United States Patent

[11] 3,559,927

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[32] Priority **Aug. 21, 1968**
[33] **Canada**
[31] **28,072**

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[54] **HELICOPTER RAPID SECURING DEVICE**
13 Claims, 13 Drawing Figs.

[52] **U.S. Cl.** **244/115**
[51] **Int. Cl.** **B64f 1/12**
[50] **Field of Search** 244/115, 116, 114, 17.17; 114/43.5

[56] **References Cited**
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3,151,826	10/1964	Michel	244/115
3,303,807	2/1967	Stewart et al.	244/115X

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Assistant Examiner—Paul E. Sauberer
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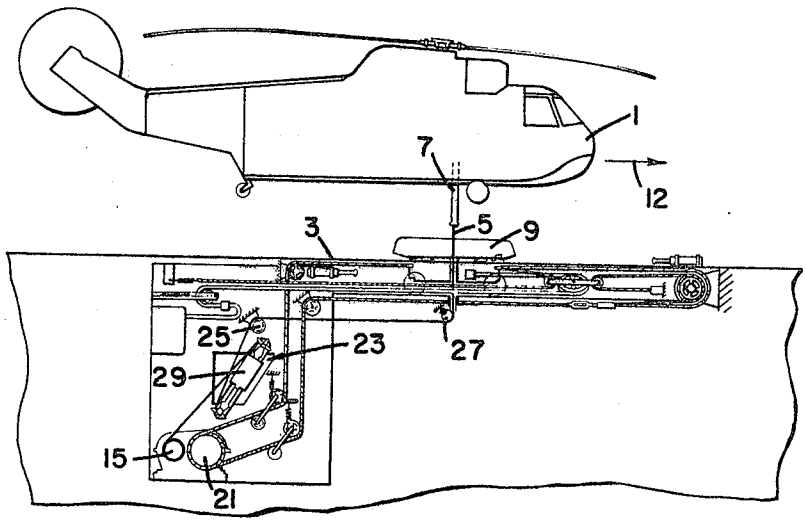
ABSTRACT: An improved probe for mounting on the underside of a helicopter, to be used when landing on the deck of a ship. The ship would be provided with a trap device which grasps the probe and holds it and the helicopter immediately touches down. The improved probe is telescopic and has a compression spring at its upper end biassing it downwardly. Below the spring is provided a latch which locks to the probe a haul-down cable extending from the helicopter to the ship.



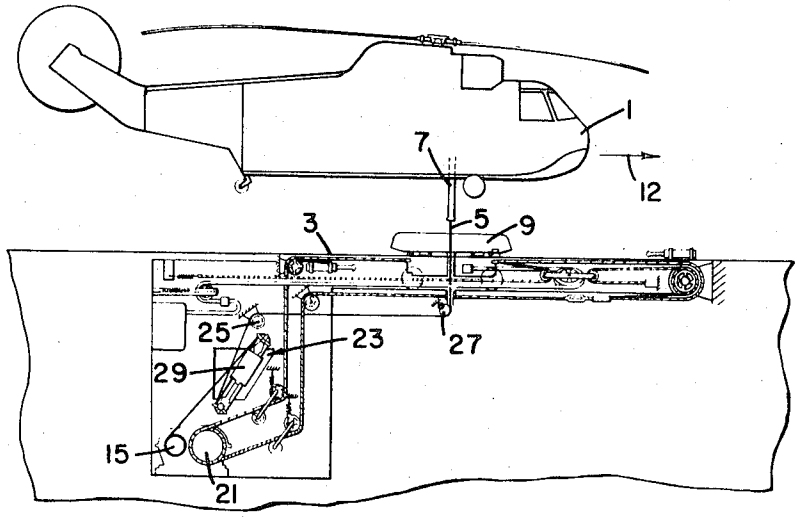


FIG. 1

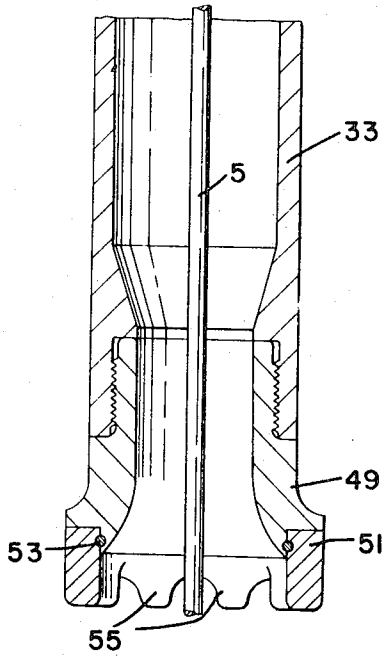


FIG. 2

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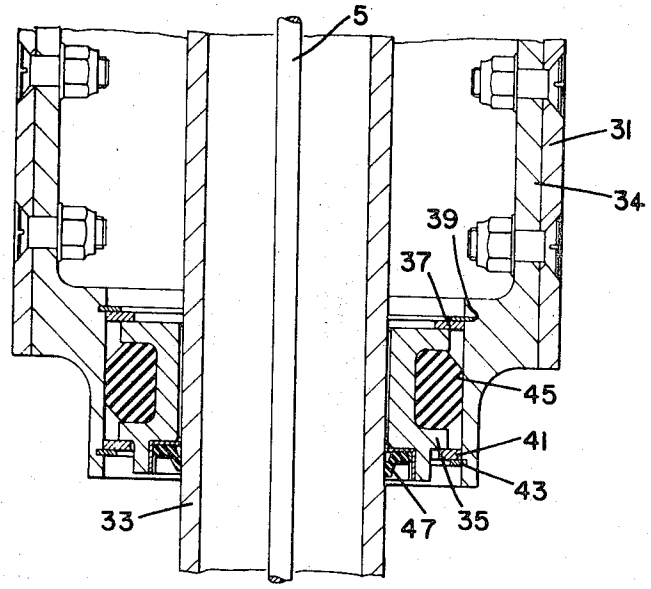

FIG. 3

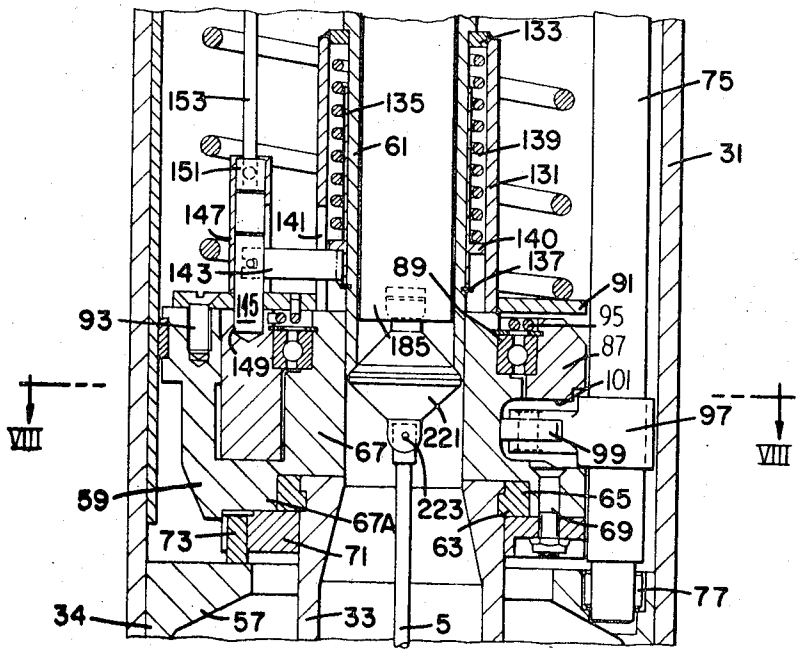

FIG. 4

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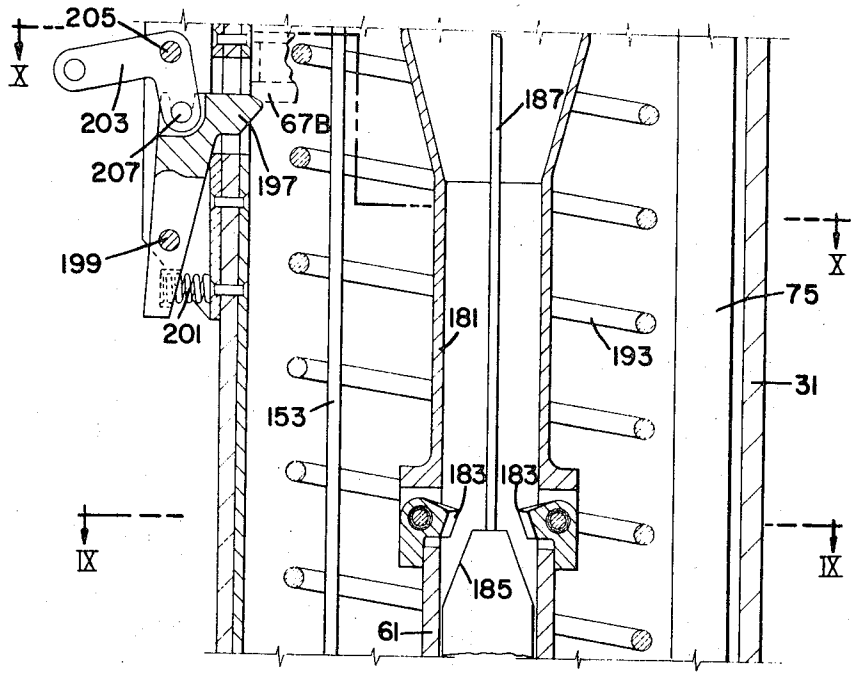

FIG. 5

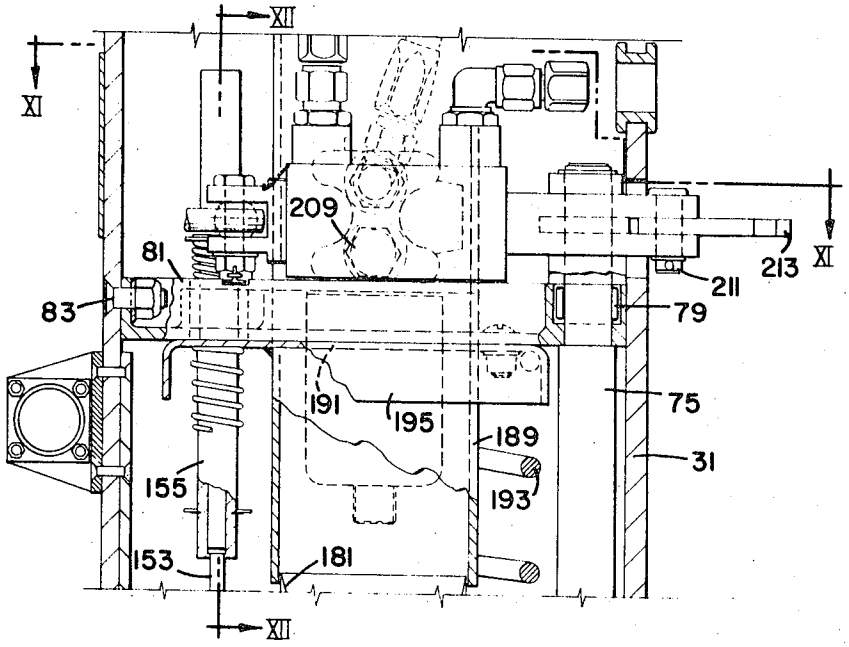

FIG. 6

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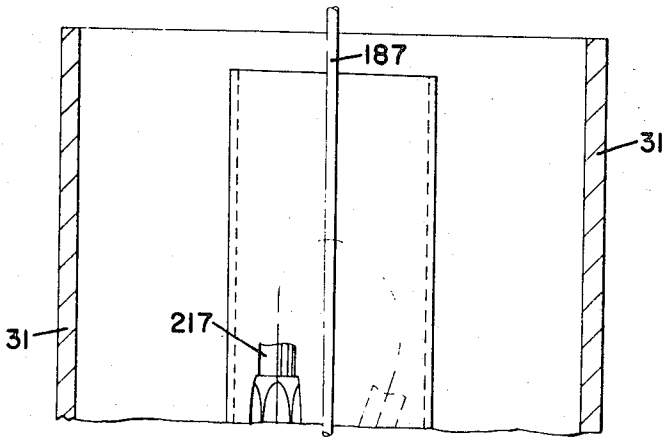

FIG. 7

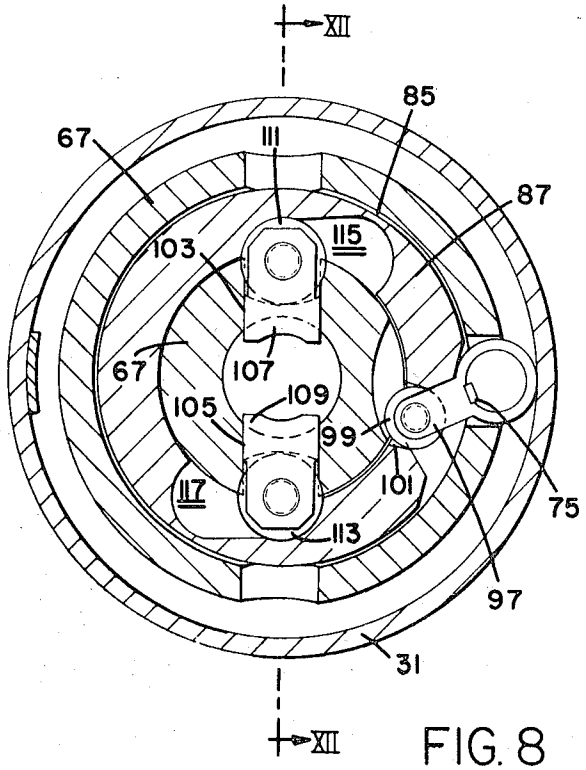

FIG. 8

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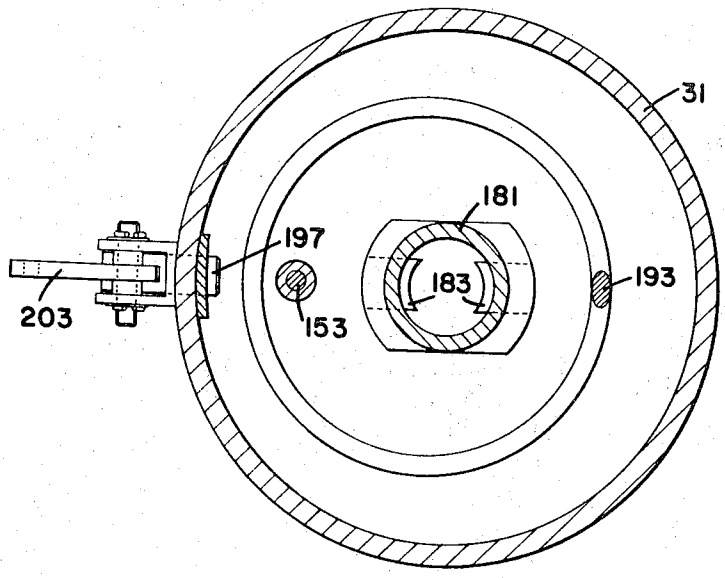

FIG. 10

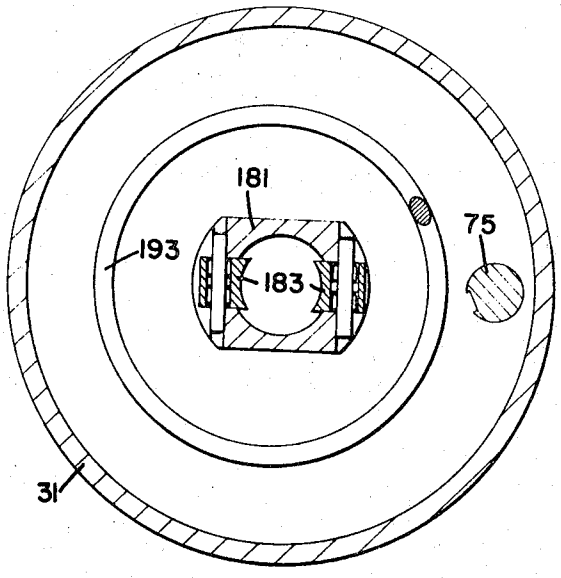

FIG. 9

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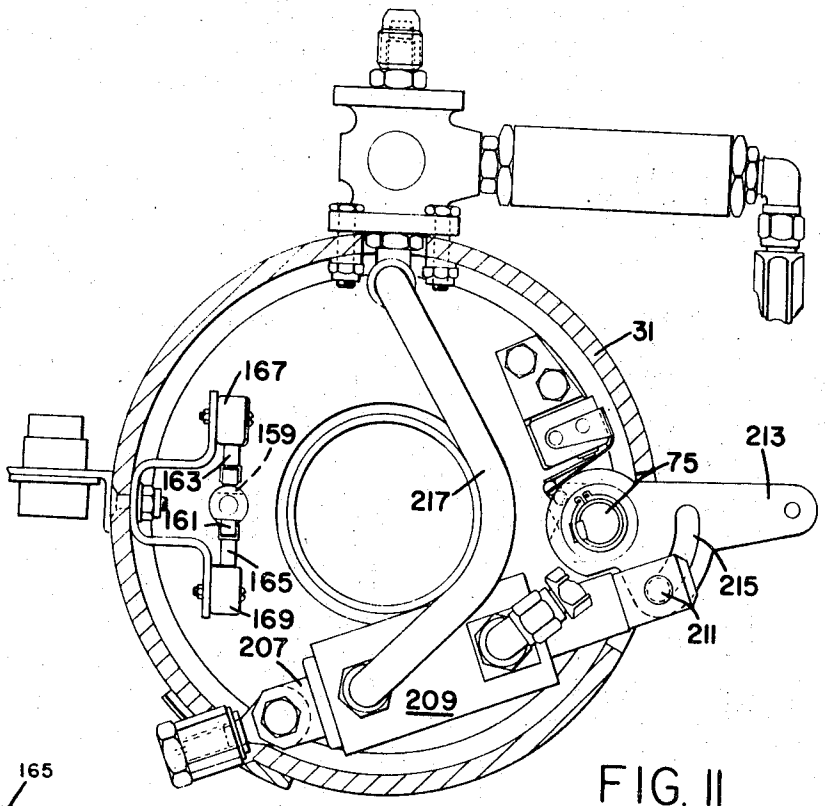

FIG. 11

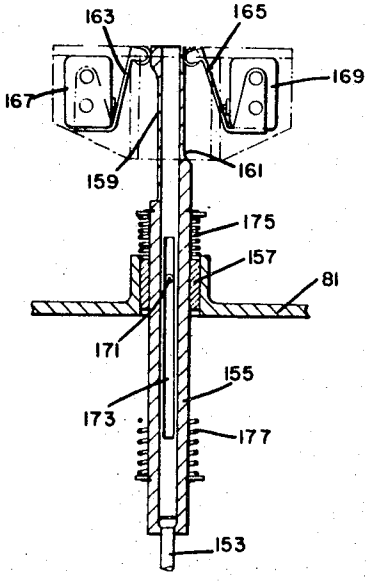

FIG. 12

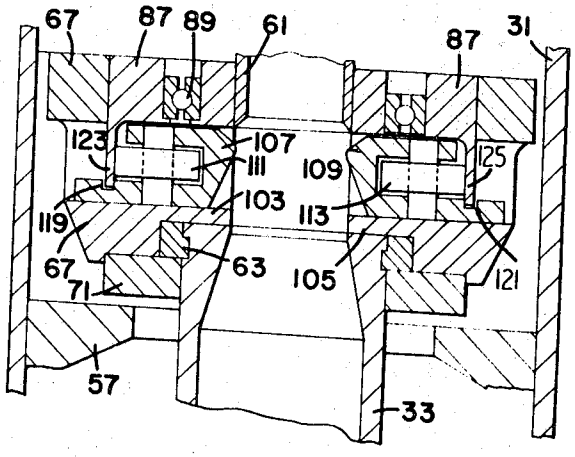

FIG. 13

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HELICOPTER RAPID SECURING DEVICE

It has been proposed in the copending Canadian Pat. applications Nos. 887,011 and 914,140, in which myself Asbjorn Baekken and William G. Stewart are named as the co-inventors application Ser. No. 404,374, filed Oct. 16, 1964, now U.S. Pat. No. 3,303,807, that a helicopter shall be hauled down onto the deck of a ship at sea by a cable acting against the lift produced by the helicopter rotor. This enables the helicopter to land safely despite pitching of the ship and despite the action of wind on the aircraft. In that proposal, a probe carried by the helicopter is seized in a trap carried by the ship so that once the helicopter has landed it is held firmly against movement relative to the ship, and eventually the trap is used to transport the helicopter bodily into a hangar in which the helicopter is stored.

An object of the present invention is the provision of an improved form of probe which is more compact than that described and illustrated in the above-mentioned two patent applications.

The present invention relates to a probe device suitable for mounting on the underside of an aircraft capable of hovering flight, and adapted to be grasped during landing of that aircraft at a landing station by a trap device positioned at that station, the probe device comprising a housing, a cylindrical probe telescopically mounted in the housing and movable axially between a lower extended position in which it extends beyond the bottom of the housing and an upper retracted position in which a large part of the probe is disposed within the housing, a passageway through the center of the probe, compression spring means acting between an upper part of the housing and an abutment on the probe and tending to move the probe towards its extended position, messenger means by which a cable can be drawn up into the probe and latching means carried by and movable with the probe and disposed below the spring means and adapted to engage and retain a complementary fitting at the top of the cable and by which the messenger means is connected to the cable.

The invention will now be described, by way of example, with reference to the accompanying drawings, in which:

FIG. 1 is a side elevation of a helicopter in the final stages of being winched down onto the deck of a ship;

FIGS. 2 to 7 when arranged one above the other in that order with FIG. 2 at the bottom form a sectional side elevation of the probe shown in FIG. 1;

FIG. 8 is a sectional plan view taken on the line VIII–VIII of FIG. 4;

FIG. 9 is a sectional plan view taken on the line IX–IX of FIG. 5;

FIG. 10 is a sectional plan view taken on the line X–X of FIG. 6;

FIG. 11 is a sectional plan view taken on the line XI–XI of FIG. 6;

FIG. 12 is a sectional aft elevation taken on the line XII–XII of FIG. 6;

FIG. 13 is a sectional side elevation taken on the line XIII–XIII of FIG. 8 and taken in the direction indicated by the arrows, the parts of the mechanism being shown in an alternative limiting position.

Referring to the drawings of the present application, Canadian Pat. application No. 914,140 filed Oct. 16, 1964 in the names of William G. Steward and Asbjorn Baekken discloses a system (see FIG. 1) for hauling a helicopter 1 down onto the deck 3 of a ship at sea, the helicopter first picking up by messenger line a cable 5 from the ship flight deck 3 and then, after that cable has been secured to the helicopter, a controller on the ship by means of a constant-tension winch hauling the helicopter down by the cable 5 against the lift of the helicopter rotor until a probe 7 on the underside of the helicopter is clamped within a trap 9 in the present drawing. The trap can then be moved forwardly of the ship (i.e. in the direction of arrow 12), taking the helicopter with it, into a hangar.

As described in that earlier patent application, an electric motor (not shown) is coupled to the driving shaft of a variable displacement hydraulic pump, connected in closed circuit to a fixed displacement hydraulic motor. Such an arrangement is well known in the art, and commonly makes use of a pump with a tiltable swash plate or, as in the embodiment described, a pump with a fixed swash plate but an adjustable tilt head. The output shaft of this hydraulic motor is connected through a gearbox alternatively either to a drum 15 of a haul-down winch or to a drum 21 of a trap-traversing winch. The present invention does not relate to the trap-traversing winch, which is used merely for moving the trap 9 into and out of the hangar referred to above.

The cable 5 has one end wound on the drum 15 and extends from the winch drum first over pulleys of a rope accumulator 23 and then round a guide sheave 25 and finally over a sheave 27 before passing upwardly through the deck 3 to the helicopter 1. The rope accumulator includes a first set of pulleys and a second set of pulleys, the two sets being biased apart by a pneumatic cylinder device 29 which has a force/displacement characteristic such that the force biasing the two sets of pulleys apart increases progressively as the two sets are forced closer together by the tension in the cable 5.

The present invention relates to an improved construction for the probe 7, and FIGS. 2 to 13 show the construction of the probe in detail. The probe includes a tubular probe housing 31 (see FIGS. 3 to 8) and a tubular probe 33 of lesser diameter and arranged to extend telescopically into the housing 31. The lower end of the housing is closed by a plug 34 (see FIG. 3) provided with a metal bearing sleeve 35 axially located by an upper ring 37 engaging a circlip 39 and by a lower ring 41 engaging a circlip 43. This bearing sleeve is resiliently centered by a resilient ring 45 and a dirt-sealing ring 47 carried by sleeve 35 tightly engages the probe 33. The lower end of the probe 33 (see FIG. 2) is provided with a bush 49 which at its lower end carries a concentric and rotatable ring 51, the ring being retained by a spring ring 53 and being formed with castellations 55 which permit the cable 5 to pass laterally from inside of the probe without being crushed between the probe and the ship deck 3.

The upper end of the plug 34 (see FIG. 4) is formed with a radially inwardly extending flange 57 which terminates short of the probe 33 and serves as a stop limiting downward movement of the probe. When the telescopic probe is in its downward limiting position, an upper end of the probe lies a short distance above the flange 57, and locked to this end of the probe is a locking mechanism assembly 59 which also serves to secure to the probe a tubular intermediate extension 61, of lesser diameter than the probe. Near its upper end the probe is formed with a peripheral groove 63 into which are fitted the parts of a segmental junk ring 65. An annular locking mechanism block 67 fits around the tubular extension 61 and butts against both the top of the probe 33 and the top of the junk ring 65, a downwardly extending flange 67A on the block preventing radially outwards displacement of the parts of the junk ring 65 and the block being clamped by bolts 69 to an annular plate 71. Rubber buffer pins 73 fitted in holes in plate 71 are arranged to engage the flange 57 to cushion impact of the plate 71 with the flange.

The annular block 67 is held against rotation in the housing 31 (see FIGS. 4 and 8) by a vertical actuating shaft 75 journaled at its lower end in a needle bearing 77 carried by the flange 57 and journaled near its upper end (see FIG. 6) in a needle bearing 79 carried by a transverse plate 81 secured by bolts 83 to the housing 31. Block 67 is formed (see FIG. 8) with an annular groove 85 extending into the block from its upper surface and accommodating a rotatable cam member 87. This member 87 is carried (see FIG. 4) by the outer race of a ball bearing 89 the inner race of which is a tight fit on a central boss of the block 67. The top of groove 85 is closed by an annular plate 91 secured to the block 67 by screws 93. A spiral spring 95 has one end located in a hole as shown in the cover plate 91 and has the other end located as shown in a

hole in the rotatable member **87**. and this spring biases the rotatable member **87** in an anticlockwise direction (viewed as in FIG. **8**). Near its lower end, the actuating shaft **75** carries (see FIG. **8**) a keyed lever arm **97** provided with a roller **99** at its free end. Roller **99** is disposed in a radial hole **101** in the rotatable cam member **87**, the inner part of the block **67** being suitably cut away to permit rotation of the lever arm through an arc to move the cam member between the limiting positions shown respectively in FIGS. **8** and **13**. The inner annulus of block **67** is formed (see FIG. **8**) with two radial bores **103** and **105** which accommodate respectively two clamping members **107** and **109** which at their outer ends are bifurcated to carry rollers **111** and **113**. These two rollers engage respectively in two cam slots **115** and **117** in the inner surface of the cam member **87** and the clamping members are also formed with outward extensions which (see FIG. **13**) are formed with slots **119** and **121** into which depend tongues **123** and **125** of the cam member. During clockwise rotation of the cam member **87** towards the position shown in FIG. **8**, the cam slots **115** and **117** acting on the rollers **111** and **113** move the clamping members **107** and **109** radially inwards. During anticlockwise rotation of the cam member **87** away from the position shown in FIG. **8**, the tongues **123** and **125** act on the radially outer sides of the slots **119** and **121** to move the clamping members **107** and **109** radially outwards.

Welded to the top of cover plate **91** (see FIG. **4**) is a short tube **131** which is concentric with the extension **61** and which at its upper end is welded to an annular ring **133** to form a guide and a stop for the extension **61**. In the annular space between the tube **131** and the extension **61** is disposed a sleeve **135** slidably mounted on the extension and having its downward movement limited by a circlip **137** fitted to the extension. A compression spring **139** acts between the ring **133** and a flange **140** on the sleeve **135** and tends to force the sleeve **135** downwards on the extension. One side of the tube **131** is formed with an axial slot **141** through which extends an arm **143** secured to sleeve **135** and engaging a plunger **145** guided in a cylindrical guide **147** mounted on the cover plate **91**. The rotatable cam member **87** is formed with an axial hole **149** into which the lower end of plunger **145** can enter to hold the cam member **87** against rotation under the effect of the spring **95**. Thus plunger **145** can be left in the position shown to hold the cam member **87** against rotation, but when the probe extension **61** is forced upwards telescopically relative to the block **67**, the plunger **145** also moves upwards to free member **87** and so to permit the spring **95** to rotate the cam member **87** and cause the two clamping members **107** and **109** to move radially inwardly. Only limited upward movement of the extension **61** relative to block **67** can take place before the top of sleeve **135** engages ring **133**, so that the lower end of the extension **61** cannot come free from the block. Disposed in an upper end of the guide **147** is indicating member **151** which is moved upwardly through a short distance when the plunger **145** is raised in the above manner. Member **151** is mounted on the lower end of a rod **153** which at its upper end is carried by a plunger **155** (see FIG. **12**) slidably mounted in a bush **157** carried by the plate **81**. Plunger **155** is formed near its upper end on one side with a cam surface **159** and on its opposite side with a cam surface **161**, these cam surfaces acting respectively on the actuating levers **163** and **165** of two microswitches **167** and **169**. A pin **171** acting in a slot **173** of the plunger prevents rotation of the plunger, and springs **175** and **177** acting against stops on the plunger ensure that stopping of the plunger by the stops takes place progressively. It will be seen that switch **167** provides an indication that the plunger **145** is engaged in the cam member **87** and that switch **169** provides an indication that tubular probe extension **61** has been forced up so that sleeve **135** has butted against the ring **133** and lifted the whole assembly **59**.

At its upper end the tubular intermediate extension **61** is fitted (see FIG. **5**) within the enlarged bottom end of a tubular upper extension **181**, and this enlarged bottom end is provided with two weighted pawls **183** mounted on horizontal pivots and so shaped that a messenger weight indicated diagrammatically at **185** can, when lowered through the upper extension **181**, rotate those pawls to permit downward passage of the messenger weight, but when subsequently drawn upwardly by a messenger cable **187**, is obstructed by the pawls, which cannot rotate in the opposite direction. The upper end of the upper extension **181** diverges upwardly, and fits within a concentric tubular shield **189** (see FIG. **6**), which shield is welded to the lower surface of the plate **81**. Plate **81** is formed with a central aperture **191** large enough to permit the messenger weight to pass through. A compression spring **193** is disposed in the annular space surrounding the intermediate extension **61** and the upper extension **181**, the upper end of this spring being centered by and bearing against a dish **195** bolted to the plate **81** and the lower end of the spring bearing against the top of the cover plate **91**. This spring ten to hold the assembly **59**, and with it the probe **33**, down in a lower limiting position in which the rubber buffers **73** on plate **71** engage the flange **57** and in which the probe extends a considerable distance below the housing **31**. When the probe **33** is forced upwardly against the force of spring **193**, the assembly **59** also rises until the rim of block **67** reaches the position shown in dotted outline at **67B** in FIG. **5**, in which it has pressed outwardly a pawl **197** mounted on a pivot pin **199** and biased inwardly of the housing **31** by a compression spring **201**, and has become lodged on top of the pawl which then restrains the whole assembly in this raised position.

A bellcrank lever **203** mounted on a pivot pin **205** carries on one arm a pin **206** engaged in a notch in the pawl **197**, so that the pawl can be moved outwardly to free the assembly **59** by the action of a cable attached to the other end of the bellcrank and operated from the helicopter cockpit. On top of plate **81** is mounted a hydraulic actuator **209** (see FIG. **11**) the ram **207** of which is coupled by a pin **211** to a lever **213** mounted on top of the actuating shaft **75**. Pin **211** extends into an arcuate slot **215** in the lever **213**, and the arrangement is such that when hydraulic fluid under pressure is supplied through pipe **217** to the actuator **209** the ram **207** is forced to the left thereby turning lever **213** and shaft **75** clockwise (as viewed in FIG. **11**) and opening the locks by turning cam **87** anticlockwise (as viewed in FIG. **8**) and driving clamping members **107** and **109** outward. Slot **215** in lever **213** permits manual operation of locks by overriding hydraulic ram **207** when lever through a cable attachment to its outer hold is moved clockwise.

The messenger weight **185** contains spring-loaded catches adapted to lock onto a bulbous upper end of a coupling **221** secured by a shear pin **223** to the upper end of cable **5**.

Considering now the operation of the apparatus, in normal flight the helicopter will leave the probe **33** raised into the housing **31** and held in the raised position by the pawl **197** shown in FIG. **5**. As the helicopter approaches the ship preparatory to landing, the probe **33** is lowered by disengagement of pawl **197** through operation of bellcrank **203** as mentioned above, and by lowering of messenger weight **185**. The compression spring **193** ensures that the probe **33** is lowered to its down position. The downward operation of the messenger weight automatically feeds hydraulic fluid through pipe **117** forcing ram **107** to the right and through the action of pin **211** in the slot **215** moves the lever **213** in a clockwise direction from position as shown in FIG. **11**. This movement of the lever through rotation of the shaft **75** and the arm **97** rotates the cam **87** in an anticlockwise direction from the position shown in FIG. **8** to a position in which the clamping members **107** and **109** are in their outermost positions and the plunger **145** is located in the hole **149** in order to retain the cam member **87** in this position. When the supply of fluid under pressure through pipe **217** is discontinued the ram **207** moves back to its right-hand extreme position, thus moving pin **211** to the right-hand end of slot **115**, so that it will not prevent subsequent anticlockwise rotation of the lever **213**.

The messenger weight **185** is now lowered by its cable **187** through tubular extension **181**, past the pawls **183**, through

the extension **61**, past the clamping members **107** and **109**, and out of the probe **33** to the deck of the ship. On the deck of the ship a member of the ship's crew first earths the messenger weight with insulated tongs to discharge static electricity, and then forces the spring catches in the messenger weight over the bulbous upper end of coupling **221** to couple the cable **5** to the cable **187**. Cable **187** is now wound in on a winch drum carried by the helicopter, and weight **185** is drawn up into the probe **33** until the conical upper surface of the coupling **221** engages the lower end of the tubular extension **61**. Continued upwards movement of the messenger weight **185** causes the coupling **221** to raise the tubular extension **61** against the action of the spring **139**, so that the arm **143** lifts the plunger **145** and releases the cam member **87**. Spring **95** then rotates the cam member so that the two clamping members **107** and **109** are moved inwardly to their innerlocking positions, the coupling **221** being above these members. As the messenger weight **185** rises still further, the upward movement of the extension **61** is checked by engagement of the upper end of sleeve **135** with the ring **133**, and the spring catches in the messenger weight are then forced off the bulbous upper end of coupling **221**, which drops back to lie on top of the clamping members **107** and **109**.

The helicopter is now tethered by the cable **5** to the winch on the ship, and the helicopter is drawn down onto the deck of the ship in a controlled manner by the action of the cable acting against the lift produced by the helicopter rotor. When the probe **33** has entered the trap **9**, the trap is fired and the helicopter probe is securely held by the trap to hold the helicopter safely despite pitching and rolling of the ship.

When desired, the coupling **221** can be released from the helicopter by the supply of air to the pneumatic actuator **209**, the ram **207** then moving to the left to move the lever **213** in a clockwise direction to restore it to its open position, in which the cam member **87** has rotated to move the clamping members **107** and **109** outwardly, so releasing the coupling **221**.

It will be seen that the probe now described and claimed differs from the probes of the two prior patent applications by virtue of its novel arrangement of the spring **193**. The overall height is much reduced by the use of latching means which are provided below this spring (instead of above it), since this enables the messenger weight to be accommodated inside the spring rather than above it.

I claim:

1. A probe device suitable for mounting on the underside of an aircraft capable of hovering flight, and adapted to be grasped during landing of that aircraft at a landing station by a trap device positioned at that station, the probe device comprising:

a. a housing;
b. a cylindrical probe telescopically mounted in the housing;
c. the probe being movable axially between a lower extended position in which it extends downwardly below the housing and an upper retracted position in which at least a major part of the probe is disposed within the housing;
d. a passageway extending axially through the probe;
e. an upper part of the housing;
f. an abutment on the probe;
g. compression spring means acting between the said upper part of the housing and the said abutment on the probe and tending to move the probe towards the said lower extended position;
h. messenger cable means carried by the housing and having a coupling by which a haul-down cable can be drawn up by the messenger cable means into the probe; and
i. latching means carried by and movable with the probe, and disposed below the said compression spring means; whereby in use a complementary fitting at an upper end of the said haul-down cable can be latched by the latching means to secure the upper end of the haul-down cable to the probe and thus to the housing and to the aircraft.

2. A probe device according to claim **1**, and in which the latching means comprise:

a. an inner guide ring;
b. radial apertures formed in the inner guide ring,
c. latch members radially slidable in the said apertures.
d. an outer cam ring rotatable about the inner guide ring;
e. cam surfaces formed on the outer cam ring;
f. the cam surfaces being adapted during rotation of the cam ring in a first direction to move the latch members inwardly to engage and to retain the said complementary fitting;
g. the cam surfaces being adapted during rotation of the cam ring in the opposite direction to permit outward movement of the latch members to free the said complementary fitting.

3. A probe device according to claim **2**, in which the cam ring is also provided with additional cam surfaces, and these cam surfaces are arranged to act on surfaces on the latch members and are effective to move those latch members positively from the latched inwards position to the released outward position during rotation of the cam ring in the said opposite direction.

4. A probe device according to claim **2**, and in which:

a. an actuating rod for the cam ring extends axially down one side of, and inside, the housing;
b. a lever is carried by the lower end of the said rod;
c. the cam ring is provided with a slot; and
d. the lever is arranged to engage in the said slot; whereby rotation of the actuating rod effects rotation of the cam ring and thus locking or unlocking of the latching means.

5. A probe device according to claim **2**, in which:

a. spring means are arranged to bias the cam ring in such a direction as to cause the latch members to move radially inwardly;
b. locking means are arranged to hold the cam ring in position against the action of the spring means; and
c. release means are provided by which the locking means can be rendered ineffective.

6. A probe device according to claim **5**, in which:

a. the release means comprise a pin;
b. the pin is movable axially of the probe between a first position and a second position;
c. in the first position the pin locks the cam means to the remainder of the probe; and
d. in the second position the pin releases the cam means and permits them to be moved by the spring means to move the latch members inwardly to their engaged position.

7. A probe device according to claim **6**, and in which:

a. an abutment is arranged to be engaged by the said complementary fitting as it rises above a predetermined level in the probe; and
b. engagement of the abutment by the fitting moves the pin axially to release the cam means.

8. A probe device according to claim **7**, and in which:

a. indicating means are associated with the pin; and
b. the indicating means are arranged to provide an indication remotely of the probe that the cam ring is in either of its limiting positions.

9. A probe device according to claim **1**, and in which:

a. abutment means are provided in the passageway above the latching means; and
b. the messenger means by engaging these abutments means can be employed to draw the probe upwardly against the action of the compression spring means to its upwardly retracted position.

10. A probe device according to claim **9**, and in which:

a. readily releasable holding means are provided in the housing;
b. these holding means are effective to retain the probe in the retracted position; and
c. these holding means can be readily released to permit the probe to assume its extended position.

11. A probe device according to claim **9**, and in which the abutment means are so formed that the messenger means can be lowered past the abutment means but are stopped by those abutment means during upward movement.

12. A probe device according to claim **4**, and in which:

a. a power device is disposed in an upper part of the housing;
b. a lost-motion device connects the power device to the actuating rod;
c. the power device is effective to rotate the actuating rod to effect rotation of the cam ring and thus unlocking of the latching means;
d. spring means are arranged to bias the cam ring in such a direction as to tend to cause the latch members to move radially inwardly;
e. the lost-motion device is arranged to permit the power device to assume a position corresponding to the locked state of the latching means while the latching means are still held in the unlocked state by the locking device against the action of the spring means; and
f. the lost-motion device nonetheless permits the spring means to move the latch members radially inwards when the locking device is made inoperative.

13. A probe device according to claim 1, and in which:
a. a coaxial rotatable ring is provided on the lower end of the probe;
b. substantially radial notches are formed in the said ring;
c. these notches are distributed about the lower end of the probe;
d. these notches have a depth greater than the diameter of the haul-down cable; and
e. these notches are effective firstly to accommodate without nipping the cable when the probe engages a flat surface; and secondly by rotation of the ring to enable the haul-down cable to extend radially from the probe.