft comes to a halt latest when the
35 loop reduced to the minimum size allowed by construction.

When said value for fixed free length of tether is predetermined such that the decelerated aircraft comes to stand within a predetermined target area at said ground site, ground handling

- 3 -

of the aircraft may be simplified and further automatized. In particular, automated systems can rely on the fact that the aircraft stands in a predefined target area after landing. Thus, the invention allows for simpler and thus easier-to-automate ground handling of the aircraft.

It is of advantage when the aircraft approaches the ground site against the wind, which is beneficial in terms of stable flight conditions and a lower allowable aircraft velocity upon approach. In general, an approach against the wind can increase the safety margin and thus leads to reduced constraints on the flight path for automated landing procedures.

It is further beneficial when a runway for the aircraft at said ground site is oriented to align with the direction of approach of the aircraft, which avoids the need for complex flight maneuvers. In general, an approach against the wind can increase the safety margin and thus leads to reduced constraints on the flight path for automated landing procedures.

It is most beneficial when the aircraft approaches against the wind, while the runway is aligned with direction of approach.

The object of the invention is also achieved by a launch and land system for a tethered aircraft comprising a runway for the aircraft, a winch for the tether, and a retention system for forming a loop of the tether between the winch and the aircraft approaching the runway, wherein said retention system features a damping device for damping a tightening of said loop caused due to movement of the aircraft upon approach and landing in order to decelerate said aircraft.

The launch and land system according to the invention is in particular designed and constructed to be operated pursuant a method for landing a tethered aircraft according to the invention as described above.

For aligning the runway with the wind and/or with a direction of approach of the aircraft, the runway is for instance rotatable

- 4 -

around a vertical axis.

In a preferred embodiment of the invention, the guiding device for the tether is arranged approximately in the middle of the runway and/or close to a rotational axis of the runway. This
5 way, the guiding device can be arranged stationary even when the runway is orientable or rotatable.

It is further preferred that the guiding device is rotatable, preferably co-axially with rotatable runway, in order to enable
10 straight guidance of the tether towards the airborne aircraft without sharp bends of the tether.

In a preferred embodiment of the invention, the retention device
15 comprises a movable slider with a roller, wherein an axis of said roller is aligned essentially horizontal and across a direction of movability of said slider. For instance, said direction of movability of the slider is aligned with the runway. This arrangement provides for most simple and stable
20 construction for forming a loop in the tether.

When said roller has a varying diameter along its axis, with larger diameter towards both ends and smaller diameter in between, the tether running over the roller is guided self-aligning without further lateral guides.
25

In a preferred embodiment of the invention, said roller comprises two concentric tubes, which are radially linked with each other by at least one flexible element, wherein the roller
30 is supported at the slider via said inner tube and wherein the roller engages with the tether via said outer tube. In this embodiment, the flexible element serves as a cushion for dampening peak forces acting on the system, for instance when the initially slack tether in the loop is tightened and abruptly
35 engages with the roller.

In a particular preferred embodiment of the invention, said damping device comprises a shock absorber, in particular a hydraulic shock absorber, for dissipating the kinetic energy of

- 5 -

the aircraft.

It is further preferred when said damping device comprises a pulley assembly for connecting the slider to the shock absorber, wherein the pulley assembly in particular comprises at least one cable and at least one pulley to guide said cable. It is one advantage of this embodiment that a pulley block assembly can provide for a transmission with non-unity ratio between the slider and the shock absorber, allowing for a relatively long distance of slider movement to correspond to a relatively short stroke of the shock absorber. It is another advantage that a pulley block assembly provides for some flexibility, which helps to damped peak forces .

In another preferred embodiment of the invention, the retention device comprises a positioning mechanism for positioning said slider at least in an extended position for maximum retention of the tether and/or in a parking position for no engagement of the roller with the tether.

The invention is described below, without restricting the general intent of the invention, based on exemplary embodiments with reference to the drawings. The drawings show in:

Fig. 1 schematically an exemplary embodiment of a launch and land system according to the invention;

Fig. 2 schematically a sectional side view side of the launch and land system in fig. 1;

Fig. 3 schematically a damping mechanism for a launch and land system according to the invention;

Fig. 4 schematically a sectional side view of an alternative launch and land system according to the invention;

Fig. 5a-c schematically an exemplary sequence for launching a tethered aircraft according to the invention;

- 6 -

Fig. 6a-d schematically an exemplary sequence for landing a tethered aircraft according to the invention;

5 Fig. 7a-c schematically an exemplary sequence for ground handling a tethered aircraft according to the invention; and

10 Fig. 8 schematically details of a landing gear for automated ground handling according to the invention .

In the drawings, the same or similar types of elements or respectively corresponding parts are provided with the same
15 reference numbers in order to prevent the elements from needing to be reintroduced.

Figure 1 shows an exemplary embodiment of a launch and land system 1 according to the invention. The launch and land system
20 1 comprises a platform 10. The platform 10 serves as a runway 12 for a tethered aircraft 90. The tether 92 is guided through the platform by means of a swivel mechanism 60, located essential in the center of the platform 10.

25 A slider 42 with a roller 46 is movable along rails 44 in order to capture the tether 92 close to the swivel mechanism 60, in order to form a loop of said tether 92. Rails 44 provide for an extended position for slider 42, where slider 42 is positioned at maximum distance from the swivel and thus retention of tether
30 92 is maximized. Rails 44 preferably also provide for a parking position for slider 42, where the roller 46 is disengagement from the tether 92.

A ramp 48 is provided to shield the slider 42 and the roller 46
35 from collisions with the landing gear 94 of the approaching aircraft 90 .

The direction of approach of the aircraft 90 is indicated by arrow 91.

- 7 -

On the far end of the runway 12, as seen by the approaching aircraft 90, there is provided for a target area 14, where the aircraft 90 will come to a halt after landing and deceleration.

5 The target area 14 is laterally bordered by guide rails 80. Said guide rails 80 restrict the aircraft 90 to remain inside the target area 14 when rolling across the platform 10 during ground handling .

10 The launch and land system 1 also comprises a catapult with two catapult arms 30 for launching the aircraft 90. For this purpose, each catapult arm 30 has a shuttle 34, respectively, which engage with the aircraft 90, for instance with the landing gear 94 of the aircraft, allowing to accelerate the aircraft 90
15 along the catapult arms 30.

Figure 2 shows a sectional view of the launch and land system 1 as shown in fig. 1 along the line A-A. As can be seen, the platform 10 comprises wheel sets 20 resting on a circular rail
20 22, thus allowing the platform 10 to rotate around a vertical axis, which is indicated by a dash-dotted line in fig. 2 .

Underneath the swivel mechanism 60, there is provided for a winch 62 with a winch drive 64 for the tether 92. By guiding the
25 tether 92 along the axis of rotation of the platform 10, it is possible to position the winch 62 and winch drive 64 stationary underneath the platform 10. However, those skilled in the art will appreciate that this is just an example and that the winch 62 and winch drive 64 can also be arranged to move with the
30 rotatable platform 10.

Also shown in fig. 2 is a damping mechanism 41 connected to the slider 42, which is constructed and designed for damping
movement of the slider 42 along the slider rails 44.

35

A catapult drive 32 is provided to drive the catapult shuttles 34 along the catapult arms 30, respectively. Those skilled in the art will appreciate that having one catapult drive 32 for two shuttles 34 of two catapult arms 30 is just an exemplary

- 8 -

embodiment. In alternative embodiments of the invention, a separate catapult drive 32 can be foreseen for each of the shuttles 34, while other embodiments may have just one catapult arm 30 with one shuttle 34 and one catapult drive 32.

5

The slider 42 with roller 46 and the damping mechanism 41 are part of a tether retention system, which is shown in detail in fig. 3. The slider 42 is movable along two slider rails 44. Inside the slider rails 44 run respective drive belts (not
10 visible) running over sheaves 54 on either ends of the slider rails 44 and driven by respective slider drives 55 for positioning of the slider 42 along the slider rails 44.

Similarly, the ramp 48 is movable along the slider rails 44 by
15 means of belts driven by respective ramp drives 56. In particular, the slider 42 and the ramp 48 can be positioned independently from each other. Those skilled in the art will appreciate that it is also possible within the scope of the invention to couple slider 42 and ramp 48 for simultaneous
20 movement by means of a common drive.

In addition to the mechanism for positioning the slider 42 as just described, the slider 42 is coupled to a shock absorber 50 via a pulley block assembly. For instance, the shock absorber 50
25 comprises a piston moving in a cylinder.

In the exemplary embodiment shown in fig. 3, the pulley block assembly comprises a dynamic block 51 arranged at the movable part of the shock absorber 50, a static block 52 being fixed in
30 position relative to shock absorber 50, and cables running over the pulley blocks 51, 52 and connected towards the slider 42. These cables are not shown entirely in fig. 3 for reasons of simplicity. The pulley block assembly serves as transmission between the slider 42 and the shock absorber 50, respectively.

35

Said transmission provides for non-unity ratio of distance moved by the slider 42 and the stroke of the shock absorber 50, for instance for a ratio of six to one. At the same time, the transmission introduces a certain flexibility between the slider

- 9 -

42 and the shock absorber 50, in order to dampen abrupt forces acting on the slider 42 and/or the roller 46 of the slider 42.

As the slider 42 moves along the slider rails rails 44, the
5 shock absorber 50 gets compressed. In order to uncompress the shock absorber 50, thereby moving the slider 42 backwards, a pulley block drive 53 acting on the dynamic pulley block 51 is provided.

10 As a matter of fact, the pulley block drive 53 and the slider drives 55 potentially counteract and block each other. It is therefore beneficial when at least one of said drives 53, 55 can be switched to minimum counter torque and/or can be mechanically disengaged from the slider 42, for instance by means of a clutch
15 and/or a torque limiter.

Figure 4 shows an alternative embodiment of the invention in a sectional view similar to the view depicted in fig. 2. In this embodiment, the damping mechanism 41 and the roller 46 are
20 positioned stationary with the winch 62 and the winch drive 64, respectively. This reduces the number of elements on the rotatable platform 10. In this embodiment, the swivel mechanism 60 is located close to the outer circumference of the platform 10 in order to make almost the full platform diameter available
25 for the runway 12. Sheaves 65 on the platform 10 and sheaves 66 arranged stationary are used to guide the tether 92 from the swivel mechanism 60 over the roller 46 to the winch 62.

Figures 5 a-c illustrate the sequence of automated launching
30 according to the invention of a tethered aircraft 90. Figure 5a shows the launch and land system 1 according to the invention as described in figs. 1-3 with the aircraft 90 position at one end of the runway 12, the landing gear 94 in engagement with the catapult shuttles 34 and the slider 42 positioned underneath the
35 aircraft 90. The aircraft 90 is accelerated by the catapult shuttles 34 to a velocity fast enough for the aircraft 90 to take off (fig. 5b), thereby pulling the tether 92 from the winch 62. Until now, the slider 42 remains essentially in the initial position, with the damping mechanism 41 eventually smoothing

- 10 -

out peak forces occurring while pulling out the tether 92.

Fig. 5c shows a top view of the launch and land system 1 according to the invention and of the flight path during launching sequence of the aircraft 90. As can be seen, the runway 12 has been aligned to start the aircraft 90 against the wind, which is indicated by arrow 5. Successively, the initial velocity of the aircraft 90 gained from the catapult start is used to fly an arc with increasing distance to the platform 10 towards the downwind side of the launch and land system 1. Once the aircraft 90 is downwind of the launch and land system 1, the winch 62 is driven by the winch drive 64 to pull the aircraft 90 towards the platform 10 against the wind 5, allowing the aircraft 90 to gain altitude.

Simultaneously, the slider 42 is moved along the slider rails 44, eventually crossing the swivel mechanism 60 in the center of the platform 10, thereby disengaging from the tether 92. This way, the roller 46 of slider 42 does not touch the tether 92 during normal flight operation, which beneficially avoids unnecessary wear on the roller 46 and/or the tether 92, respectively.

Once enough altitude is reached, the aircraft 90 is ready for normal flight operation, for instance for harvesting wind energy for production of electricity. Such operation is for instance described in detail in EP 2 631 468 A1, see in particular figs. 2a and 2b with corresponding description within this document.

During normal flight operation of the aircraft 10, the platform 10 or the runway 12, respectively, remain preferably aligned with the wind 5. It is further beneficial when the swivel mechanism 60 turns relative to the platform 10 in order to follow the flight pattern of the aircraft 90 to ensure straight guidance of the tether 92 through the platform 10, which minimizes wear on the tether 92.

The sequence of automated landing according to the invention of the tethered aircraft 90 is illustrated by figs. 6 a-d.

- 11 -

Figure 6a shows the initial approach of the aircraft 90 towards the launch and land system 1 according to the invention. During the approach, the tether 92 is reeled in by means of the winch 62 and winch drive 64, which shortens the free length of tether 92 between the aircraft 90 and the winch 62. During this phase, the tether 92 is for instance kept approximately straightened without exerting significant pulling force on the aircraft 90.

10 When the free length of tether 92 reaches a predetermined value, operation of the winch 62 is ceased and the winch 62 is locked in order to keep the free length of tether 92 constant. Alternatively, a break acting on the tether 92, which for instance is located at or close to the swivel mechanism 60, is closed, thereby holding tight on the tether 92. At this point in time, the slider is positioned at the extreme position for maximum retention of the tether 92, with the tether 92 running below the roller 46 of the slider 42. With the free length of tether 92 fixed and the aircraft 90 still moving, the tether 92 falls slack as the aircraft 90 moves over the slider 42. This phase of landing is depicted in fig. 6b.

When the aircraft 90 crosses the slider 42, either in flight or rolling on the runway 12, a loop is formed in the tether 92 extending from the swivel mechanism 60 over the roller 46 to the aircraft 90. The tether 92 in this loop is initially slack (cf. fig. 6b), as described above, and tensioned by the moving aircraft 90 (cf. fig. 6c).

30 As the tether 92 in the loop is straightened out, the moving aircraft 90 is exerting a pull on the the slider 42 via the roller 46, which is also acting on the shock absorber 50. Thus, the kinetic energy of the aircraft 90 is dissipated by the shock absorber 50. Regardless whether the aircraft 90 is still flying or already has touched ground and is rolling on the runway 12, the aircraft 90 is thereby decelerated until coming to a complete halt within the target 14 before the end of the runway 12 on the platform 10 (cf. fig. 6d).

- 12 -

After the aircraft 90 has been landed and decelerated to a stop within the target area 14, the invention also provides for automated ground handling of the aircraft 90, in particular for aligning and securing the aircraft 90 on top of the platform 10.

5

For this purpose, the platform 10 comprises guide rails 80 on either side of the target area 14. These guide rails 80 are arranged in a funnel-shaped way with the wider side of the funnel being oriented towards an edge of the platform 10 and the narrower side of the funnel being oriented towards the the swivel mechanism 60.

10

By using the winch 62 and winch drive 64 together with the tether 92, the aircraft 90 standing in the target area 14 is pulled backwards to the narrow side of the funnel, as illustrated by figs. 7 a-c. The aircraft 90 eventually is pulled against one of the guide rails 80. The guide rails 80 in particular provide a step or edge, constraining the aircraft 90 to within the target area 14.

15

20

For instance, as shown in fig. 8, the landing gear 94 of the aircraft 90 is equipped with guiding devices 97 adjacent to the wheels 95, which are suited to engage with the guide rails 80 in order to avoid the landing gear 94 to roll over said guide rails 80.

25

Due to the funnel shaped arrangement of the guide rails 80, the aircraft 90 is guided towards a defined position within the narrow side of the funnel shape of the target area 14 when pulled backwards by means of the tether 92. This way, the aircraft 90 is for instance brought to a target position with defined orientation directly above the swivel mechanism 60, where the aircraft 90 can either be secured for parking or can be loaded onto the catapult system for re-launch.

30

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- 13 -

References

	1	launch and land system
	5	wind
5	10	platform
	12	runway
	14	target area
	20	wheel set
	22	circular rail
10	30	catapult arm
	32	catapult drive
	34	catapult shuttle
	41	damping mechanism
	42	slider
15	44	slider rail
	46	roller
	48	ramp
	50	shock absorber
	51	dynamic pulley block
20	52	stationary pulley block
	53	pulley block drive
	54	sheave
	55	slider drive
	56	ramp drive
25	60	swivel mechanism
	62	winch
	64	winch drive
	65	sheave
	66	sheave
30	80	guide rail
	90	aircraft
	91	direction of approach
	92	tether
	94	landing gear
35	95	wheel
	97	guiding device

- 14 -

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5 Method for landing a tethered aircraft and launch and land
system

Claims

10

1. Method for landing a tethered aircraft, comprising the
steps of

15

- approaching a ground site with said aircraft, thereby
shortening free length of tether between the aircraft
and the ground site until said free length of tether
reaches a predetermined value,
- further approaching the ground site with said aircraft,
thereby keeping free length of tether fixed at said
predetermined value,
- retaining the tether to form a loop, wherein the loop
is tensed and tightened by the moving aircraft, and
- damping said tightening of said loop in order to
decelerate the aircraft until it stands at the ground
site.

25

2. Method according to claim 1,
characterized in that
said value for fixed free length of tether is predetermined
such that the decelerated aircraft comes to stand within a
predetermined target area at said ground site.

30

3. Method according to claim 1 or 2,
characterized in that
the aircraft approaches the ground site against the wind
and/or that a runway for the aircraft at said ground site
is oriented to align with the direction of approach of the
aircraft.

35

- 15 -

4. Launch and land system for a tethered aircraft comprising a runway for the aircraft, a winch for the tether, and a retention system for forming a loop of the tether between the winch and the aircraft approaching the runway, wherein said retention system features a damping device for damping a tightening of said loop caused due to movement of the aircraft upon approach and landing in order to decelerate said aircraft.
5. Launch and land system according to claim 4, characterized in that the retention device comprises a movable slider with a roller, wherein an axis of said roller is aligned essentially horizontal and across a direction of movability of said slider, wherein in particular said direction of movability of the slider is aligned with the runway.
6. Launch and land system according to claim 5, characterized in that said roller has a varying diameter along its axis, with larger diameter towards both ends and smaller diameter in between .
7. Launch and land system according to claim 5 or claim 6, characterized in that said roller comprises two concentric tubes, which are radially linked with each other by at least one flexible element, wherein the roller is supported at the slider via said inner tube and wherein the roller engages with the tether via said outer tube.
8. Launch and land system according to one of claims 4 to 7, characterized in that

- 16 -

said damping device comprises a shock absorber, in particular a hydraulic shock absorber.

- 5 9. Launch and land system according to claim 8,
characterized in that
said damping device comprises a pulley assembly for
connecting the slider to the shock absorber, wherein the
pulley assembly in particular comprises at least one cable
10 and at least one pulley to guide said cable.
10. Launch and land system according to one of claims 4 to 9,
characterized in that
15 the retention device comprises a positioning mechanism for
positioning said slider at least in an extended position
for maximum retention of the tether and/or in a parking
position for no engagement of the roller with the tether.

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1/7

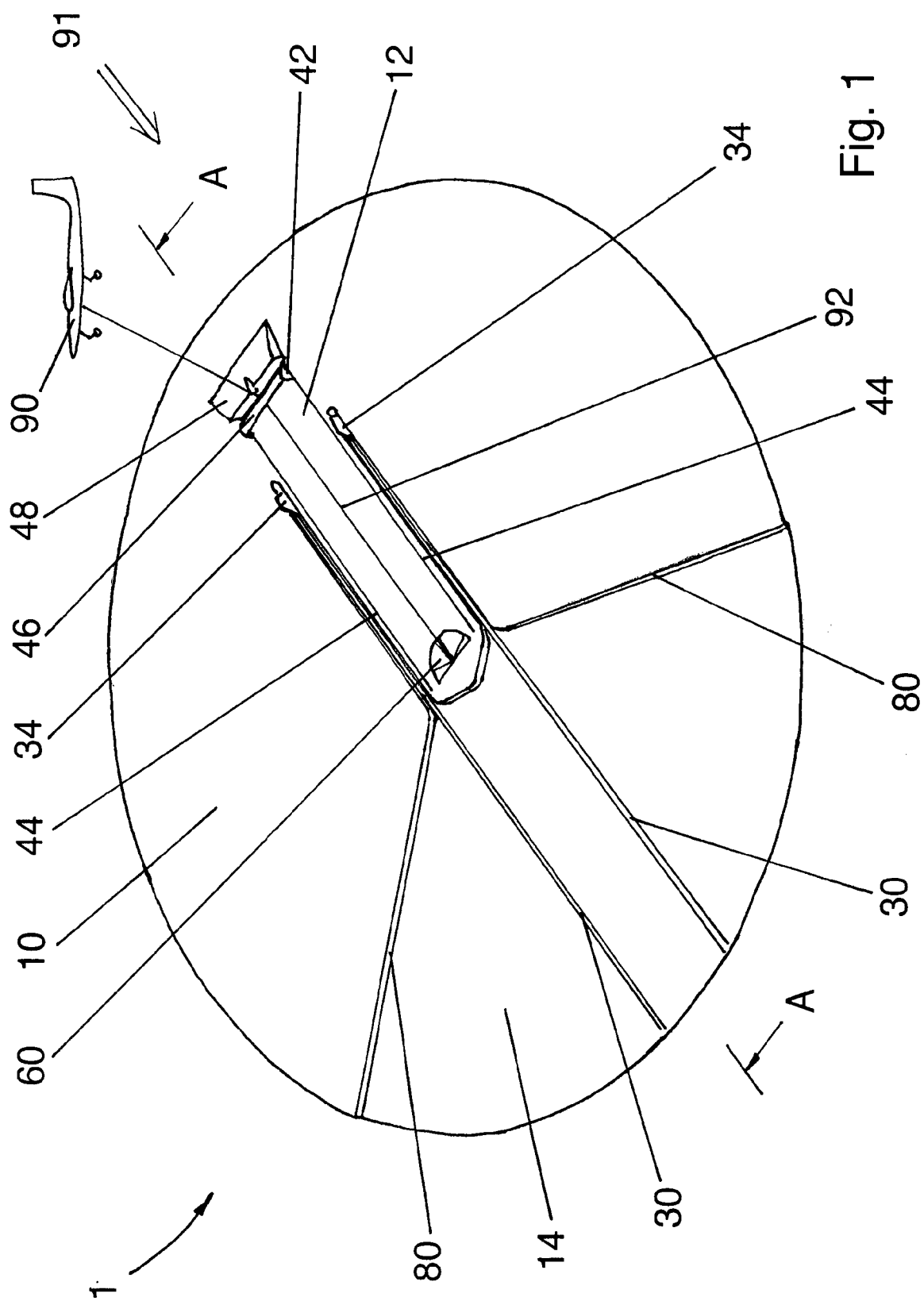
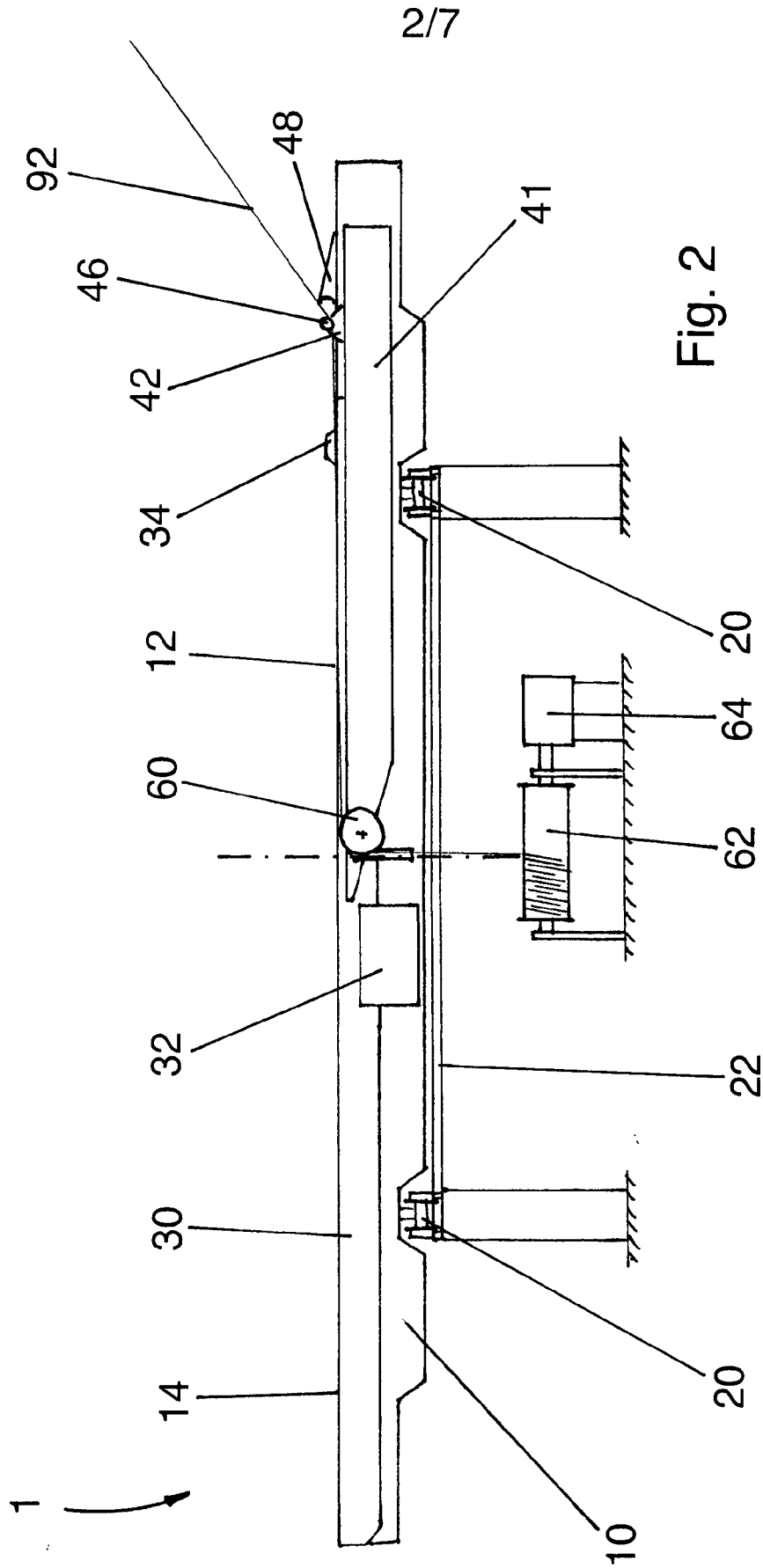
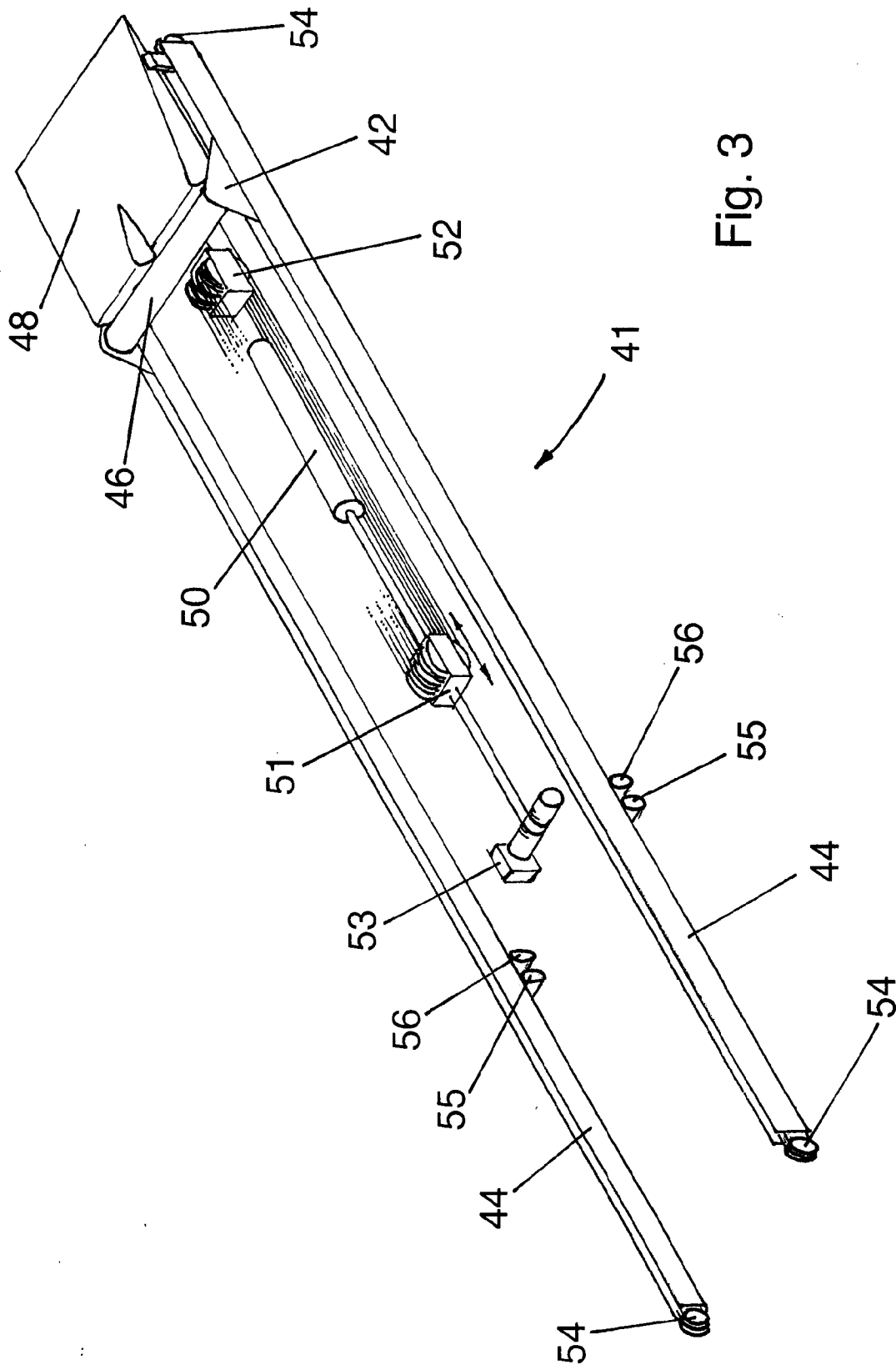


Fig. 1



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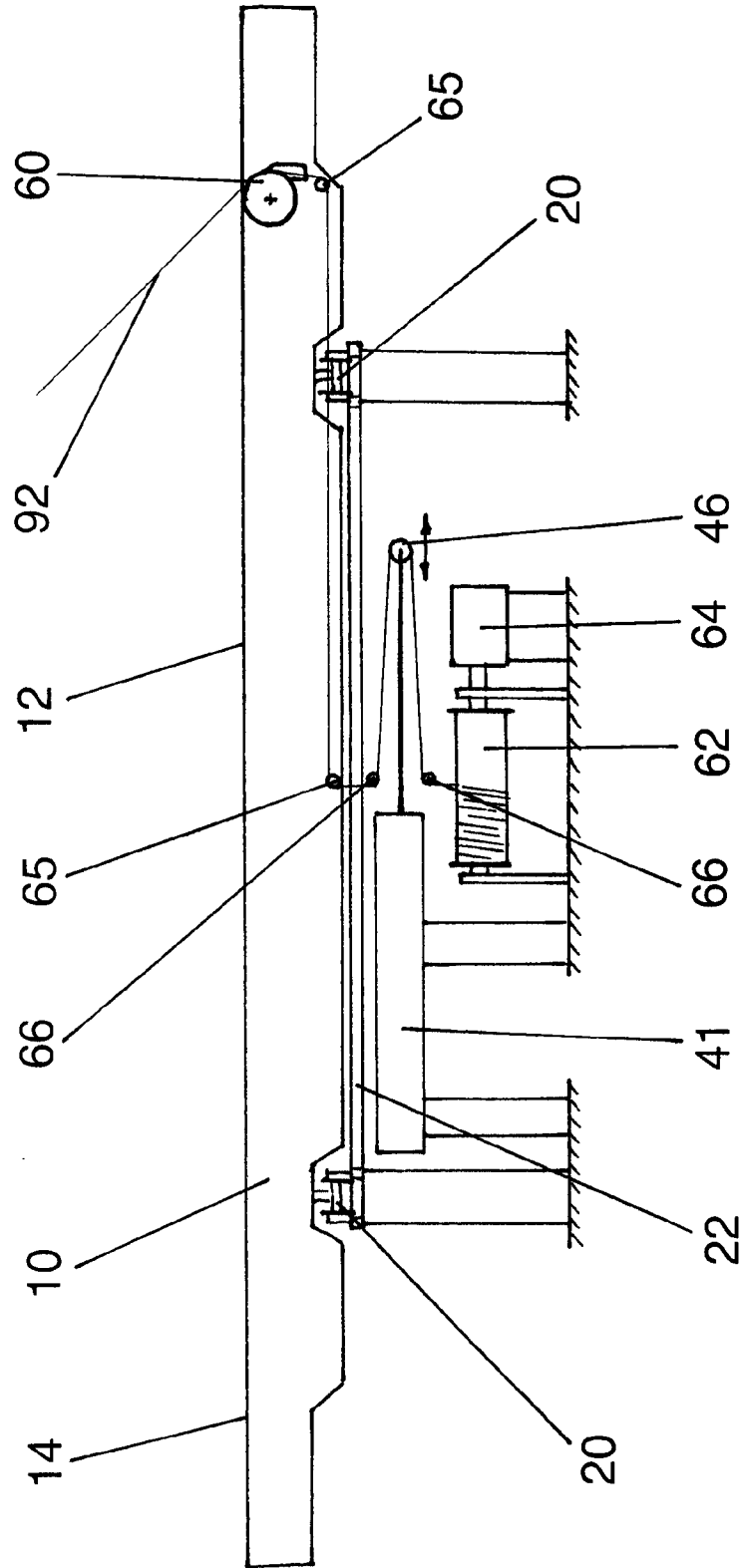
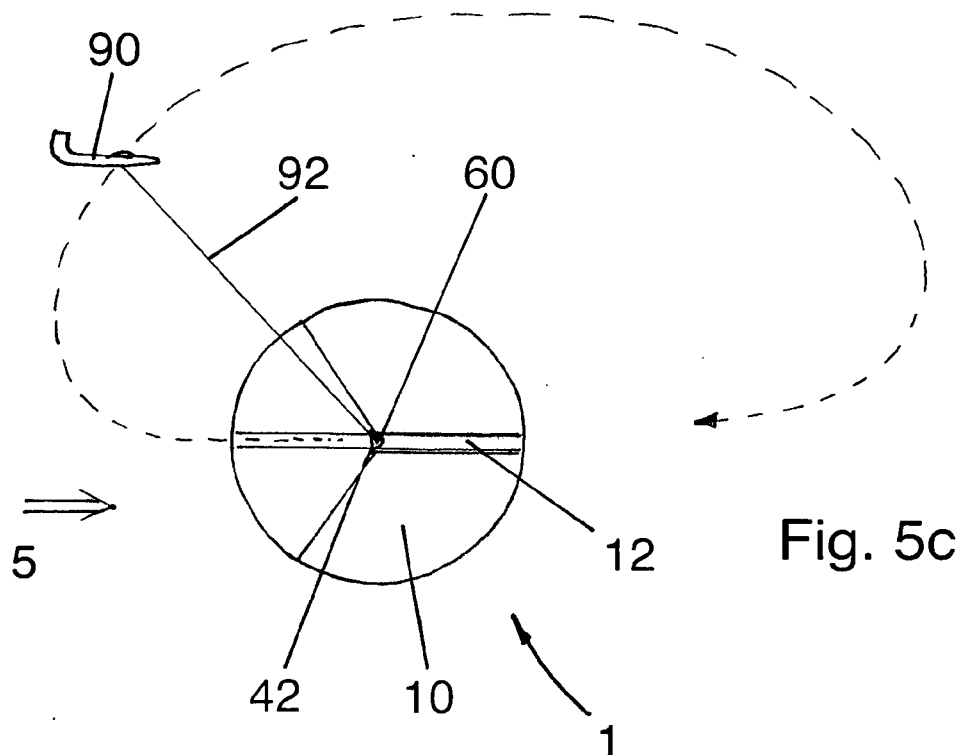
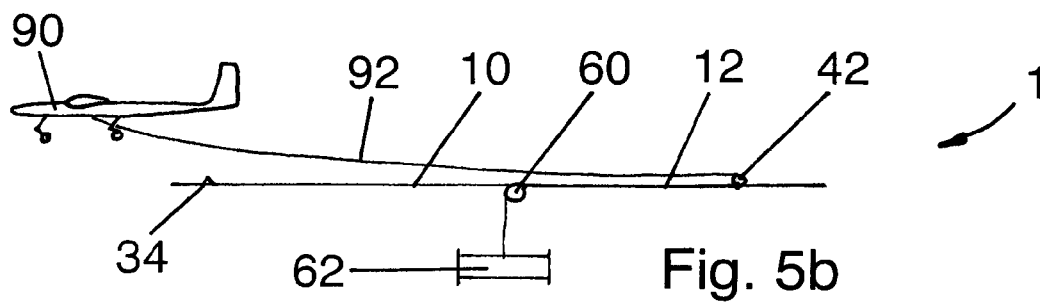
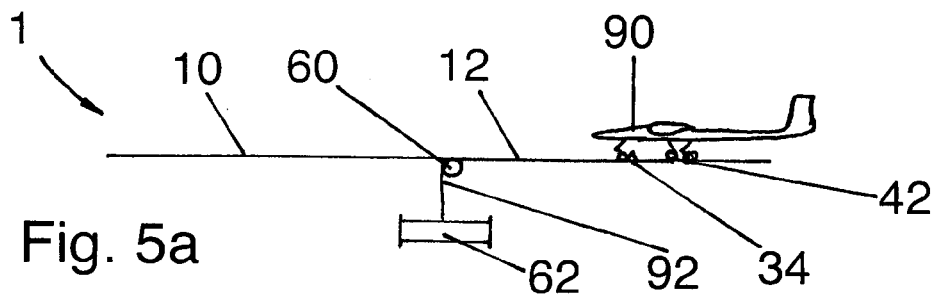
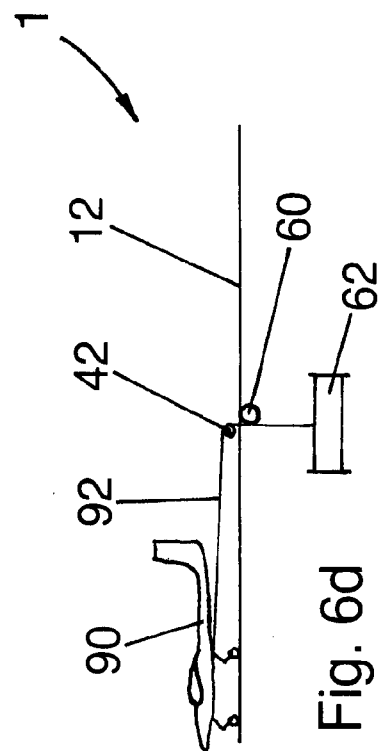
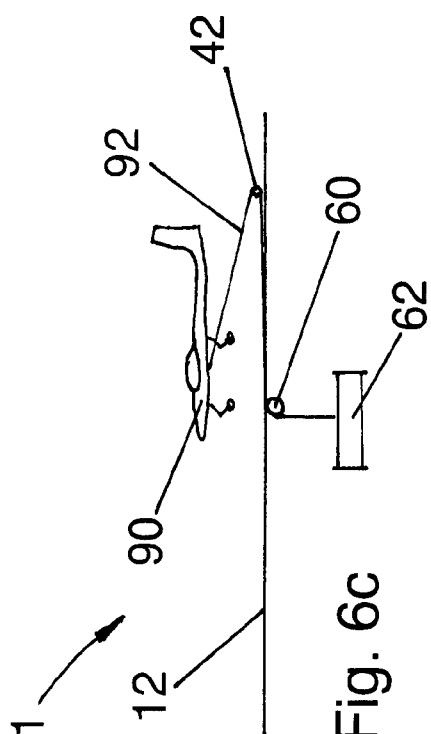
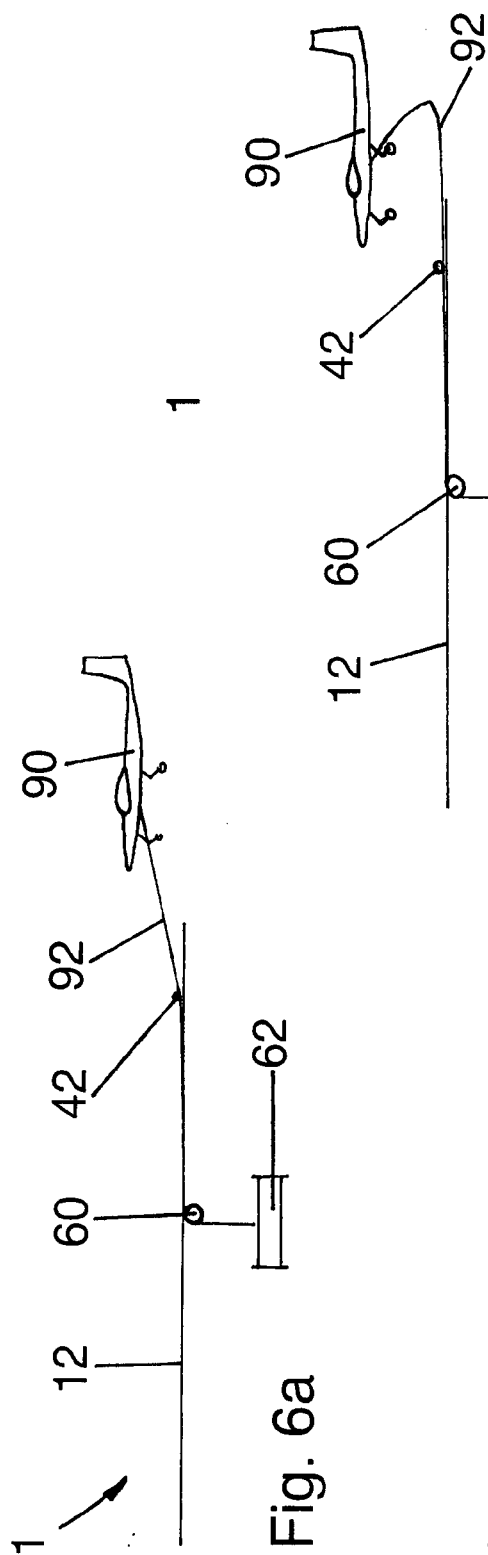


Fig. 4

5/7





7/7

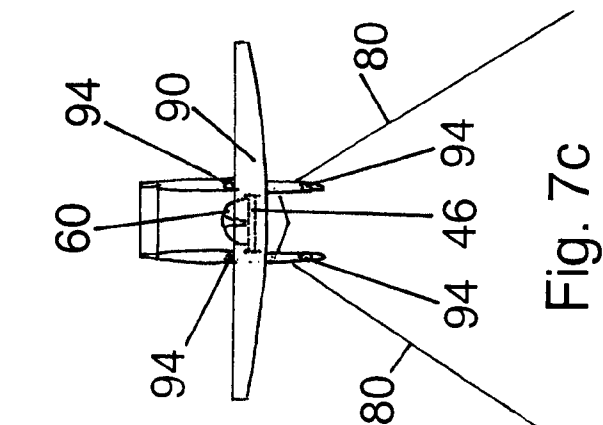


Fig. 7c

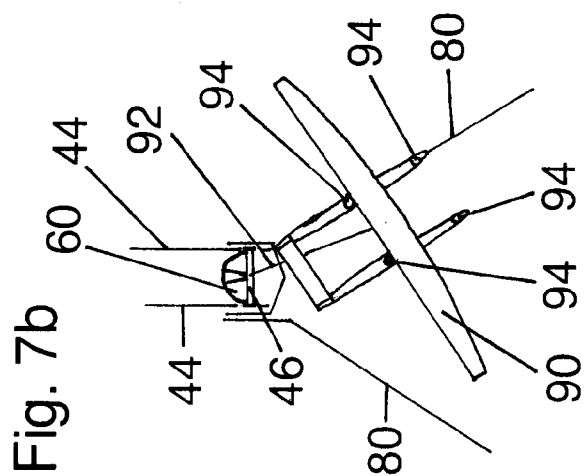


Fig. 7b

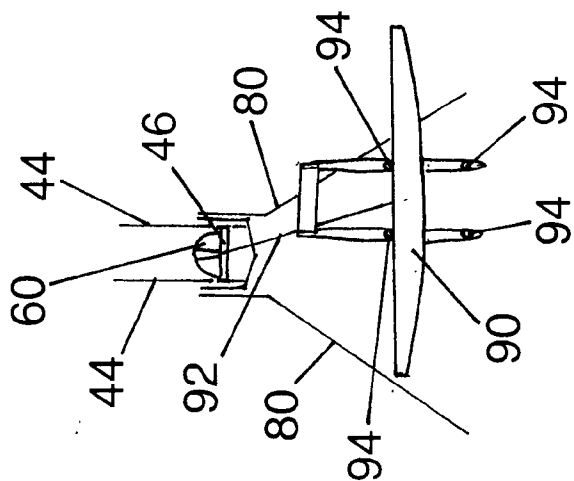


Fig. 7a

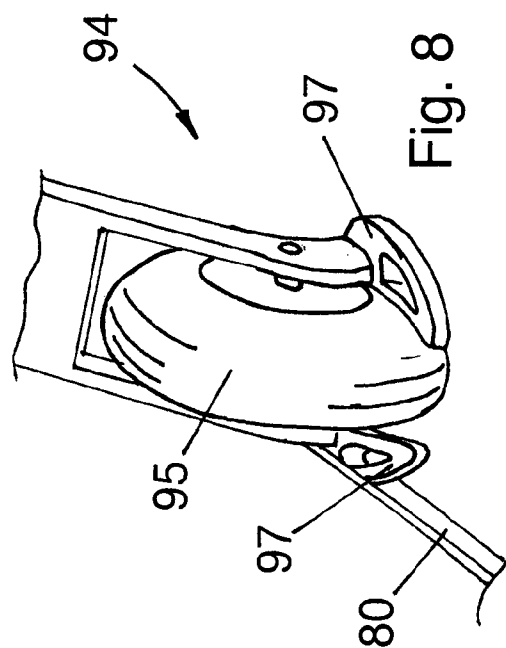


Fig. 8

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2018/059308

A. CLASSIFICATION OF SUBJECT MATTER INV. B64C39/02 B64F1/04 B64F1/08 ADD. B64F1/06		
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 B64F		
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) 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	US 2012/187243 AI (GOLDIE JAMES [US] ET AL) 26 July 2012 (2012-07-26)	4,5 ,8-10
Y	paragraph [0014] - paragraph [0047]	6
A	figures 1-15 -----	7
Y	US 8 421 257 B2 (CHERNYSHOV DIMITRI [US]) 16 April 2013 (2013-04-16)	6
A	column 5, line 6 - column 9, line 38 figures 1-6c -----	4
A	US 4 790 497 A (YOFFE MEIR [IL]) 13 December 1988 (1988-12-13) column 1, line 36 - column 4, line 10 figures 1-4a -----	1-3
A	DE 43 09 751 AI (IRLINGER GERHARD [DE]) 13 October 1994 (1994-10-13) the whole document -----	1-3
-/- .		
<div style="display: flex; justify-content: space-between;"> <input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex. </div>		
<div style="display: flex;"> <div style="flex: 1;"> <p>* Special categories of cited documents :</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier application or patent but published on or after the international filing date</p> <p>"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)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="flex: 1;"> <p>"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</p> <p>"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</p> <p>"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</p> <p>"&" document member of the same patent family</p> </div> </div>		
Date of the actual completion of the international search	Date of mailing of the international search report	
2 July 2018	18/07/2018	
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Gluck, Michael	

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2018/059308

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2011/121557 A2 (KITENERGY S R L [IT] ; MI LANESE MARIO [IT] ; FAGIANO LORENZO [IT] ; GERLE) 6 October 2011 (2011-10-06) page 6, line 30 - page 13, line 1 figures 1-5 -----	4-10
A	WO 2013/156680 A1 (ALULA ENERGY OY [FI]) 24 October 2013 (2013-10-24) the whole document -----	1-10
A	CN 103 121 509 A (HUANG SHANGLI) 29 May 2013 (2013-05-29) paragraph [0046] - paragraph [0150] figures 1-6 -----	4,8,9
A	US 2 969 944 A (KNECHT FORREST E) 31 January 1961 (1961-01-31) column 1, line 38 - column 3, line 5 figures 1,2 -----	4,8,9
A	US 7 504 741 B2 (SKYSAI LS GMBH & CO KG [DE]) 17 March 2009 (2009-03-17) column 10, line 1 - column 11, line 22 figures 1-3 -----	1-4

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2018/059308

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2012187243	A1	26-07-2012	NONE
US 8421257	B2	16-04-2013	NONE
US 4790497	A	13-12-1988	NONE
DE 4309751	A1	13-10-1994	NONE
WO 2011121557	A2	06-10-2011	CA 2794344 A1 06-10-2011 CN 103038501 A 10-04-2013 DK 2553262 T3 13-04-2015 EP 2553262 A2 06-02-2013 ES 2534776 T3 28-04-2015 IT 1399971 B1 09-05-2013 JP 5841124 B2 13-01-2016 JP 2013527893 A 04-07-2013 RU 2012146377 A 10-05-2014 US 2013078097 A1 28-03-2013 WO 2011121557 A2 06-10-2011
WO 2013156680	A1	24-10-2013	NONE
CN 103121509	A	29-05-2013	NONE
US 2969944	A	31-01-1961	NONE
US 7504741	B2	17-03-2009	AU 2007234013 A1 11-10-2007 CA 2645355 A1 11-10-2007 CN 101421512 A 29-04-2009 DE 202006005389 U1 02-08-2007 DK 2004991 T3 21-01-2013 EP 2004991 A1 24-12-2008 HK 1122088 A1 19-09-2013 KR 20090005120 A 12-01-2009 NZ 571316 A 12-01-2012 US 2007228738 A1 04-10-2007 WO 2007112993 A1 11-10-2007