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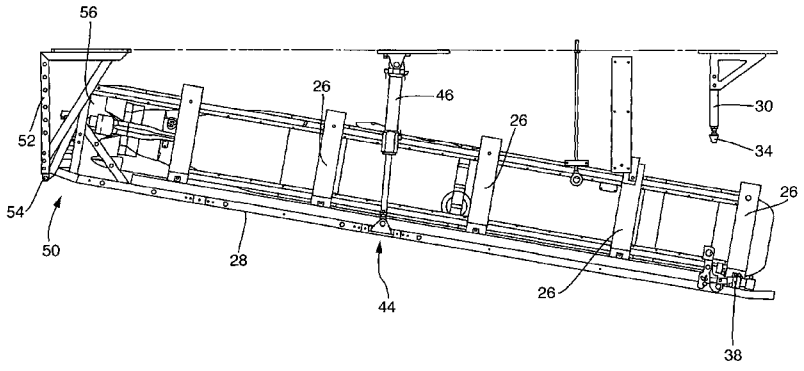
— *with international search report (Art. 21(3))*

(54) **Title**: UNMANNED UNDERWATER VEHICLE PAYLOAD LAUNCH

Fig. 3



(57) **Abstract**: There is described an unmanned underwater vehicle (UUV) and a launch mechanism mounted within/upon such a UUV. The invention provides a mechanism for launching a payload from a maritime vessel comprising: first, second and third connection members (22a, 22b, 22c), each configured to be connected to a roof portion of a payload bay of the vessel; guide means (24,26,28) configured to move between a first, stowed position, substantially parallel to a longitudinal axis of the vessel and a second, deployed position orientated at an angle to the longitudinal axis; a locking strut (30), depending from a first connection member (22a), located substantially perpendicular therefrom and extending to a support surface (28) of the guide means in its stowed position; an extendable strut (44), connected between a second connection member (22b) and a mid- section of the support surface; and a clamping assembly (50), depending from a third connection member (22c), the clamping assembly configured to provide a pivot point (54) for preventing relative translational movement of the guide means whilst permitting rotational movement of the guide means relative to the vessel. A method of launching a payload from a maritime vessel is also described.

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UNMANNED UNDERWATER VEHICLE PAYLOAD LAUNCH

The present invention relates to unmanned underwater vehicles (UUV), in particular to a launch mechanism mounted within/upon such a UUV for launching a payload from the UUV.

Conventionally payloads of the type and size described herewithin are launched from other types of vehicles. For example, from a helicopter, the payload is releasably connected to a lower most portion of the helicopter and the releasable connections are retracted/activated upon instruction from within the vehicle. The payload is then dropped into the water using a parachute to control the speed of descent and orientation. Upon entering the water a cavity within the payload experiences water ingress which, in turn, activates a battery. As the payload powers up a propulsion system is activated and begins to rotate The parachute is connected to the payload via a spin off sleeve and as the propulsion system becomes active and undergoes several revolutions the sleeve, and therefore the parachute become detached from the payload and are discarded in the water.

Deployment from a ship is very similar, in that the payload is dropped from a cradle using a parachute connected to the aft of the payload to control the speed of descent and orientation of the payload.

Underwater deployment of payloads, typically larger than those considered here, are effected by submarines. In a first example the payload is ejected from a tube within the vessel using a ram discharge, e.g. an air ram or a water ram, the latter being less detectable. Activation of the payload's propulsion system does not occur until after deployment. Alternatively, a "swim out system" is employed, the propulsion system is activated within the tube and the payload drives itself out of the tube. However, substantial clearance is required about the payload to avoid build up of a vacuum between the payload and a sealed end of the tube. Such a vacuum, severely inhibits forward motion of the payload and could, in the extreme prevent deployment thereof.

It is desirable to achieve launch of such a payload in a less detectable manner than is presented by the aforementioned launch mechanisms.

According to a first aspect, the present invention provides a mechanism for launching a payload from a maritime vessel comprising:

first, second and third connection members, each configured to be connected to a roof portion of a payload bay of the vessel;

guide means configured to move between a first, stowed position, substantially parallel to a longitudinal axis of the vessel and a second, deployed position orientated at an angle to the longitudinal axis;

a locking strut, depending from a first connection member, located substantially perpendicular therefrom and extending to a support surface of the guide means in its stowed position;

an extendable strut, connected between a second connection member and a mid-section of the support surface; and

a clamping assembly, depending from a third connection member, the clamping assembly configured to provide a pivot point for preventing relative translational movement of the guide means whilst permitting rotational movement of the guide means relative to the vessel.

By providing a launching mechanism having a guide means that can be rotatably deployed underwater from the maritime vessel within which it is installed, a payload can be successfully launched from a compact vessel thus reducing the optically and acoustically visible footprint of a payload launch capable vehicle. A corresponding reduction in detectability thereof is achieved.

The clamping assembly may comprise clamping means for preventing longitudinal movement of a payload received by the mechanism. The mechanism may comprise a controller, associated with the maritime vessel within which the mechanism is installed, the controller may be configured to operate the mechanism in a sequence dependent on a mode of operation to be achieved.

The locking strut may comprise a locking member; a clamping member, releasably engaged with the locking member; and an actuator, configured to control the position of the clamping member to thereby effect engagement with the locking member or release thereof.

The guide means may comprise a plurality of longitudinally extending rails and longitudinally spaced rings, the rings may be configured to receive and retain a payload by inhibiting lateral motion thereof.

The extendable strut may comprise an actuator for changing the length of the strut upon receipt of an instruction from the controller. The extendable strut may comprise first and second actuators each respective actuator may represent a respective extendable strut. The, or each, actuator may be a fluidic actuator or an electric actuator. Further, each actuator may have a sensor associated therewith, each sensor may be configured to detect an extent of lengthening of the, or each, strut.

According to a second aspect, the present invention provides an unmanned underwater vehicle, comprising a launch mechanism of the aforementioned type.

The launch mechanism may be installed within the vehicle such that it is configured to launch a payload past a fore portion of the vehicle. Alternatively, the launch mechanism may be installed such that it is configured to launch a payload past an aft portion of the vehicle.

According to a third aspect, the present invention provides a method of launching a payload from a maritime vessel having a launch mechanism comprising first, second and third connection members, each configured to be connected to a roof portion of a payload bay of the vessel;

guide means configured to move between a first, stowed position, substantially parallel to a longitudinal axis of the vessel and a second, deployed position orientated at an angle to the longitudinal axis;

a locking strut, depending from a first connection member, located substantially perpendicular therefrom and extending to a support surface of the guide means in its stowed position;

an extendable strut, connected between a second connection member and a mid-section of the support surface; and

a clamping assembly, depending from a third connection member, the clamping assembly configured to provide a pivot point for preventing relative

translational movement of the guide means whilst permitting rotational movement of the guide means relative to the vessel, the method comprising the steps of:

releasing a locking strut;

deploying the guide means;

arming a payload;

severing a data link between the payload and the vessel; and

activating a propulsion mechanism of the payload, thereby releasing and launching the payload.

The method may comprise the step of removing a battery port of the payload thus activating the propulsion mechanism of the payload. The deploying step may comprise the steps of confirming that the locking strut has been released; confirming the clamping mechanism is active; extending the extendable struts; and confirming that the guide means has been deployed evenly.

The present invention is now described in greater detail, with reference to the accompanying drawings, in which:

Figure 1 illustrates a UUV having a launch mechanism mounted there within;

Figure 2 illustrates the launch mechanism of Figure 1 in a first, stowed position; and

Figure 3 illustrates the launch mechanism of Figures 1 and 2 in a second, deployed position.

Figure 1 illustrates a schematic representation of an unmanned underwater vehicle (UUV) 5 configured for use with a payload 10. The UUV 5 comprises a payload bay 12, having a launch mechanism 14 mounted therewithin. In this embodiment, the payload bay 12 is accessed through doors 16 of a closing plate mounted flush with a lowermost surface 18 of the UUV 5. A greater level of detail of the launch mechanism 14 is shown in Figures 2 and 3.

The launch mechanism 14 comprises a framework assembly 20 having a plurality of connection members 22a, 22b, 22c for connecting the launch mechanism 14 to a parent vehicle such as a UUV 5. The connection members 22a, 22b, 22c are, preferably, secured to an upper region of the payload bay 12. The framework assembly 20 further comprises a guide means for receiving the payload 10. The guide means comprises a plurality of longitudinally extending rails 24 together with a number of longitudinally spaced guide rings 26 for receiving the payload 10. A support surface 28 or closing plate is provided at a lowermost portion of the framework assembly 20. In use, support surface 28 forms an outer skin of the UUV 5 and is configured to lie flush with surface 18 to present a substantially smooth outer skin of the UUV 5 prior to deployment of the payload 10, i.e. when the framework assembly 20 is in a stowed position. The payload 10 is, therefore, retained internally within the parent vehicle, UUV 5.

In the stowed state, as illustrated in Figure 2, support surface 28 lies substantially parallel to a longitudinal axis of the UUV 5. Struts extend from each respective connection member 22a, 22b, 22c to the support surface 28.

A locking strut 30 is provided at a fore end of the assembly 20. Locking strut 30 is connected at a proximal end thereof to the first connection member 22a. A distal portion of the locking strut 30 comprises a locking mechanism 32 which serves to prevent relative movement between support surface 28 and connection member 22a to thereby retain the assembly 20 in the stowed position and thereby retain the payload 10 within the UUV 5. The locking mechanism 32 comprises a locking member 34 configured to engage with a clamping member 36. Clamping member 36 is connected to a first actuation means 38 to enable automatic unlocking of the locking mechanism 32 and thereby release locking strut 30. A first sensor 40 is associated with the locking mechanism 32 to detect whether locking member 34 is engaged with clamping member 36 at any particular time. First sensor 40 is illustrated in the embodiment proximate to clamping member 36. The sensor can be mounted at other locations on the locking mechanism 32 or, alternatively, remotely therefrom.

A deployment strut 44 is located at an approximate mid-station along the longitudinal length of the framework assembly 20. The deployment strut 44 comprises an actuator 46 which is configured to extend and retract the strut 44, thereby lowering support surface 28 together with rails 24 and guide rings 26 such that it no longer lies substantially parallel to the longitudinal axis of the UUV 5 but rather is angled relative to the axis by an angle of approximately 15 degrees as illustrated in Figure 3. Angles in the range between 10 and 30 degrees are also used in deployment. A second sensor (not shown) is provided in combination with the actuator 46 to detect the extent of lengthening of strut 44 and, consequently, the angle to which support surface 28 has been deployed. This second sensor may be located adjacent to the actuator 46 or, alternatively, remotely therefrom. For example it may be mounted on connection member 22b and detect an approximate distance to a corresponding portion of the support surface 28 located therebelow.

A rear strut assembly 50 comprises at least one further, substantially vertical, strut 52 at a rearmost portion of the framework assembly 20. The rear strut assembly 50 effectively provides a hinge point 54 from which surface 28 is pivoted. Rear strut assembly 50 comprises a clamping mechanism 56 which serves to retain payload 10 within the launch mechanism 14 in a longitudinal sense until such time as it becomes necessary to deploy the payload 10. A third sensor (not shown) is provided within the clamping mechanism 56 to detect whether the payload 10 is currently retained by the clamping mechanism 56 or whether it has been released into the water. This third sensor may be located adjacent the clamping mechanism 56 or, alternatively, remotely therefrom. First, second and third sensors are any one or more of the type selected from magnetic sensors, optical sensors for example an interrupted beam sensing device, physical trip switch means.

Each strut 30, 44, 52 may, as described above, be provided in isolation but is, preferably, provided as a respective pair of struts 30a, 30b, 44a, 44b, 52a, 52b working in combination with one another. For any such pair of struts, say deployment struts 44a, 44b, the struts are spaced laterally from one

another. The space defined between each pair of struts being configured to accommodate a lateral dimension of the payload 10.

In operation, a particular sequence of actions/events associated with the payload 10 is adhered to. The sensors 40 are provided to facilitate this sequence and to determine whether the sequence should continue/is successful/is progressing as expected. The sequence changes dependent on the desired results to be achieved e.g. (i) deployment of the payload 10; (ii) jettisoning of the payload 10; and (iii) retraction of the payload 10.

In a straightforward deployment mode (i) an instruction is received by the launch mechanism 14 to release the locking mechanism 32. The clamping member 36 disengages from the locking member 34 by activating actuator 38. The first sensor 40 detects whether the locking mechanism 32 has, indeed, been released and reports this back to a controller of the launch mechanism 14.

The third sensor, clamping sensor, associated with the clamping mechanism 56, then confirms that the payload 10 is securely connected to the framework assembly 20 of the launch mechanism 14.

Once the confirmation has been received from the clamping sensor, the launch mechanism 14 instructs the, or each, actuator 46a, 46b to lengthen deployment struts 44a, 44b and thereby effect deployment of support surface 28 to an appropriate angle. Second sensors are associated with each deployment strut 44a, 44b to detect the extent of the lengthening of the, or each, respective strut 44a, 44b and thereby ensure that the payload is evenly deployed. A difference in the lengthening of respective struts 44a, 44b indicates that the deployment of support surface 28 has become skewed. If such inappropriate deployment of surface 28 does occur, the payload 10 may become stuck within the mechanism 14. Once deployment struts 44a, 44b are fully extended the launch mechanism 14 would be as depicted in Figure 3. At this stage, payload 10 is ready for deployment and the next stage of the sequence is effected by a control mechanism associated with the framework assembly 20.

Three particular events can be triggered by the control mechanism:

Event 1 – a standard safety and arming process associated with the payload 10.

Event 2 – disconnection a datalink between the UUV 5 and the payload 10.

Event 3 – removal of a battery port cover to expose a battery of the payload 10 to seawater which serves as an electrolyte and thereby activates the battery.

The control mechanism can be activated in any particular order to effect one or more of the events listed above. The choice of sequence effected by the control mechanism is dependent on the results to be achieved.

If the payload 10 is to be deployed then each of the Events 1, 2, 3 must be effected in that order.

The first event removes any safety mechanism inherent with the payload 10 and arms the system. The second event is then triggered by the control mechanism whereby the datalink is severed or disconnected so that no further information can be passed from the UUV 5 to the payload 10.

It is important that the third event, namely the initiation of the propulsion system is the final event. In an embodiment the initiation of the propulsion system is by removal of the battery port cover this enables a cavity associated with the battery to fill with sea water which, in turn, activates the power source and initiates the propulsion system. Such ingress is preferably rapid and uniform to initiate/activate the propulsion system in as efficient a manner as possible. The open structure of the framework assembly 20 permits this rapid ingress of sea water. As the propulsion system undergoes a number of revolutions, a spin-off sleeve (as used when a parachute is connected to the payload) is released or disengaged from the clamping mechanism 56 to thereby launch the payload 10. The propulsion system is already rotating at this stage and the payload 10 is, therefore, urged out of the launch mechanism 14 and subsequently driven away from the UUV 5. The launch mechanism 14 may be configured as illustrated to launch the payload 10 forwards from the vehicle, i.e. past a fore section of the vehicle 5. Alternatively, the launch mechanism 14

may be configured to launch the payload 10 rearwards from the vehicle, i.e. past an aft section of the vehicle 5.

An alternative mode of operation would be simply to jettison the payload 10 either for self destruction or for recovery at a later time. Such circumstances may arise when the UVV 5 must rapidly return to a base station from which it was launched. In this alternative mode of operation the sequence of the control mechanism could be altered to by-pass the first event. The second event would still occur but the third event would be avoided. The payload 10 would be disengaged from the clamping assembly 56 by means of a severing device in the clamping assembly 56, such as a release catch or an explosive bolt. If a decision is taken to not deploy the payload 10 after the surface 28 has been lowered, the launch mechanism 14 can be retracted into the payload bay 12 of the UUV 5 for either subsequent deployment or for returning to the base station.

CLAIMS

1. A mechanism for launching a payload from a maritime vessel comprising:

first, second and third connection members, each configured to be connected to a roof portion of a payload bay of the vessel;

guide means configured to move between a first, stowed position, substantially parallel to a longitudinal axis of the vessel and a second, deployed position orientated at an angle to the longitudinal axis;

a locking strut, depending from a first connection member, located substantially perpendicular therefrom and extending to a support surface of the guide means in its stowed position;

an extendable strut, connected between a second connection member and a mid-section of the support surface; and

a clamping assembly, depending from a third connection member, the clamping assembly configured to provide a pivot point for preventing relative translational movement of the guide means whilst permitting rotational movement of the guide means relative to the vessel.

2. A launch mechanism according to Claim 1, wherein the clamping assembly comprises clamping means for preventing longitudinal movement of a payload received by the mechanism.

3. A launch mechanism according to Claim 1 or Claim 2, comprising a controller, associated with the maritime vessel within which the mechanism is installed, the controller being configured to operate the mechanism in a sequence dependent on a mode of operation to be achieved.

4. A mechanism according to any preceding claim, wherein the locking strut comprises:

a locking member;

a clamping member, releasably engaged with the locking member; and

an actuator, configured to control the position of the clamping member to thereby effect engagement with the locking member or release thereof.

5. A mechanism according to any preceding claim, wherein the guide means comprises a plurality of longitudinally extending rails and longitudinally spaced rings, the rings being configured to receive and retain a payload by inhibiting lateral motion thereof.

6. A mechanism according to any preceding claim, wherein the extendable strut comprises an actuator for changing the length of the strut upon receipt of an instruction from the controller.

7. A mechanism according to Claim 6, wherein the extendable strut comprises first and second actuators.

8. A mechanism according to Claim 6 or Claim 7, wherein the, or each, actuator is a fluidic actuator or an electric actuator.

9. A mechanism according to any of Claims 6 to 8, wherein each actuator has a sensor associated therewith, each sensor being configured to detect an extent of lengthening of the, or each, strut.

10. An unmanned underwater vehicle, comprising a launch mechanism according to any preceding claim.

11. A vehicle according to Claim 10, wherein the launch mechanism is installed so that it is configured to launch a payload past a fore portion of the vehicle.

12. A vehicle according to Claim 10, wherein the launch mechanism is installed so that it is configured to launch a payload past an aft portion of the vehicle.

13. A vehicle according to any preceding claim, wherein the launch mechanism comprises a framework assembly.

14. A method of launching a payload from a maritime vessel having a launch mechanism comprising first, second and third connection members, each configured to be connected to a roof portion of a payload bay of the vessel;

guide means configured to move between a first, stowed position, substantially parallel to a longitudinal axis of the vessel and a second, deployed position orientated at an angle to the longitudinal axis;

a locking strut, depending from a first connection member, located substantially perpendicular therefrom and extending to a support surface of the guide means in its stowed position;

an extendable strut, connected between a second connection member and a mid-section of the support surface; and a clamping assembly, depending from a third connection member, the clamping assembly configured to provide a pivot point for preventing relative translational movement of the guide means whilst permitting rotational movement of the guide means relative to the vessel,

the method comprising the steps of:

releasing a locking strut;

deploying the guide means;

arming a payload;

severing a data link between the payload and the vessel; and activating a propulsion mechanism of the payload, thereby releasing and launching the payload.

15. A method according to Claim 14, further comprising the step of removing a battery port of the payload to activate a propulsion mechanism of the payload.

16. A method according to Claim 14 or Claim 15, wherein the deploying step comprises the steps of:-

confirming that the locking strut has been released;

confirming the clamping mechanism is active;

extending the extendable struts; and

confirming that the guide means has been deployed evenly.

17. A mechanism for launching a payload substantially as described herein with reference to the accompanying drawings.

18. An unmanned underwater vehicle substantially as described herein with reference to the accompanying drawings.

19. A method of launching a payload from a maritime vessel substantially as described herein with reference to the accompanying drawings.

Fig. 1

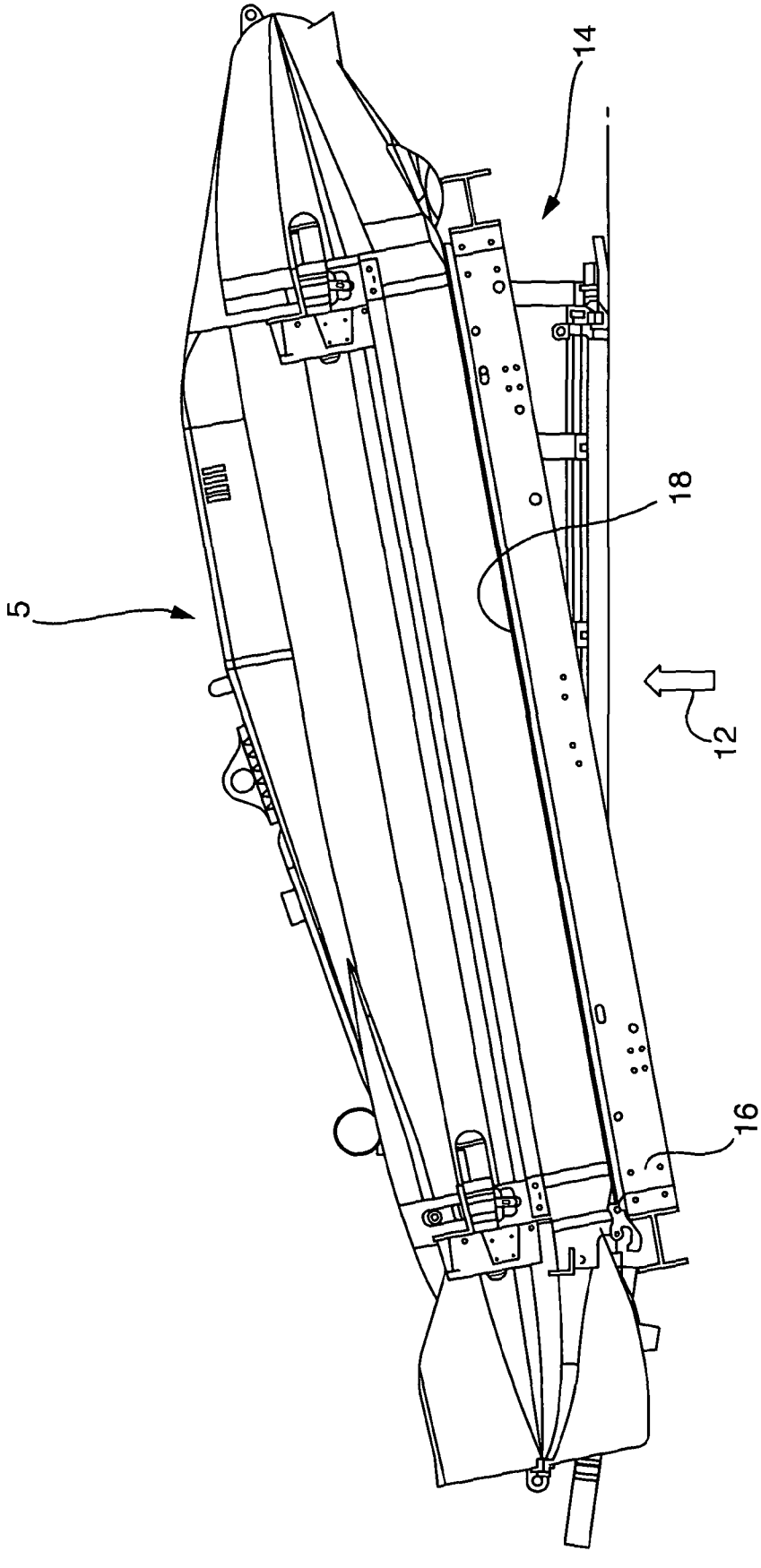


Fig. 2

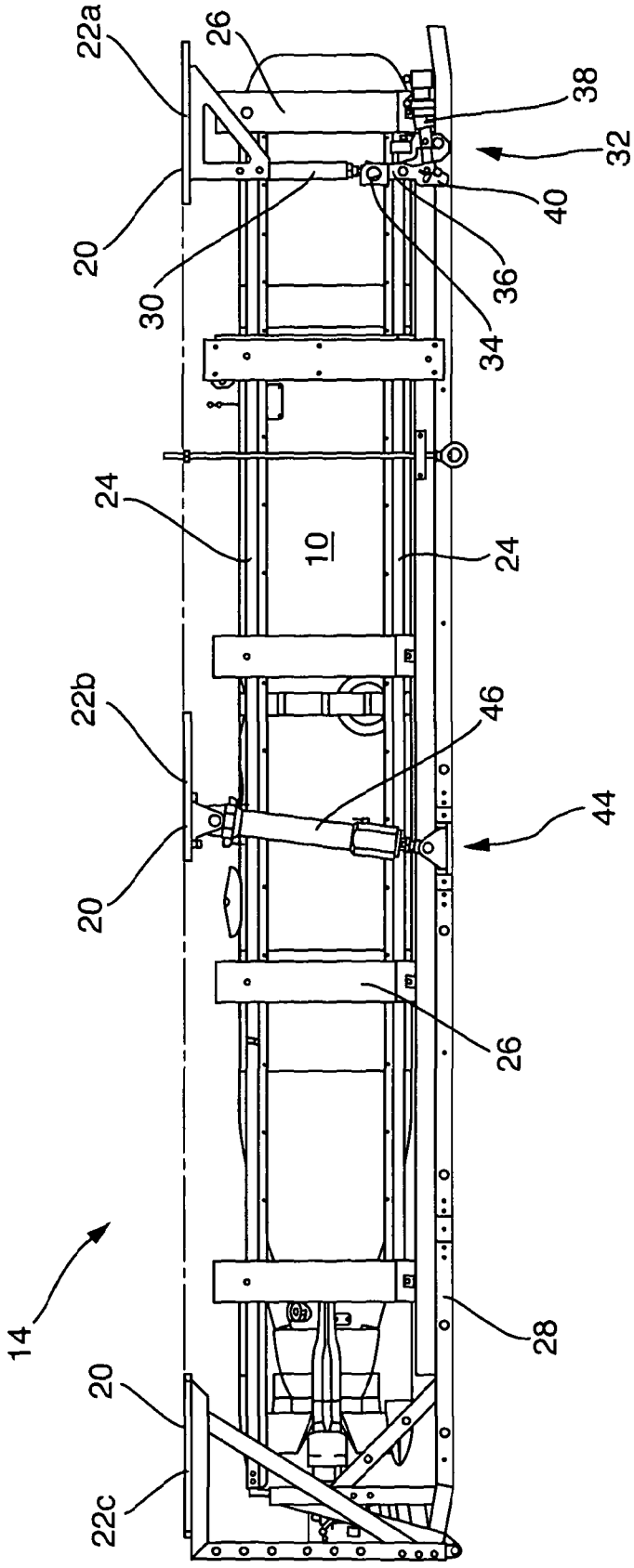
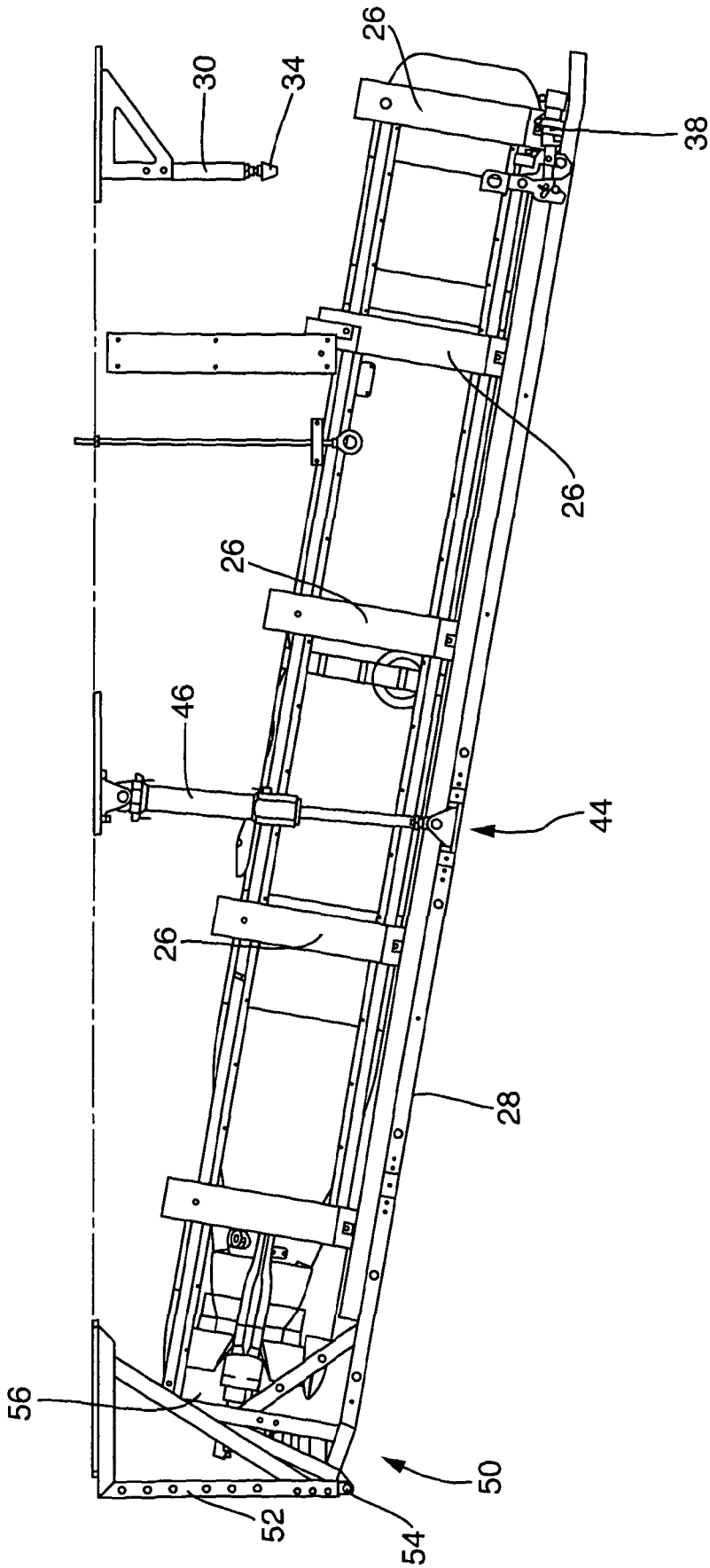


Fig. 3



INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2011/051450

A. CLASSIFICATION OF SUBJECT MATTER
INV. F41F3/10 B63G8/32
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)
F41F B63G

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	DE 100 31 409 C1 (HOWALDTSWERKE DEUTSCHE WERFT [DE]) 6 September 2001 (2001-09-06) column 1, lines 3-7, 43-48 column 3, line 17 - column 4, line 60 figures 1, 4, 6, 8, 9	1-11 13-16
Y A	FR 349 955 A (TURC HENRI LOUIS JOSEPH CLEMENT [FR]) 18 August 1905 (1905-08-18) page 1, lines 1-11 page 2, line 23 - page 3, line 74 page 4, lines 63-101 figures 1, 2, 4, 5	13 1-5, 9-12,14, 16
Y	US 5 363 791 A (STALLARD III CLINTON W [US]) 15 November 1994 (1994-11-15) column 3, line 29 - column 4, line 4 figures 1-3, 6	14-16

-/--

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

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"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)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"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

"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

"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.

"&" 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 October 2011	24/10/2011

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	Van Leeuwen, Erik

INTERNATIONAL SEARCH REPORT

International application No.
PCT/GB2011/051450

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

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

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

2. ☒ Claims Nos.: 17-19
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
see FURTHER INFORMATION sheet PCT/ISA/210

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

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

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

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box II.2

Claims Nos.: 17-19

Claims 17-19 solely rely on a reference to the description and the drawings. According to Rule 6.2(a) PCT, claims should not contain such references except where absolutely necessary, which is not the case here.

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guideline C-VI, 8.2), should the problems which led to the Article 17(2) declaration be overcome.

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2011/051450

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 448 941 A (GODFREY DANIEL M [US] ET AL) 12 September 1995 (1995-09-12)	1-4
A	column 2, lines 5-15 column 3, lines 19-38 column 4, line 30 - column 5, line 1 column 5, lines 31-34 figures 4A, 4B	14

X	US 5 050 523 A (SCHWEMIN JOHN A [US] ET AL) 24 September 1991 (1991-09-24) column 1, line 58 - column 2, line 18 column 4, lines 7-35 column 5, lines 5-27 figures 2, 3	1-12,14

A	GB 115 049 A (MYERS GEORGE FRANCIS [US]) 2 May 1918 (1918-05-02) page 2, lines 5-9 page 2, line 33 - page 3, line 16 figures 1, 3-5	1,3,5,6, 9-11,14

A	US 5 786 545 A (HILLENBRAND CHRISTOPHER F [US]) 28 July 1998 (1998-07-28) column 2, lines 6-10 figures 1, 2, 8-10	10-12

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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