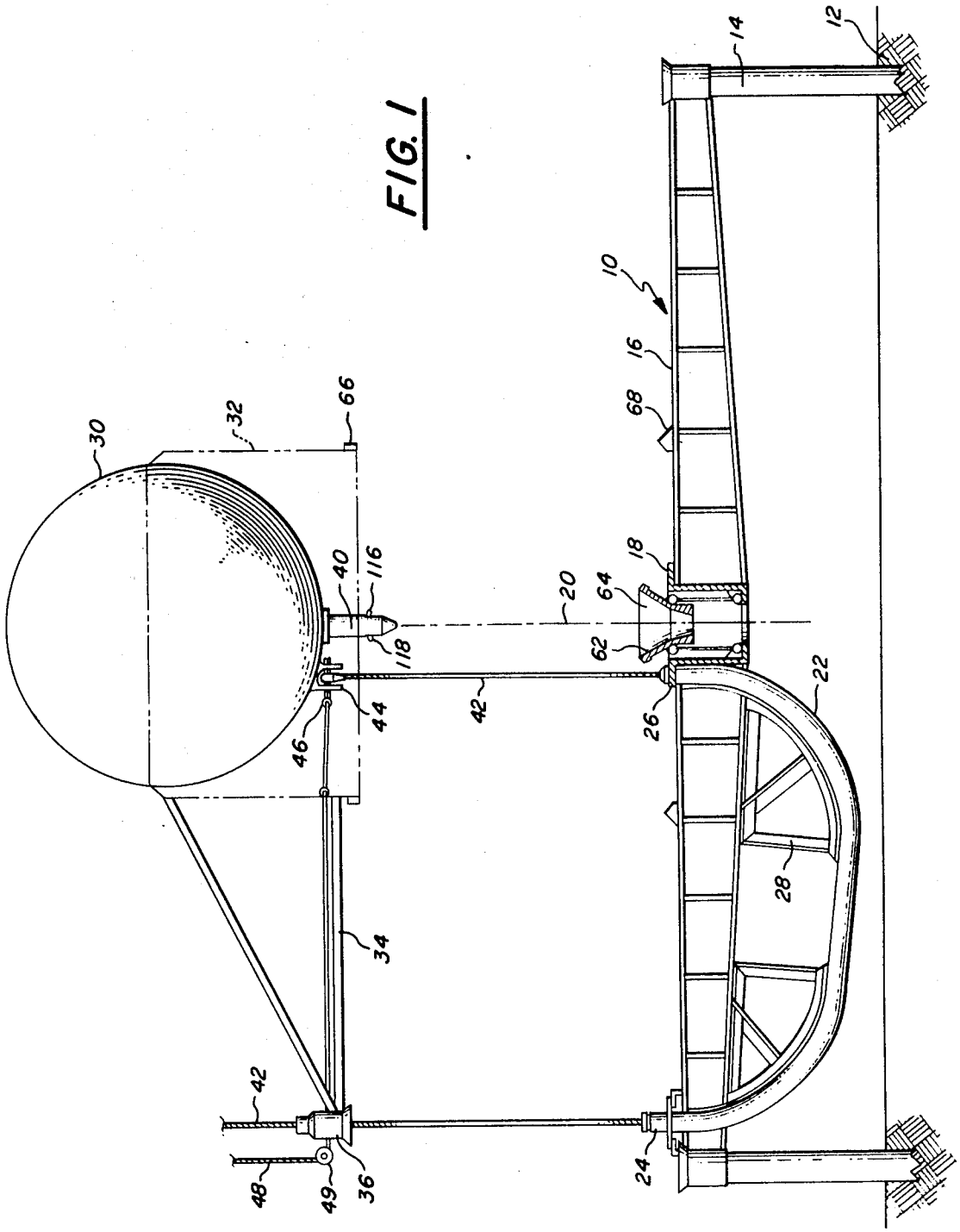
Oct. 5, 1971 R. G. COOK 3,609,981

OCEAN DESCENT SYSTEM METHOD AND MEANS

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FIG. 1



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OCEAN DESCENT SYSTEM METHOD AND MEANS

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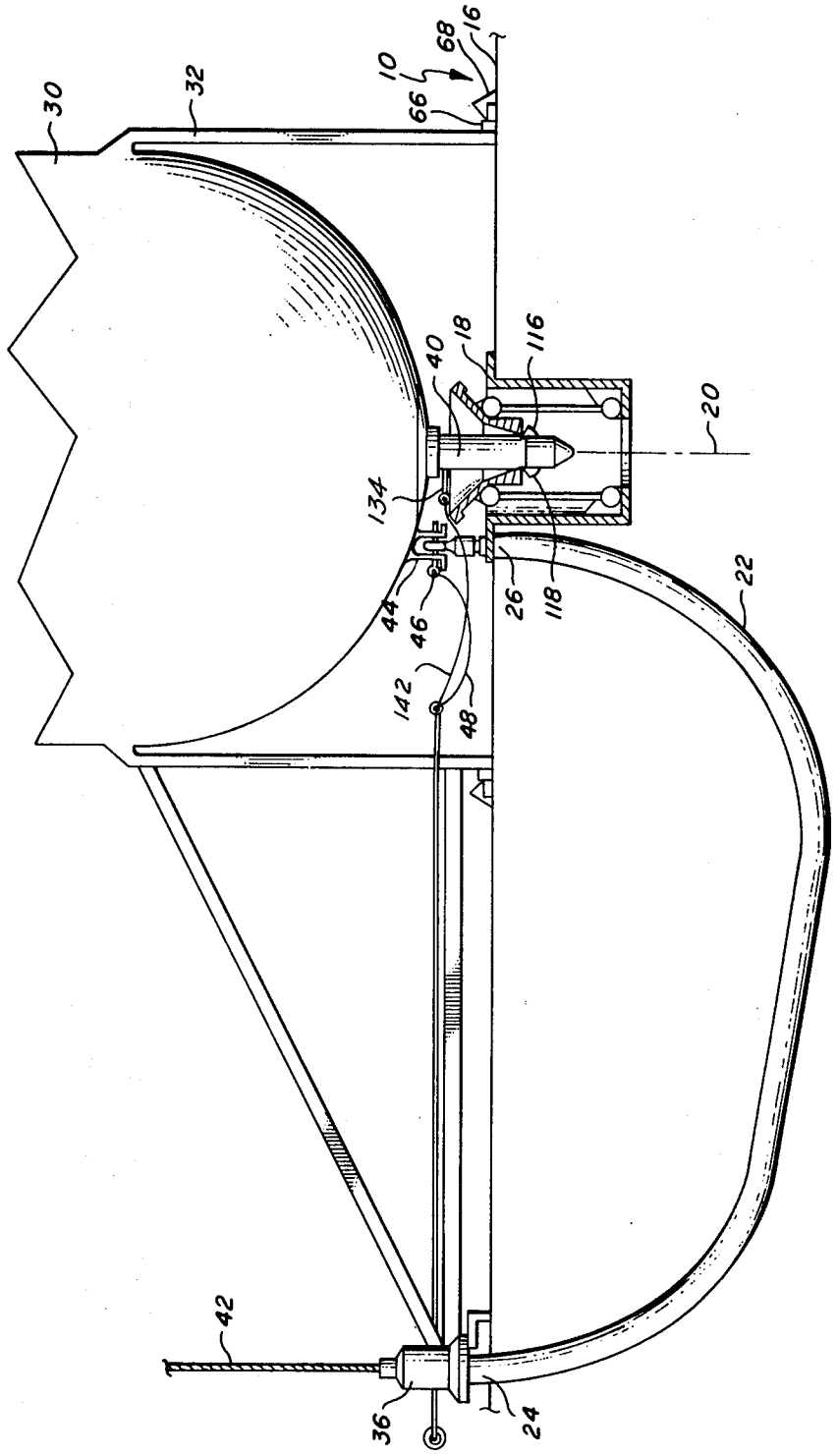


FIG. 2

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OCEAN DESCENT SYSTEM METHOD AND MEANS

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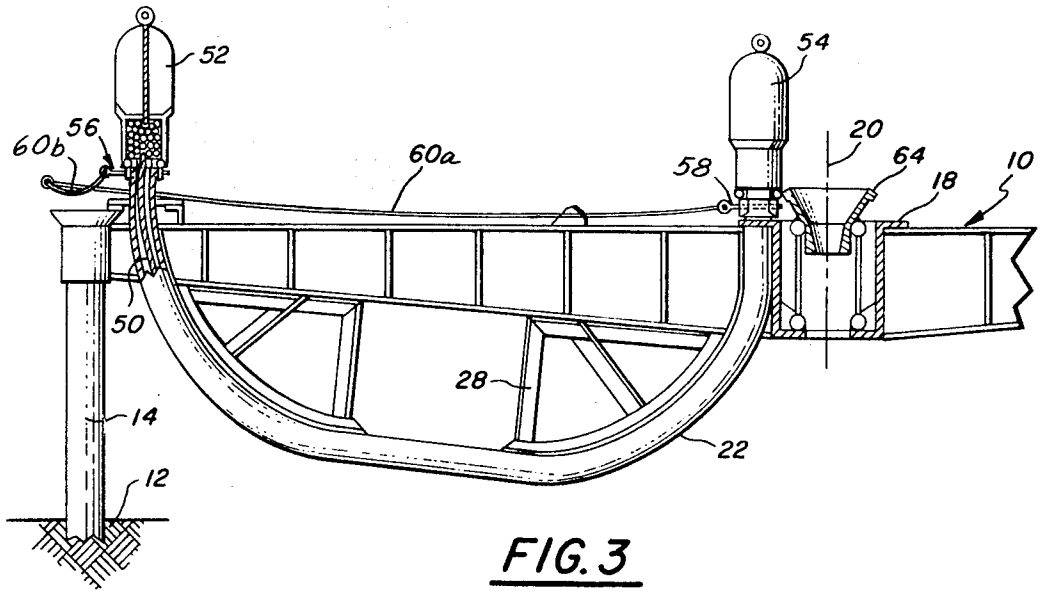


FIG. 3

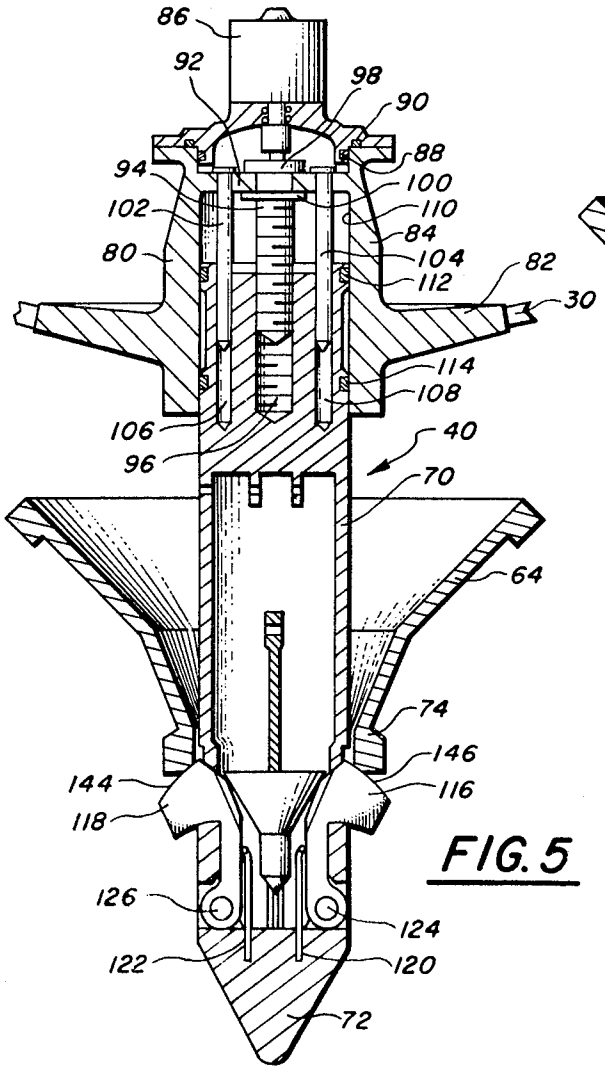


FIG. 5

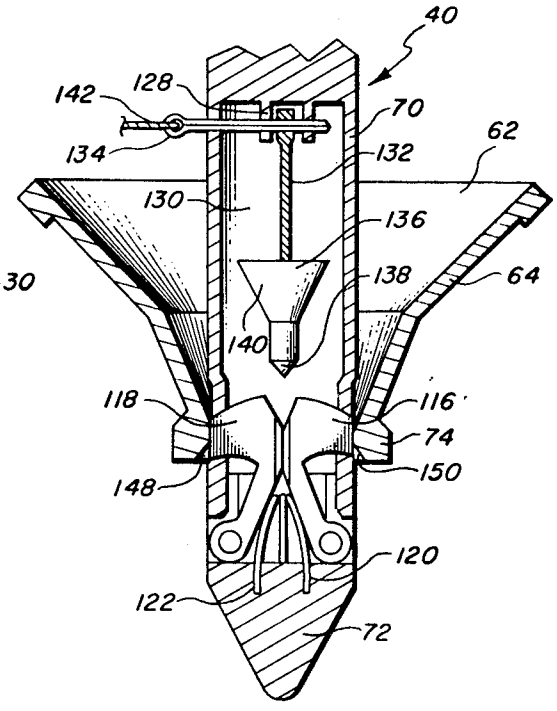


FIG. 4

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3,609,981

OCEAN DESCENT SYSTEM METHOD AND MEANS

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Int. Cl. E02b 17/02
U.S. Cl. 61—69 7 Claims

ABSTRACT OF THE DISCLOSURE

In offshore oil production operations, a platform is initially secured to the ocean floor, and a submersible housing is thereafter hauled down from the ocean surface in precise directional orientation with respect to the platform, as required for mating of structural attach connections therebetween. Orientation is achieved by use of a U-shaped hawsepipe on the platform, through which the haul-down hawser is threaded, the pipe ends being spaced apart a fixed distance. A guide arm system mounted on the housing engages the hawser at two locations spaced apart a distance coinciding with the mentioned pipe ends. Locking connection elements on the platform and housing interengage automatically due to precise orientation therebetween as the housing moves into mating relationship with the platform.

BACKGROUND OF THE INVENTION

Offshore oil production operations as currently practiced involve a multitude of economic and technological limitations which become rapidly more overwhelming as the depth of such operations increases. Recent interest in exploration and tapping of suboceanic oil fields in depths ten or twenty times greater than those now considered maximum will require development of new techniques and structures never before achieved in the prior art. Thus, many of the common techniques used for oil drilling and production in water depths of 300 to 600 feet are totally useless at depths beyond 600 feet. However, exploration plans currently envision oil drilling and production operations in depths of several thousand feet where hydrostatic pressure completely prohibit diver support and other expedients now widely used.

SUMMARY OF THE INVENTION

The invention in this case involves essentially a two-step installation method for erecting complex structures on the ocean floor at depths as much as 6,000 feet. The novel method begins with installation of a polygonal base or platform **10** shown in FIG. 1 secured to ocean floor **12** by a plurality of upright pilings or stanchions **14**. Platform **10** has a deck or upper surface **16** containing a center aperture **18** of essentially cylindrical form and concentric about a center axis **20** longitudinal therethrough. Platform **10** is further provided with a generally U-shaped hawsepipe **22** extending below the surface of deck **16** and having opposite spaced-apart ends **24** and **26**. Hawsepipe **22** is securely affixed to platform **10** by suitable means and forms a permanent part of the platform structure. Installation of hollow airtight housings, either in unitary capsule or segmented form as required to complete the installation of equipment or habitable quarters on platform **10**, is illustratively shown by reference to hollow housing **30** shown in FIG. 1. Housing **30** is further provided with a rigid projecting brace or arm **34** having an elongate hollow cup or tubular fitting **36** secured to the distal end thereof. Housing **30** is further provided with locking means in the form of elongate probe **40** downwardly depending therefrom and centered within skirt portion **32** as shown in FIG. 1. In the descent mode, hawser **42** is secured at

one end thereof to housing **30** by suitable means such as pin and clevis assembly **44** and the hawser is threaded through hawsepipe **22** and fitting **36** as suggested in FIG. 1, extending upwardly to a drum or motor driven winch (not shown) on the ocean surface. Operation of the mentioned winch causes upward pull on hawser **42** along the portion thereof which penetrates fitting **36**, resulting in downward pull of the hawser portion connected to housing **30**. Near the mating position between housing **30** and platform **10**, it will be understood that the rotational position and lateral location of housing **30** are both determined and controlled by the relationship between hawsepipe **22** and arm **34**. Thus, since the distance between clevis attachment **44** and fitting **36** substantially coincides with the distance between opposite ends **24** and **26** of hawsepipe **11**, hawser **42** will pull or otherwise forcibly move fittings **36** and **44** into close proximity with ends **24** and **26**. The foregoing alignment function performed by the arrangement of hawser **42** within hawsepipe **22** results in precise orientational congruity between probe **40** and center axis **20** of aperture **18** so that the locking probe and receptacle mounted on housing **30** and platform **10**, respectively, will automatically interengage in a manner particularly shown by FIGS. 2, 4, and 5.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a side elevational view, partly in cross-section, of the novel structure with the two major components disengaged from each other,

FIG. 2 shows an isolated elevational view of a portion of the structure shown in FIG. 1 but with the two major structural components operatively engaged,

FIG. 3 shows a side elevational view, partly broken away, of a portion of the structure shown in FIG. 1 but with the marker buoys and pilot lines operatively associated therewith,

FIG. 4 shows a cross-sectional isolated view of the locking probe in an interim position of incomplate engagement between the two major component of FIG. 1, and

FIG. 5 shows a cross-sectional isolated view of the same structure as in FIG. 4 but with the probe in locking interengagement position securing together the two major components shown particularly in FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now in detail to the drawings mentioned above and particularly to FIG. 1, it may be seen that the inventive concept in this case contemplates a base or platform structure such as generally denoted by reference numerals **10**. Base component **10** is supported on the ocean floor **12** and in vertically spaced relationship therewith by a plurality of upright pilings or stanchions **14**. Platform **10** may be substantially round or polygonal in plan view or any other convenient shape, but in any case should have sufficient size and strength to support and retain the apparatus, protective housings or other such items which are sought to be secured proximate the ocean floor. For example, platform **10** may comprise a plurality of trusses in a star pattern projecting radially outwardly from a centerline **20**. Platform **10** preferably has a substantially planar deck **16** containing a center aperture **18** wherein suitable means are situated for locking additional structure to the platform in a manner described more fully below. Platform **10** also is formed with a hollow U-shaped hawsepipe **22** permanently secured thereto and having opposite ends **24** and **26** spaced apart, upwardly directed, vertically oriented, and substantially parallel to each other. Hawsepipe **22** may be secured to platform **10** by any suitable means such as welded braces **28** shown in FIG. 1.

It will be understood that platform **10** and the elements

secured thereto as discussed above are initially mounted on the ocean floor before erection of the total structure contemplated in this case. After the mounting of platform **10** in the manner shown in FIG. 1, means are provided for using hawsepipe **22** in subsequent operations for lowering deep oceanic structures into position on platform **10**. Referring to FIG. 3, the foregoing means includes a pilot-line **50** which is initially threaded through hawsepipe **22**, preferably before platform **10** and components joined thereto are installed on the ocean floor. Pilot line **50** should comprise material having sufficient strength and water resistance such as nylon, and is long enough to reach the surface at each of its ends while still threaded through hawsepipe. The opposite ends of line **50** each have a buoyant mass or float **52** and **54** secured thereto, suitable lengths of line **50** being stowed in floats **52** and **54** both of which can be released by suitable means when line **50** is needed for use. Floats **52** and **54** may be released from platform **10** by pulling lanyards **60***a* and **60***b*, which withdraw pins **56** and **58**. Upon removal of pins **56** and **58**, floats **52** and **54** are enabled to rise to the surface dragging the end of line **50** to which each float is attached. Thereafter, line **50** is used to install the hauldown cable or hawser **42** shown in FIG. 1, for example. Illustratively, float **54** may be removed from the end of line **50** on the ocean surface, and one end of hawser **42** may be secured to line **50** in place of the mentioned float. Thereafter, upward pulling are sought to be secured proximate the ocan floor. For exforce on the end of line **50** secured to float **52** on the surface by suitable means such as a winch (not shown), will result in downward pull of hawser **42** which should continue until the hawser is completely threaded through hawsepipe **22** and returns to the ocean surface through end **24** of the pipe. Thereafter, the hauldown operation discussed below may begin.

With hawser **42** completely threaded through hawsepipe **22** as shown in FIG. 1, for example, that portion of the hawser protruding from end opening **26** is secured to buoyancy housing **30** by any suitable means such as clevis **44**. Thus, a pair of downwardly depending brackets formed on housing **30** has a looped end of hawser **42** secured releasably therebetween by a removable pin **46** which may be conveniently connected to such pin-pulling means as remotely operated cable **48** operatively associated with guide pulley **49** mounted on fitting **36**.

Housing **30** incorporates stabilizing and control means co-operating with hawser **42** to maintain continuous direction orientation of the housing throughout its descent from the ocean surface to the ocean floor. The stated means include projecting arm support means **34** welded or otherwise secured to a depending skirt portion **32** on housing **30**. Arm **34** has a hollow cup or cable follower fitting **36** affixed on the distal end thereof and through which the end of hawser **42** protruding from end opening **24** of hawsepipe **22** penetrates. From the foregoing arrangement, it will be understood that upward force on the end of hawser **42** and opposite from its connection with housing **30** will cause downward pull on the housing against the upward force resulting from buoyancy of the housing as it is hauled down deeper toward the ocean floor. During descent of housing **30** in the foregoing manner, rotation of the housing about an axis through the same and corresponding generally with center axis **20** in FIG. 1 is effectively prevented by interengagement of fitting **36** and hawser **42**. Moreover, since the spacing between the locations **36** and **44** where hawser **42** engages housing **30** and structural components secured thereto, is essentially equal to the lateral distance between ends **24** and **26** of hawsepipe **22**, it will be understood that housing **30** will be laterally and rotationally oriented in precise predetermined relationship with respect to platform **10** as required for interengagement of their respective attaching means, which function in the manner now to be discussed.

The mentioned attachment or locking means includes an elongate substantially cylindrical probe **40** downwardly depending from housing **30** as shown in FIG. 1, for example. Probe **40** is adapted to contact the sloping sides **62** of a generally conical receptacle **64** and to be guided thereby into a position of substantially concentric alignment with axis **20**. Receptacle **64** is secured within center aperture **18** of platform **10**, and is closely proximate probe **40** at the inner periphery of lower end portion **74** of the receptacle when both are fully operatively interengaged in locking position. Referring to FIG. 2, in the final position of interengagement between major components **10** and **30**, probe **40** is retained within receptacle **64** and relatively horizontal motion is restrained by skirt lip **66** and platform cams **68** so that items **10** and **30** are correctly and precisely oriented. Thus, the end **26** of hawsepipe **22** is spaced from center axis **20** by a distance substantially coinciding with the distance between the center longitudinal axis of probe **40** and the center of clevis **44**. The foregoing dimensional relationship, together with the fact the clevis **44** and fitting **36** are spaced apart a lateral distance substantially coinciding with the distance between ends **24** and **26**, results in automatic alignment of probe **10** during the last few feet of downward travel of the housing.

Referring to FIGS. 4 and 5, it may be seen that probe **40** has substantially cylindrical portion **70** and a generally conical nose portion **72**. Probe **40** extends from and is otherwise supported on hollow housing **30** by suitable means including motor mount **80**. Mount **80** has a massive flange **82** joined to housing **30** for transferring loads between probe **40** and the housing. Mount **80** further comprises an elongate, somewhat cylindrical portion **84** with a hydraulic or electric motor drive means **86** affixed on the upper end thereof and in sealing relationship therewith as suggested by ring seals **88** and **90** in FIG. 5. Mount **80** has a partition or flange-like projection **92** integrally formed therein and having a center aperture through which a jackscrew **94** extends from motor **86** to the upper portion **70** of probe **40**. Thus, jackscrew **94** operatively engages the internal threads of a hole **96** formed in the center of cylindrical portion **70** and concentric with the longitudinal axis thereof. Upper and lower flanges **98** and **100** on jackscrew **94** engage the opposite sides of partition **92** in the manner suggested by FIG. 5, thus preventing relative vertical movement between the jackscrew and the partition. From the foregoing structural arrangement, it will be understood that rotation of jackscrew **94** by operation of drive motor **86** causes vertical translation of probe **40** relative to housing **30** due to force transmitted between the threads of the jackscrew and those on the inside of hole **96**. For reasons discussed below, probe **40** is in the lowermost position relative to motor mount **80** during the descent mode, and is moved upwardly by actuation of motor **86** only after docking of housing **30** on platform **10** is otherwise completed.

Guide and restraining means are also provided to prevent rotation of probe **40** during translational movement thereof caused by rotation of jackscrew **94**. The mentioned guide means may take the form of one or more downwardly extending pins such as suggested by pins **102** and **104** welded on or otherwise affixed to partition **92** and extending into holes **106** and **108** formed in probe **40** and in sliding relationship therewith as suggested in FIG. 5. Vertical sliding movement of cylindrical portion **70** relative to the internal surface **110** of motor mount **80** is thus permitted by the operative relationship therebetween, while suitable sealing means are provided to prevent or minimize sea water leakage and may take form of O rings **112** and **114**.

As further seen from FIG. 5, probe **40** includes self-activating interlocking means in the form of pivoting projection plates or blades **116** and **118** mounted within a hollow cavity **130** in probe **40**. Although only two blades are shown in FIGS. 4 and 5, it will be understood that

four or more such blades may be used instead of only two. During the descent mode, blades **116** and **118** may remain extended in the position shown by FIGS. 1 and 5, for example, and are held in such position by suitable resilient means such as leaf springs or the like as shown by springs **120** and **122** seen in FIGS. 4 and 5. Each of the stated springs bears against a separate one of the blades **116** and **118** which are pivotally movable about stationary pins **124** and **126**, respectively. As probe **40** moves downardly into receptacle **64**, the narrow lower portion **74** of the receptacle contacts the outer distal ends of blades **116** and **118** and cams both blades into the retracted position suggested by FIG. 4 against the biasing force of springs **120** and **122**. After probe **40** has moved downwardly through receptacle **64** a distance whereby blades **116** and **118** no longer contact the inner peripheral surface of portion **74** on the receptacle, both blades rotate outwardly through suitable slots in the opposite sides of cavity **130** under the force of springs **120** and **122** about their respective pivot centers through pins **124** and **126**.

With blades **116** and **118** thus extended, means are provided for preventing radial inward movement of both blades such as would be necessary to retract the same into cavity **130**. The stated means may take the form shown in FIG. 4 showing downwardly depending flanges **128** secured or otherwise formed on the upper end of cavity **130**. Centered between brackets **128** a link **132** having a hole therein through which a pin **134** extends in the manner shown by FIG. 4. Link **132** is joined to a relatively heavy mass **136** having a nose portion **138** and conical side surfaces **140**. Pin **134** releasably retains link **132** between brackets **128** in the position shown by FIG. 4 during descent of housing **30** and probe **40** from the ocean surface. During the final stage of descent, after the probe penetrates through receptacle **64** an amount sufficient to permit extension of blades **116** and **118** in the manner suggested by FIG. 5, pin **134** is pulled by any suitable means such as a control line **142** either automatically or manually operated upon complete interengagement of probe **40** and receptacle **64**. When pin **46** is pulled laterally from the side of probe **40**, mass **136**, which has sufficient bulk or weight to drop vertically under the force of gravity, plunges downwardly into the position shown by FIG. 5, whereby conical surface **140** forcibly cams blades **116** and **118** radially outwardly and the cylindrical portion retains the same in the extended position to resist any loads applied to the blades which would tend to withdraw the same. With blades **116** and **118** thus firmly held in the extended position, motor **86** may be actuated by any suitable remote means to rotate jackscrew **94** in a direction resulting in upward movement of probe **40**, since the probe is in the downwardly extended position in relation to motor mount **80** prior to interlocking engagement with receptacle **64**. Operation of motor **86** with blades **116** and **118** fully extended will result in upward movement of probe **40** until the bearing surfaces **144** and **146** of blades **116** and **118**, respectively, contact the beveled edge **148** and **150** of lower portion **74** of the receptacle. When the blades are in the position thus shown by FIG. 5, actuation of motor **86** may be terminated and housing **30** will remain firmly interlocked with platform **10** by the structural interconnection thereof as suggested in FIG. 2, for example.

I claim:

1. In structure for securing apparatus on the ocean floor:

a first structural component adapted for support on said ocean floor,

a hollow generally U-shaped hawsepipe affixed to said first component with the opposite open ends of said tube each being substantially vertically oriented and upwardly directed,

a second structural component adapted for support on said first component and

hawser means including a hawser attached at one end thereof to said second component threaded through said hawsepipe for hauling said second component down to said first component by pulling upwardly on the other end of said hawser opposite from said one end.

2. The structure set forth in claim **1** above, further including:

a projecting arm on said second component, and

a tubular fitting affixed to the distal end of said projecting arm,

said hawser being slidably threaded through said tubular fitting to maintain the directional position of said second structural component in general correspondence with the relative position of said one hawser end and said other hawser end.

3. The structure set forth in claim **2** above, wherein:

said one end of said hawser is attached to said second structural component at a predetermined distance from said tubular fitting, said distance corresponding to the distance between said opposite open ends of said U-shaped hawsepipe.

4. The structure set forth in claim **1**, further including:

interengagable locking means on said first and second structural components for securing both said components together in relatively fixed relationship,

said locking means including an elongate probe on said second structural component and receptacle means mounted on said first structural component and adapted to receive said probe.

5. The structure set forth in claim **4** above, further including:

extendable blade means in said probe for preventing removal of said probe from said receptacle during mutual interengagement thereof, and

holding means in said probe for holding said blade means in extended position.

6. A method of assembling at least two structural components on the ocean floor, comprising:

initially securing one of said components on the ocean floor,

engaging a mid-portion of a hawser with said one component and in sliding relationship therewith,

securing one end of said hawser to the other of said structural components, and

applying upward pulling force to the end of said hawser opposite from said one end to cause downward pulling force on said other structural component.

7. The method set forth in claim **6** above, further including:

providing directional guidance to said other structural component with respect to said one component by engaging said other structural component with both upward and downward pulling portions of said hawser.

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J. KARL BELL, Primary Examiner

U.S. Cl. X.R.

114—.5