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Cannon et al.

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[54] **APPARATUS AND METHOD FOR OFFSHORE OPERATIONS**

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[21] Appl. No.: **361,810**

Related U.S. Application Data

[63] Continuation of Ser. No. 184,728, Sept. 29, 1971, abandoned.

[52] **U.S. Cl.** ..... **61/69 R,** 61/72.3

[51] **Int. Cl.** **F16l 1/00**

[58] **Field of Search** 61/69, 72.3, 72.4, 46, 61/46.5, 63

[56] **References Cited**

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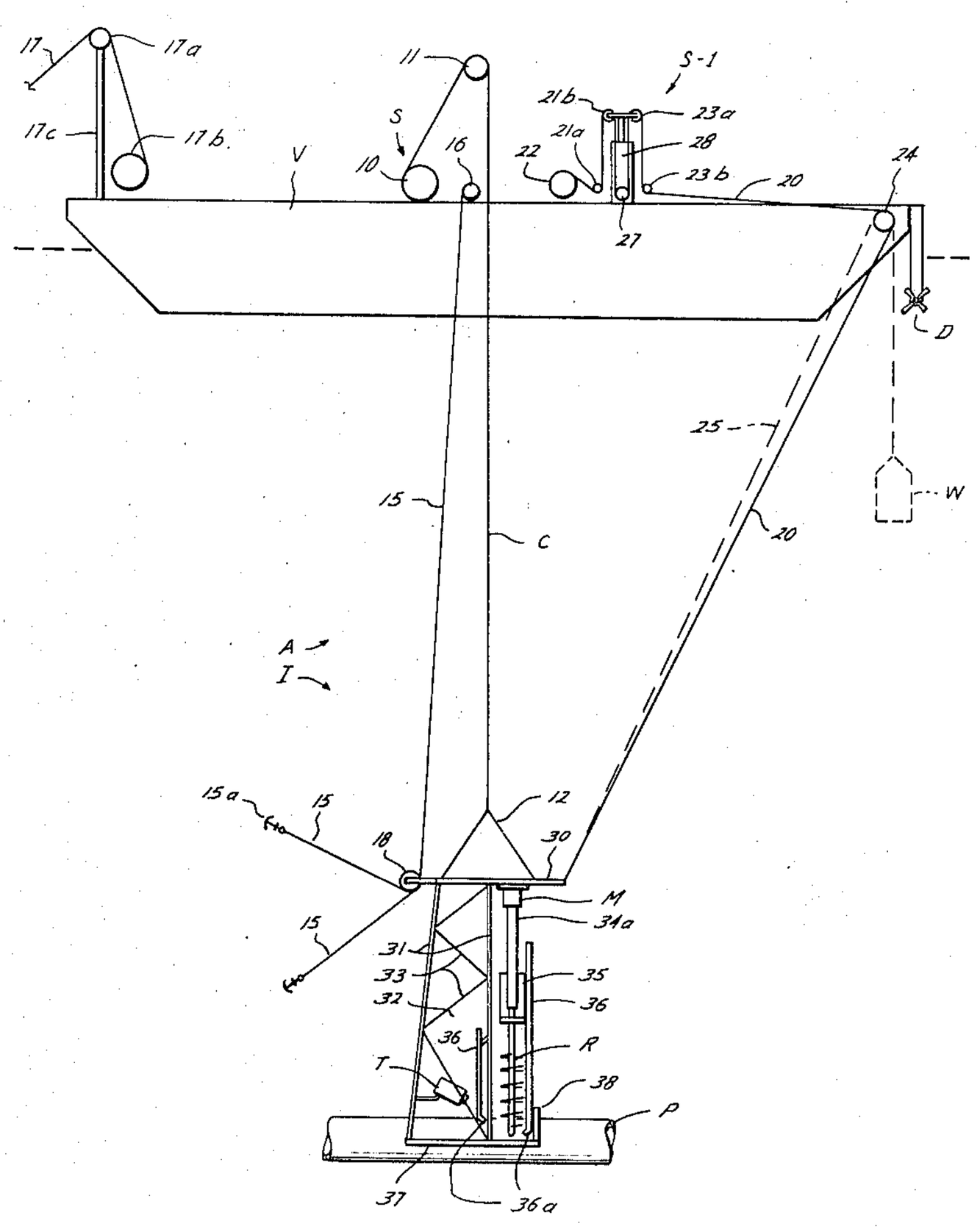
[57] **ABSTRACT**

A new and improved system, apparatus and method for performing operations on the floor of the sea or other underwater locations utilizes a combination of tension devices for maintaining work bodies in desired positions while also permitting viewing of such underwater operations by remote control television camera or other operations.

20 Claims, 9 Drawing Figures



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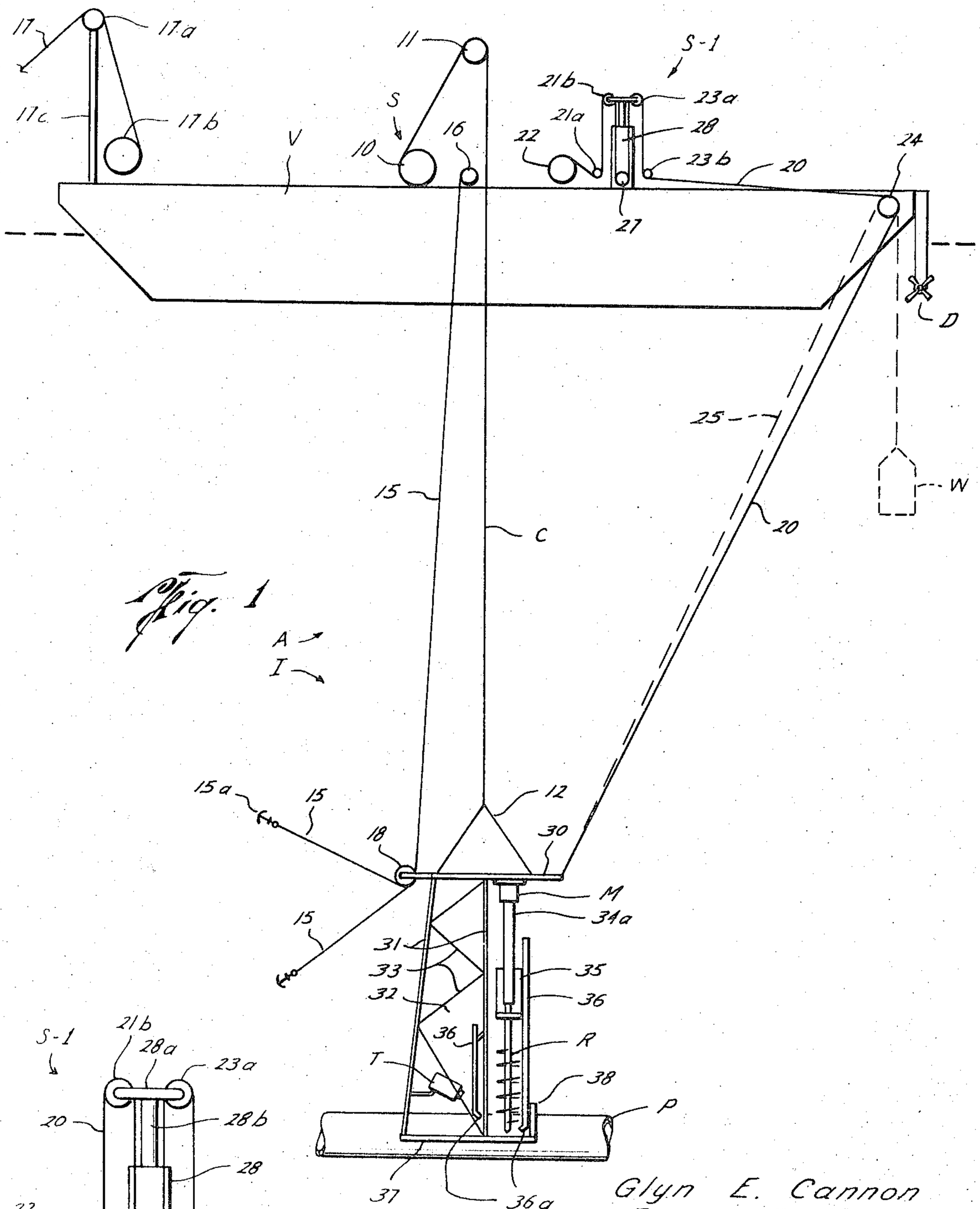

Fig. 1

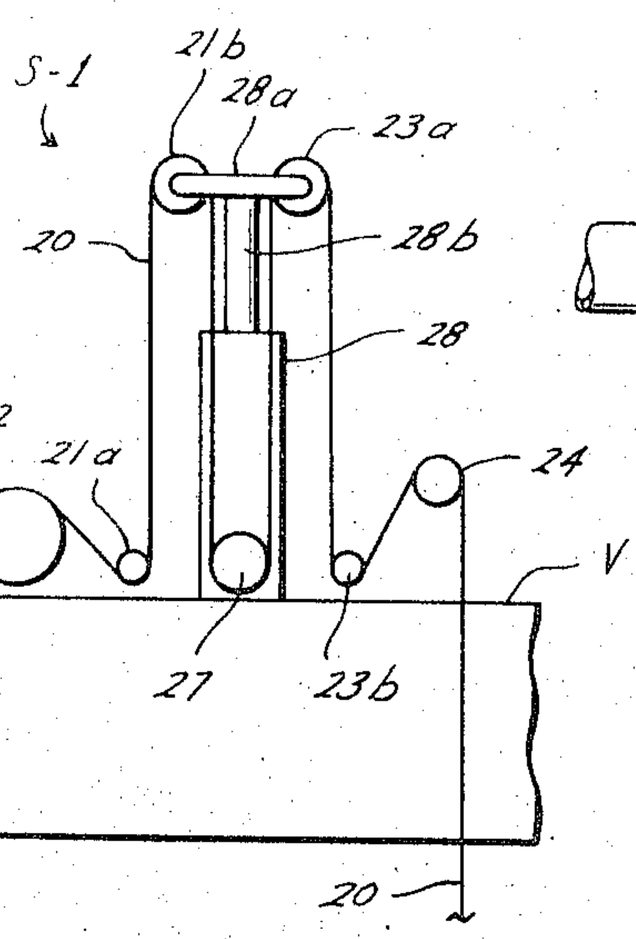

Fig. 5

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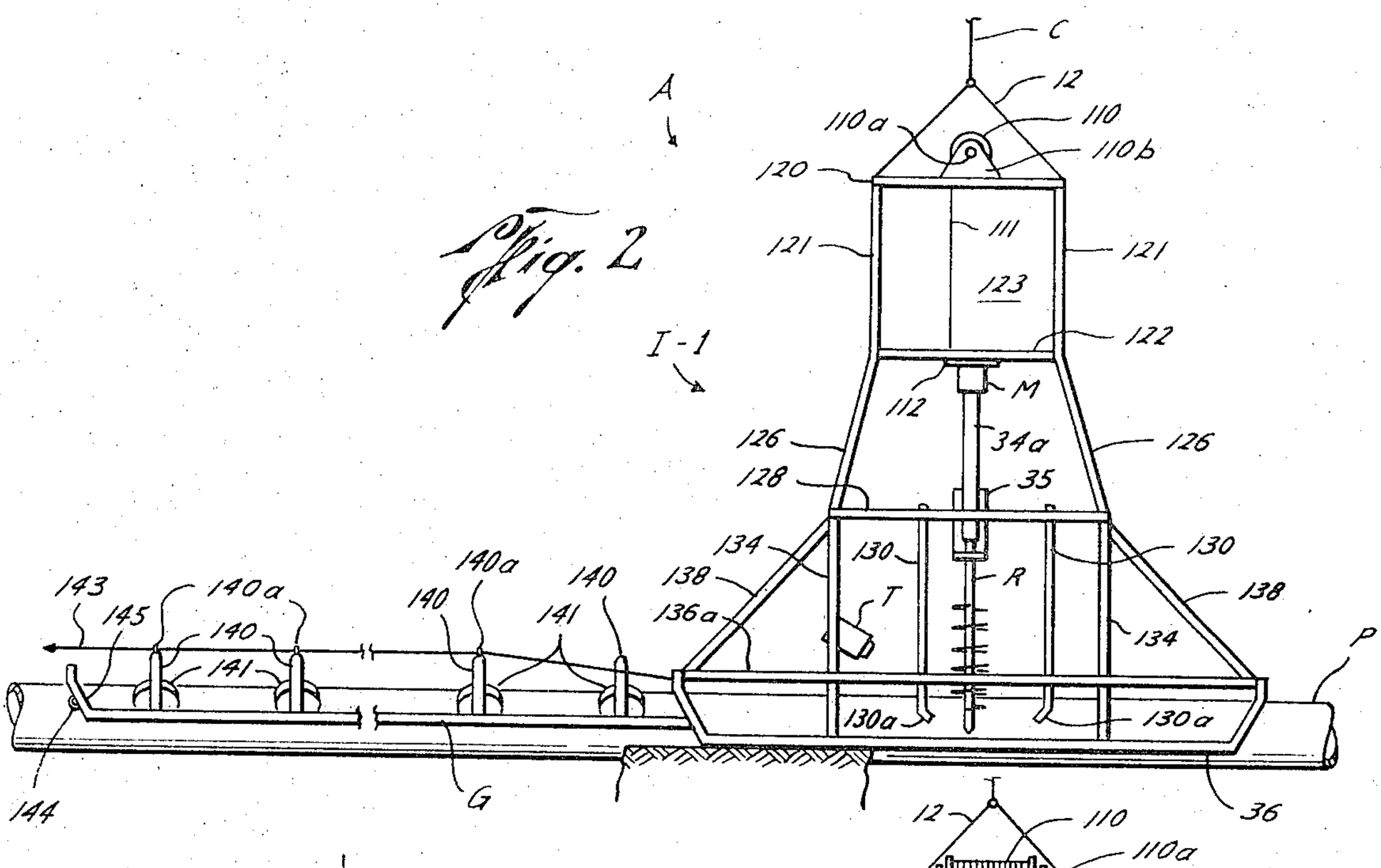

Fig. 2

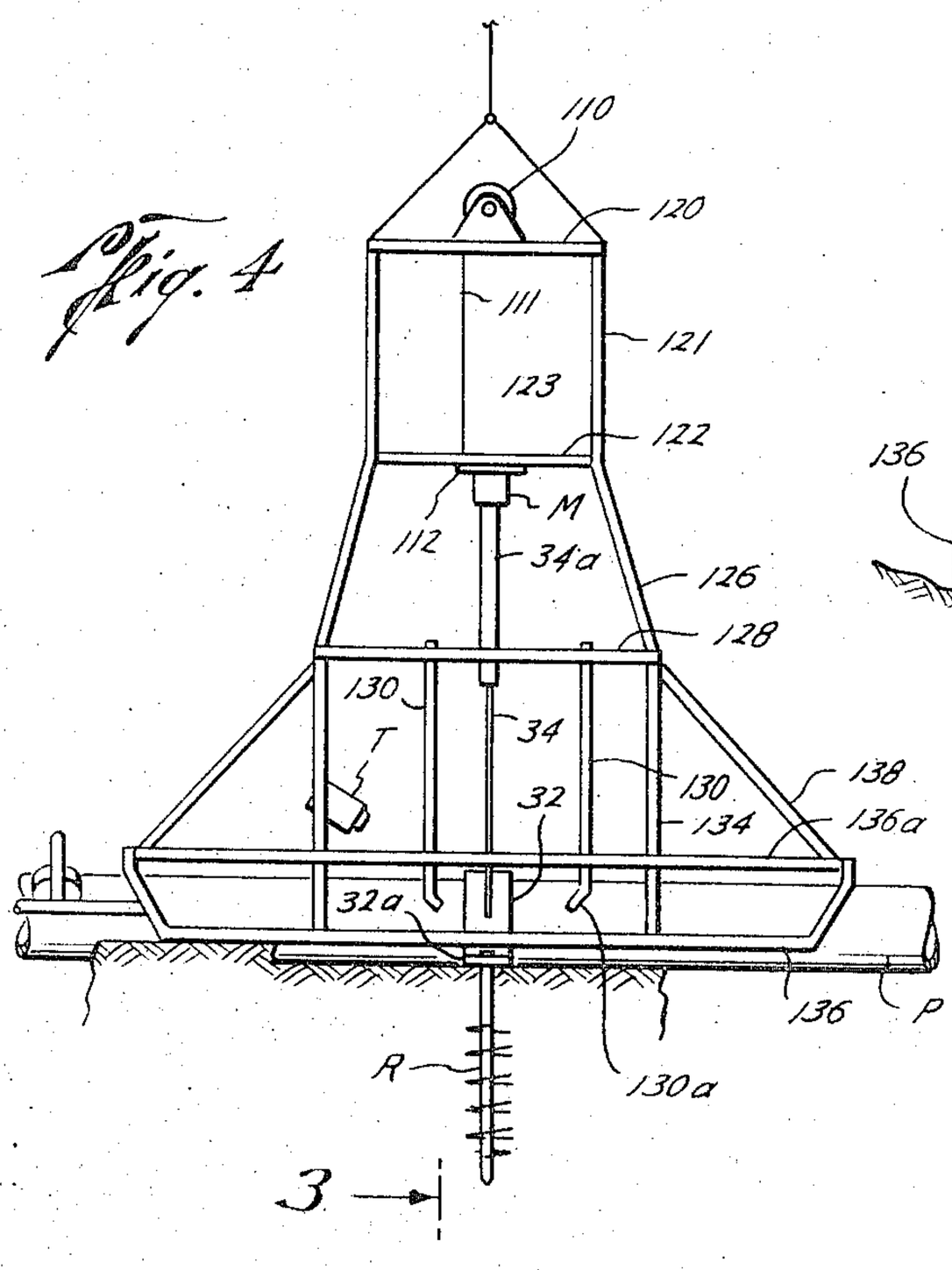

Fig. 4

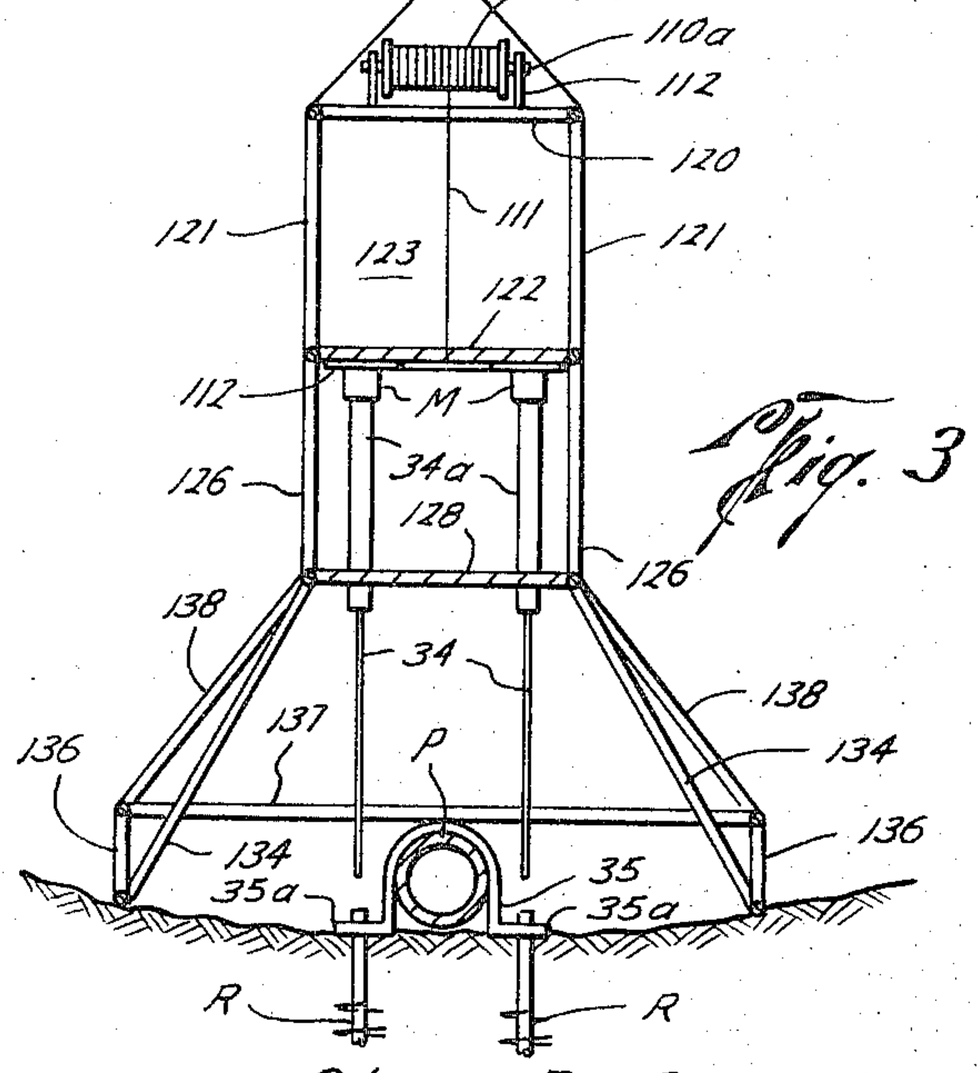

Fig. 3

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Fig. 6

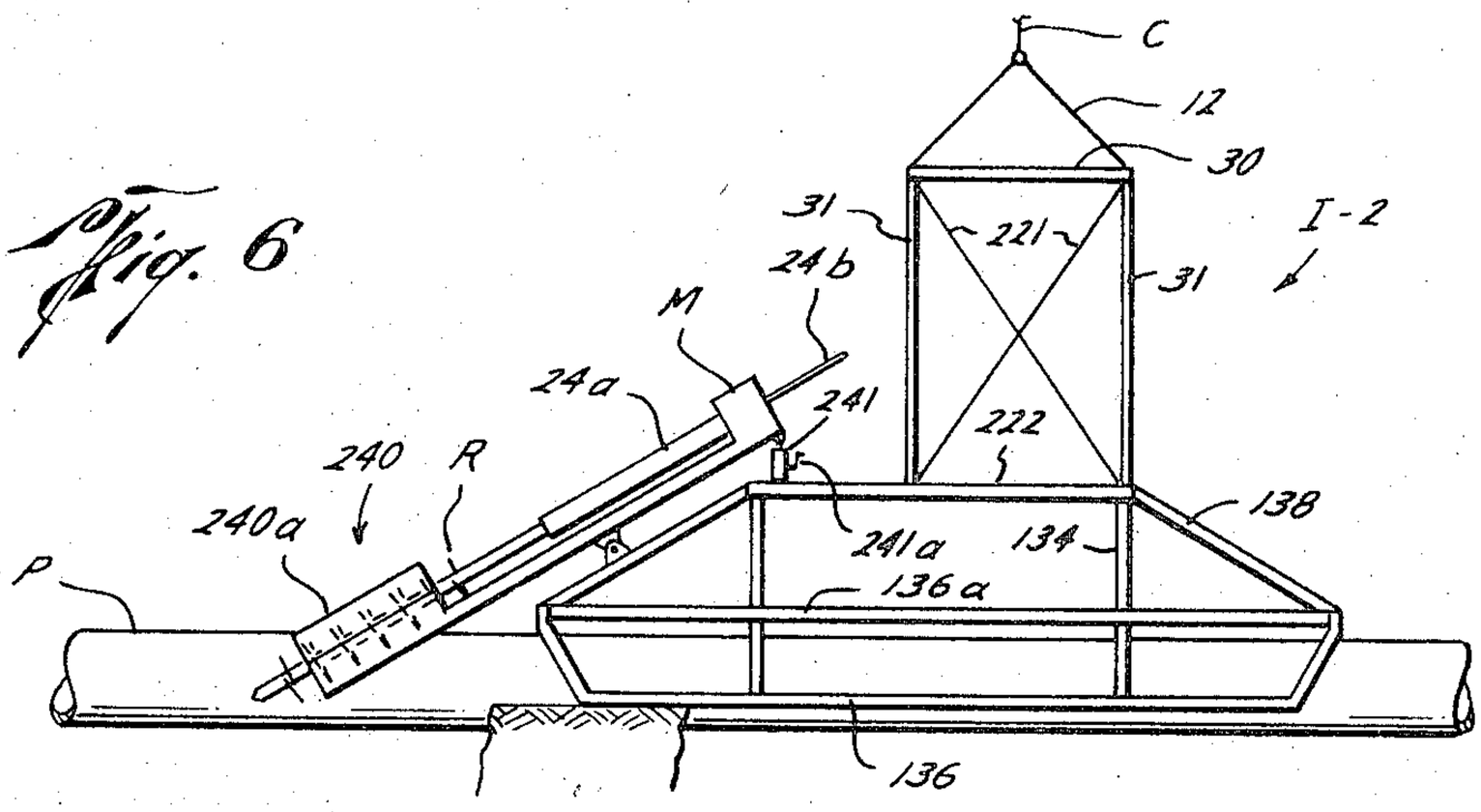


Fig. 7

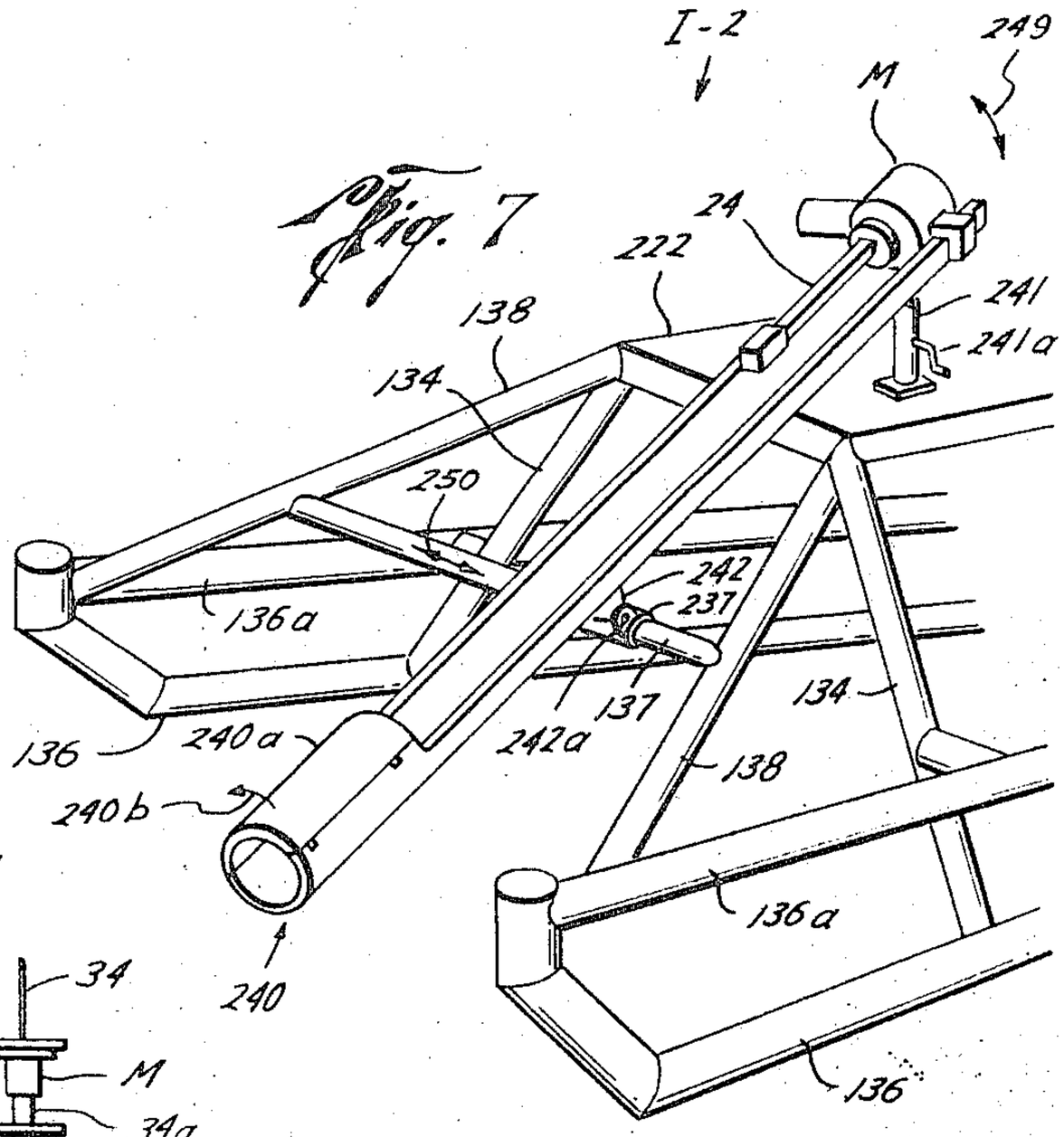
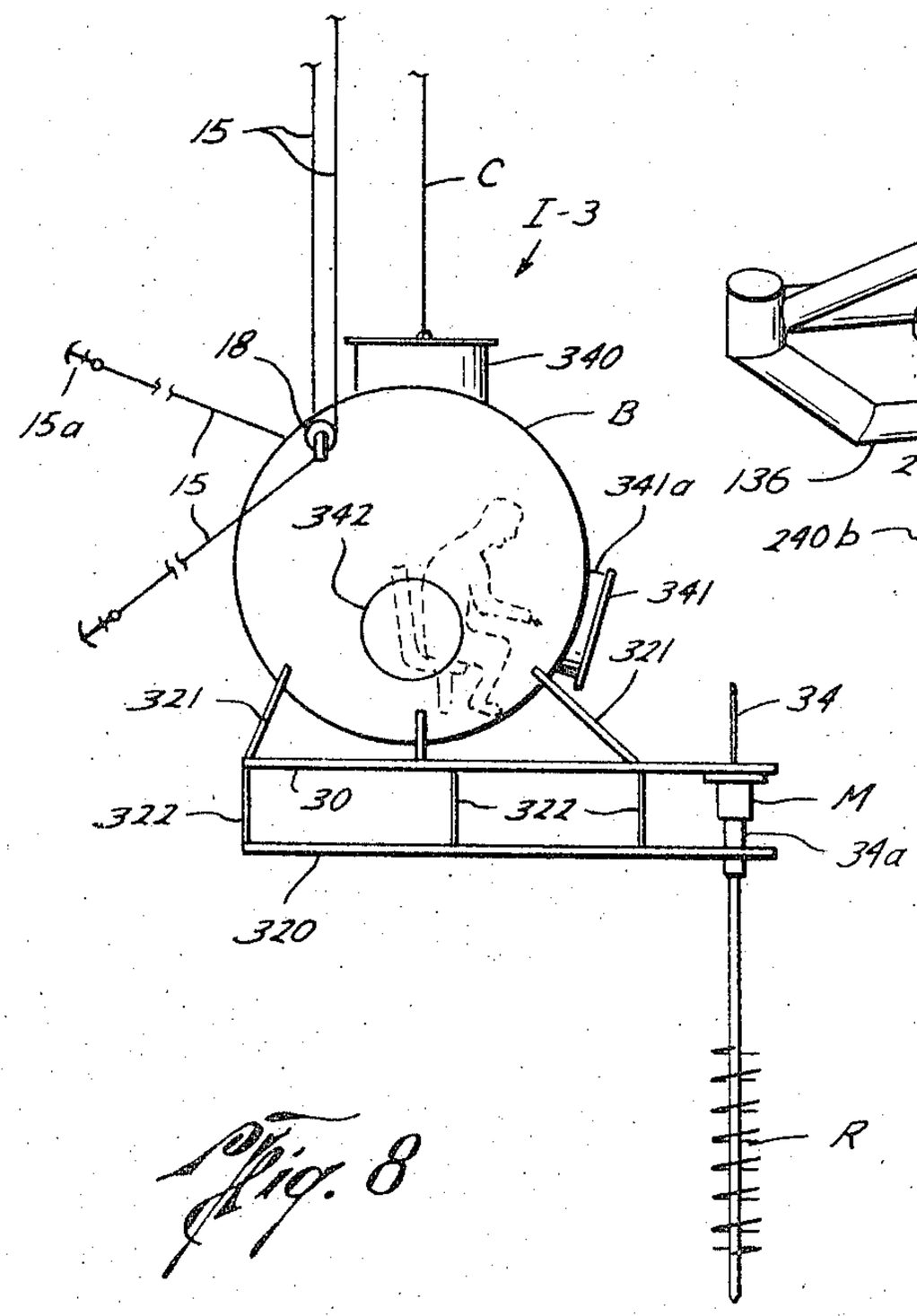


Fig. 8



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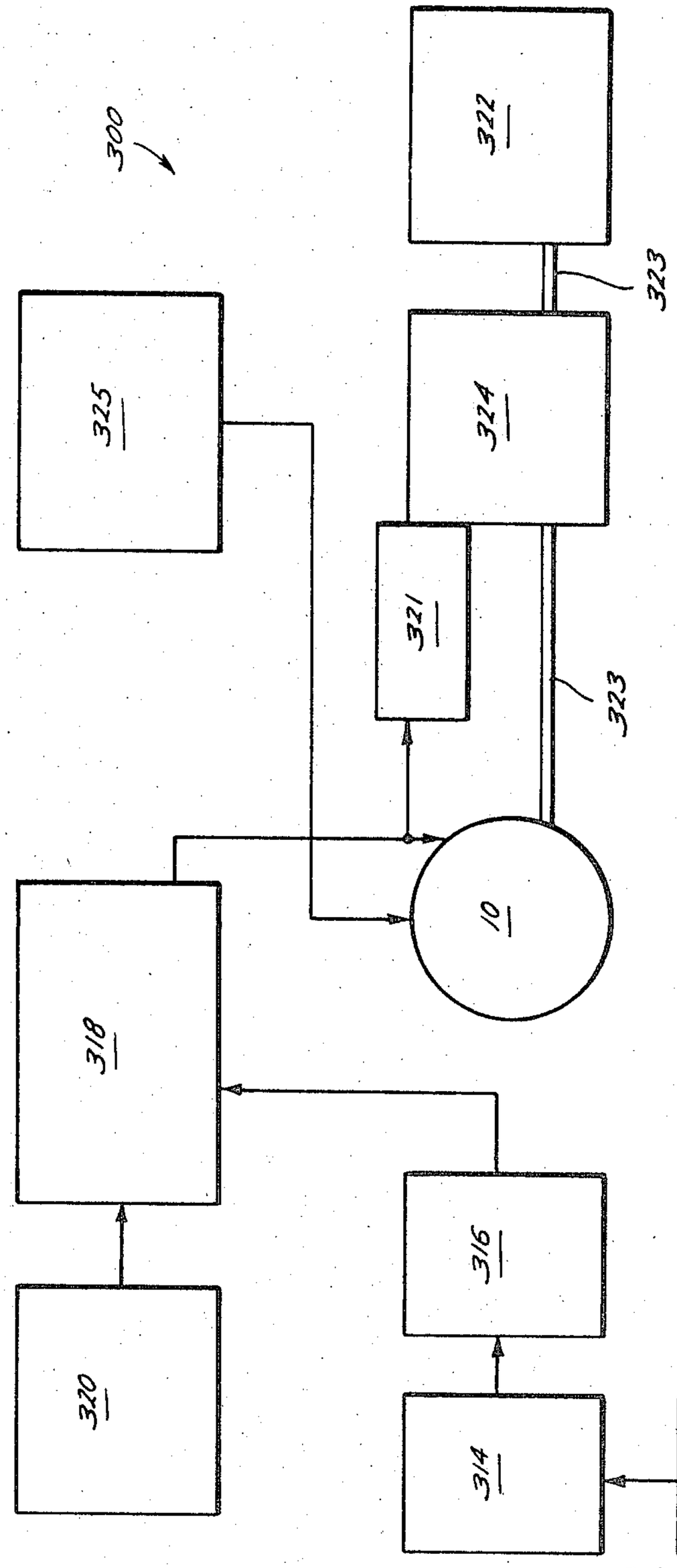

Fig. 9

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APPARATUS AND METHOD FOR OFFSHORE OPERATIONS

CROSS-REFERENCE WITH RELATED APPLICATIONS

This is a continuation of my copending application Ser. No. 184,728, filed Sept. 29, 1971, entitled "Apparatus and Method for Offshore Operations" now abandoned.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to new and improved apparatus and methods for performing offshore operations on the seabed or beneath other bodies of water.

2. Description of the Prior Art

In the prior art apparatus and methods for offshore work operations such as anchoring offshore pipelines, salvage, exploration, repair and the like, such as those of U.S. Pat. Nos. 2,355,086; 3,014,984; 3,324,239; and 3,427,812, stability of the work body or platform with respect to the support ship was difficult to achieve. Consequently, control of the position of the work body or platform with respect to the submarine work operations, was difficult to maintain and achieve, making the work operations expensive, time-consuming, and hazardous. Observation and control of the work operations was also hampered and impaired due to the imprecise control and positioning of the work platform.

SUMMARY OF THE INVENTION

Briefly, the present invention provides a new and improved method and apparatus for offshore submarine work operations, such as anchoring pipeline beneath a body of water, salvage, repair, exploration, and the like, wherein a sled or work platform or body is lowered from a marine vessel into a position adjacent the work operation, and the work is performed beneath the body of water while the position of, and relative movement between, the vessel and the work operation and work platform is controlled in order to permit stability of the platform during work operations.

Relative movement between the vessel, the pipeline or other work piece, and the work platform is controlled by sensing the position of the vessel with respect to the pipeline and regulating movement of the work platform in response to the sensed position of the vessel.

When anchoring submarine pipeline, the augers used in anchoring may be stored with the work or installation sled and accessible to the submarine installing operations in order that anchoring operations need not be interrupted for new augers for the next anchoring operation to be lowered from the vessel after a preceding anchoring operation. The augers may be driven vertically or obliquely into the earthen floor beneath the body of water, and the pipeline may be buried by entrenching the pipeline prior to anchoring it.

It is an object of the present invention to provide a new and improved method and apparatus for offshore operations.

It is an object of the present invention to provide a new and improved method and apparatus for offshore work operations beneath a body of water with improved stability of such work operations.

It is an object of the present invention to provide a new and improved method and apparatus for anchoring pipeline beneath a body of water.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an elevation view of an apparatus of the present invention for installing submarine anchors and anchoring submarine pipeline;

FIG. 2 is an elevation view of an alternative apparatus of the present invention for installing submarine anchors anad anchoring submarine pipeline;

FIG. 3 is a cross-sectional view taken along the line 3—3 of FIG. 4;

FIG. 4 is an elevation view of the apparatus of FIG. 2 with the parts thereof in slightly different positions;

FIG. 5 is an elevation view, partly schematic, of the means for controlling the relative position and alignment between the apparatus of FIG. 1 of the present invention and the work being performed;

FIG. 6 is an elevation view of an alternative apparatus for installing submarine anchors;

FIG. 7 is an isometric view of a portion of the apparatus of FIG. 6;

FIG. 8 is an elevation view of an alternative apparatus for anchoring submarine pipeline; and

FIG. 9 is a schematic block diagram of the control system of the present invention for controlling relative movement of the work platform and the underwater work operation.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In the drawings, the letter A designates generally the apparatus of the present invention for controlling offshore work operations, such as undersea search, salvage, exploration, repair, or recovery. For example, in the embodiment set forth in the accompanying drawings, a submarine pipeline P, which carries oil, gas, or other gases or fluids, is anchored to the submarine earthen floor or surface beneath a body of water, such as an ocean, sea, lake, river, or the like. It should be understood that the item "submarine" when used in connection with the description of the present invention includes and refers to objects beneath any of such bodies of water.

The apparatus A includes a work platform, which is an anchoring installation platform I when anchoring pipeline. The platform I is suspended from a marine vessel such as a barge, ship, boat, floating or fixed platform, or the like by a cable C. When the platform I engages the submarine earthen floor, such platform functions as a sled. The tension in the cable C is controlled, in a manner to be more evident hereinbelow, in order to regulate relative movement between the vessel and the work platform I and the pipeline P. It should be understood that other work bodies or work platforms are used when performing other types of offshore operations such as salvage, repair, or exploration, and relative movement of same is controlled by the method and apparatus of the system of the present invention in a like manner to the control of the movement and position of the work platform I to be set forth hereinbelow.

The cable C is stored with a tension control winch 10 of the control system S and extracted therefrom as the work platform I is lowered from the vessel to a position

adjacent the pipeline P in order to anchor such pipeline to the earthen floor beneath the body of water. The winch **10** is mounted at a suitable location with the vessel V. The cable C passes from the winch over a pulley **11** mounted with the vessel V at a suitable location and attaches with a bridle **12** to mount the work platform I with the vessel V.

The control system S of the present invention controls and regulates relative movement of the work platform I with respect to the work piece during offshore operations, for example, the installation platform I and the pipeline P during anchoring operations in order that movement of the surface vessel V is not transferred to the work platform I. As has been previously set forth, control of the movement and position of other types of work bodies or work platforms and offshore operations can be performed by the apparatus A and system S of the present invention. In the embodiment illustrated in FIG. **2** an alternative work platform I-1 anchors the pipeline P to the earthen surface beneath the body of water. However, it should be understood that the control system S may be used to regulate and control the position of and relative movement between the vessel V and each of the alternative installation sleds set forth herein, and of other work platforms and work sleds, as has been previously set forth.

One or two maximum positoning cables **15** each of which is stored at one end in a reel **16** mounted with the vessel V, and passes over a pulley **18** mounted with the work platform I. The cables **15** have anchors **15a** mounted at the ends thereof opposite the reel **16,** and are used for horizontal control and positioning the work platform I with respect to the pipeline P after the vessel V has moved into the vicinity of the submarine work operation to be performed.

An additional positioning and control cable **17,** stored on a reel **17***b* and passing over a pulley **17***a* mounted with a support arm **17***c* on the vessel V, has an anchor mounted at the opposite end thereof which is lowered into position to assist in controlling and maintaining the vessel V in the desired position relative to the pipeline P during anchoring operations. The anchors at the ends of the positioning cables **15** and **17** are positioned in the body of water or on the earthen floor beneath the body of water in order to control and maintain the work platform I in the desired position with respect to the pipeline P and the vessel V during anchoring operations.

The control system S controls and regulates relative movement of the work platform with respect to the pipeline P when the vessel V has been moved into position in the desired location relative to the pipeline P.

A sensing and control section **300** (FIG. **9**) of the control and regulation system S which regulates and controls relative movement between the vessel V and the installation sled or work platform I and the work piece or pipeline P senses the position of the work platform relative to the earthen floor beneath the body of water and compensates for movement of the vessel V with respect to the installation sled I and pipeline P by controlling the tension in the controlled tension winch system **10** (FIGS. **1** and **9**), to provide safe and stable offshore work operations with the platform I.

A transducer **310** mounted with the platform I receives an electrical signal from a sonar set **312** and transmits such signal into the body of water in order to sense the position of the work platform I relative to a sonar target, which may be the floor beneath the body of water or an object upon which work operations are being performed. The transducer **310** receives the return signal from the floor or object beneath the body of water and converts such signal into an electrical signal and furnishes such signal to the sonar set **312.**

The sonar set **312** provides an electrical output indication of the position of the platform I with respect to the floor of the body of water or object and furnishes such electrical signal to an alternating current-direct current converter **314** which receives the electrical signal indicative of the relative position of the platform I with respect to the pipeline P and the floor of the body of water and converts such into a direct current amplitude. A potentiometer or other suitable means for manually adjusting the amplitude of the direct current signal formed by the converter **314** may be provided, if desired.

The converter **314** furnishes an electrical signal to a solenoid **316** which mechanically adjusts the flow of air from a pneumatic pressure or air supply source **320** by means of a valve **318** or other suitable structure. Other means which control the flow of pressurized air from a pneumatic pressure source in response to the amplitude of a direct current signal may be used, if desired. The controlled tension winch system **10** is thus pneumatically controlled and hydraulically operated and adjusts the tension in the cable C in accordance with controls furnished through the valve **318** from the air supply **320** under control of the sonar set **312** and converter **314** and solenoid **316.**

A diesel-driven hydraulic power source **322** drives the controlled tension winch system **10** by means of a hydraulic fluid furnished through a fluid conduit **323.** A hydraulic speed and reversing control system **324** which controls and regulates the flow of hydraulic fluid through the conduit **323** is provided to control the speed and reversing of the direction of operation of the winch system **10.** An air-operated switch **321** receives pressurized air from the valve **318** and furnishes a signal indicative of a change in the relative position of the work platform I with respect to the pipeline P to the hydraulic speed and reversing control **324** in order to permit the hydraulic power supply **322** to adjust the tension in the winch **10** in accordance with the control signal provided by the sonar **312,** converter **314,** and the pneumatically-operated valve **318** controlled by the solenoid **316.**

A water-cooling system **325** is provided and provides cooling water flowing through the winch **131** in the interior thereof to prevent excess heat from resulting from the movement and adjusting the tension in the cable C by the winch **10** for safety and like purposes.

A cable **20** of a control system S-**1** (FIGS. **1** and **5**) is attached at one end thereof to the work platform I. The cable **20** is stored in a winch **22** with the vessel V, and passes from the winch **22** over pulleys **21***a*, **21***b*, **23***a*, **23***b*, **24,** and **27** to work platform. The winch **22** reels in and passes out the cable **20** as the work platform I is raised and lowered from the vessel V into position with respect to the submarine work operation. The cable **20** passes from the winch **22** over pulleys **21***a*, **21***b*, **27, 23***a*, **23***b*, and **24** into the water and to the work platform. The cable **20** provides a second attachment means for connecting the platform I with the vessel V and prevents torsion or twisting of the work plat-

form in relation to the heading of the vessel V. The double attachment of the platform I with the vessel V causes the platform I to move in conjunction with the vessel V and reduce torsion or twisting in the cable C. Additionally, the cable 15 could be mounted with and controlled by a winch of like structure and function to the winch 22, if desired.

A thruster D may be mounted with the vessel V, and may be, for example, an outboard motor or other suitable means for causing movement of a marine vessel, in order to adjust the position of the vessel V with respect to the pipeline P should the tension and torsion of the cable C become unduly large. A similar thruster may be mounted with the work platform I, if desired.

An alternative means for controlling and maintaining positioning of the work platform I with respect to the pipeline P, illustrated in phantom in the drawings (FIG. 1), comprises a cable 25 which is attached to the work platform I and passes over the pulley 24 to a dead weight W which is suspended in the body of water from the vessel V by the cable 25. When the alternative means for controlling relative movement is used, the dead weight W and the work platform I are movable with respect to the vessel V in order that movement of the vessel V does not cause movement of the work platform I. In this manner, wind, surface currents, tides, rough weather, or choppy waves at the surface of the body of water do not cause unstable and unsafe anchoring operations at the work platform I. As the vessel V moves with the rough water, the weight W will remain substantially stationary and cause the cable 25 and the platform I to remain substantially stationary, allowing the platform I to remain stable with respect to the pipeline P.

In the system S-1 (FIGS. 1 and 5) for controlling relative movement of the work platform I with respect to the pipeline p, the cable 20 absorbs the movement of the surface vessel V so that such movement is not imparted to the cable 20 and the work platform I. The cable 20 is stored in the winch 22 and passes over the pulleys 21*a*, 21*b*, 27, 23*a*, and 23*b* to pulley 24 which is fixedly mounted with respect to the vessel V. The cable 20 passes from the pulley 24 to the work platform I in order to stabilize anchoring operations. The pulleys 21*b* and 23*a* are rotatably mounted with respect to a support arm 28*a*. The support arm 28*a* is mounted at the upper end of a piston rod 28*b* attached to a piston within a pneumatic cylinder 28. The pneumatic pressure in the cylinder 28 is controlled to cause relative movement of the piston rod 28*b* and the pulleys 21*b* and 23*a* mounted therewith, in order to limit relative vertical movement of the work platform I in relation to movement of the vessel V as has been previously set forth. The piston 28 may alternatively be operated hydraulically rather than pneumatically, if desired.

The work platform I includes an upper support plate 30 (FIG. 1) mounted serving as a motor support platform and having mounted therewith a plurality of downwardly extending support legs 31. The bridle 12 is mounted at the corners of the upper surface of the upper support plate 30. A storage space 32 is formed beneath the support plate 30 and between the support arms 31 for reasons to be more evident hereinbelow. Cross-braces 33 may be used, if desired, to strengthen and support arms 31 and the support plate 30.

The motor support plate 30 is preferably formed from a suitably strong wire mesh in order to permit passage of water therethrough as the platform is lowered and moved in the water. The plate 30 has a plurality of drive motors M mounted therewith. The drive motors M may be hydraulically driven or electrically driven and receive operating power from the vessel at the surface of the body of water through suitable conduits. Each of the motors M drives a drive shaft 34 (FIG. 3) which is mounted with a housing 34a. When the motors drive the shafts 34 in a first direction of rotation, the shaft 34 is driven downwardly towards the pipeline P and the earthen floor beneath the body of water.

An anchoring auger R is mounted at a lower end of each of the drive shafts 34 and is driven into the earthen floor adjacent the pipeline P by the motor M. A U-shaped bracket, collar, or yoke 35 is mounted with the anchoring augers R at outwardly extending flange members 35*a* (FIg. 3) on each side thereof. The anchoring auger R may be a single or multi-helix anchoring auger, as desired. The collar 35 holds the pipeline P firmly in place against the earthern floor beneath the body of water, and prevents undue movement that could create stress and strain on the pipeline P which might result in rupture of the pipeline and pollution of the body of water by the fluid escaping from the pipeline P. It should be understood that belts, loops, or other suitable types of retaining devices to secure the pipeline P may be used to anchor the pipeline P to the earthen floor.

A plurality of fluid conduits 36, each having a jet stinger or suction system 36*a* formed at the lower end thereof are mounted with a support leg 31. The jets 36*a* at the ends of the conduits 36 point downwardly and inwardly toward the earthen surface adjacent the pipeline P and spray and fluidize the earthen surface with gas or liquid under pressure or in suction in order that the pipeline P may be uncovered or the covering earth removed to allow the bracket 35 to be installed beneath the earthen floor of the body of water to anchor the pipeline P.

The storage space 32 (FIG. 1) serves as a storage area space for a plurality of anchoring augers R, wherein such augers R are suspended from beneath the upper support platform 20 by hooks, clamps, or other suitable structure. The storage of the augers R in the storage space 32 permits a plurality of anchoring augers R to be stored with the work platform I and lowered with the platform I to a position adjacent the pipeline P. In this manner, the augers R are available for further anchoring operation upon completion of a prior anchoring operation by removal from the storage space 32 by the diver or by remote control equipment or by other anchoring equipment operators. In this manner, it is not necessary, as was the case in the prior art, that anchoring operations be interrupted in order that the anchoring augers for the next drilling operation be lowered from the vessel to the work platform.

A rail member 37 supports and connects the downwardly-extending support legs 31 at the lower ends of said members. A rear yoke member 36 extends between the rail members 37 at the rear ends thereof to connect same for strength and support.

In order to observe the anchoring operations being performed by the apparatus A, a television camera T (FIGS. 1 and 2) is mounted with the strut or support leg 31 of the work platform I in a position wherein observa-

tion of the anchoring operation with the anchoring auger R may be performed. Suitable illumination sources in order to illuminate the body of water and submarine earthen floor beneath the body of water in which the anchoring or other operation is taking place are also provided. The television camera T and the illumination sources receive electrical power from the support vessel through suitable conduits, and the television camera T returns a television picture of the anchoring operation to personnel aboard the vessel in order to monitor and control the anchoring operations, and remotely control such, if desired.

In an alternative work platform or installation sled I-1 of the present invention (FIGS. 2–4), like structure and parts performing like functions to the structure and parts of the installation sled I bear like reference numerals.

The cable C is stored in the vessel V and extracted therefrom as the installation sled I-1 is lowered from the vessel to a position adjacent the pipeline P. A reel **110** is rotatably mounted at an axle **110***a* thereof with respect to the installation sled I at a spindle **110***b* mounted to an upper support plate **120** of the installation sled I-1. A cable **111** is stored with the reel **110** and is attached at a motor support plate **112,** for reasons to be set forth hereinbelow.

The upper support plate **120** is mounted to the bridle **12** at its corners and is mounted above a middle support platform **112** by a plurality of upwardly extending support arms **121.** A storage space **123** is formed between the support plate **120,** the middle support platform **122** and the support arms **121** for reasons previously set forth. Cross braces may be used, if desired, to strengthen the support arms **121** and the support plate **120.** The motor support platform **112** has the drive motors M mounted therewith.

When the motors M are driving the anchoring augers R into the submarine earthen floor, the motor support plate **112** is lowered by the cable **111** to permit such anchoring operation.

A plurality of support legs **126** support the platform **122** above a lower platform **128.** The lower platform **128** is preferably formed from a wire mesh, for reasons previously set forth, and has an aperture formed therein to permit passage of the housing **34** and the drive shafts **34***a* therethrough. The aperture formed in the lower support platform **128** is of sufficient dimension to permit the passage therethrough of the pipeline anchoring collar or yoke **35** which anchors the pipeline P in place.

The anchoring auger R is mounted at a lower end of each of the drive shafts **34** and is driven into the earthen floor adjacent the pipeline P by the motor M. The U-shaped collar or yoke **35** is mounted with the anchoring augers R at outwardly-extending flange members **35***a* (FIG. **3**) on each side thereof.

A plurality of fluid conduits **130,** each having a jet **130**a formed at the lower end thereof are mounted beneath the lower support platform **128.** The jets **130***a* at the ends of the conduits **130** point downwardly and inwardly towards the earthen surface adjacent the pipeline P and spray and fluidize the earthen surface for reasons previously set forth.

A plurality of struts **134** support the lower platform **128** above a pair of runners **136** which extend longitudinally with respect to the pipeline F when the apparatus A is mounted adjacent the pipeline for anchoring operations. The runners **136** engage the earthen surface beneath the body of water and support the apparatus A above the pipeline P (FIG. **3**). A longitudinal support brace **136**a extends between the ends of the runner **136** and provides support for the runners **136.** A lateral support brace **137** extends between the runners **136** (FIG. **3**) to provide further structural support for the installation sled I at each end thereof. A plurality of angular support braces **138** are mounted between the lower support platform **128** and the inner section of the runners **136** and the lateral support braces **137** to provide further strength and support and stability for the installation sled I-1 during anchoring operations.

As previously set forth with respect to the storage space **23,** the storage space **123** (FIG. **2**) in a like manner, serves as a storage area space for a plurality of anchoring augers, wherein such augers R are suspended from beneath the upper support platform **20** by hooks, clamps, or other suitable structure.

A pair of guide bars G extend forwardly from the runners **136** in the installation sled I-1 in the direction of the longitudinal axis of the pipeline P. A plurality of yokes or collars **140** are formed extending between the guide bars G above the pipeline P. Wheels or rollers **141** are mounted with the yokes **140** and engage the exterior surface of the pipe P and support and guide the installation sled I-1 as such sled is being moved along the pipeline P between anchoring operations. An eyelet **140***a* is formed in the top surface of the yokes **140** to permit passage therethrough of a tow line or cable **143.** The tow line or cable **143** is attached with the installation sled I-1 at the runners **36** in order that the installation sled I-1 may be moved along the pipeline P after completion of each anchoring operation to a position for beginning of a new anchoring operation, as will be more evident hereinbelow. Alternately, the tow line may be attached to an eyelet **144** formed in an upwardly-extending front member **145** of the guide bar G in order that the installation sled I-1 may be towed along the pipeline P between anchoring operations.

In order to observe the anchoring operations being performed by the apparatus A, the television camera T (FIGS. **2** and **3**) is mounted with the strut **134** of the installation sled I-1 in a position wherein observation of the anchoring operation with the anchoring auger R may be performed.

When the pipeline P to be anchored has been recently installed, jet stringers or suction systems similar to jets **30** and **130** may be mounted with the guide bar G to fluidize and soften the submarine earthen floor in order to entrench the pipeline P as such pipeline is being anchored by the augers R and brackets **35.**

An installation sled I-2 (FIGS. **6** and **7**) drives the anchoring augers R obliquely into the ocean floor adjacent the pipeline P being anchored beneath the body of water. The installation sled I-2 may be used to anchor wire mesh belts circumferentially encircling the pipeline P when such belts are used to anchor the pipeline P, and in addition may be used to anchor collars or other suitable anchoring structure to the earthen floor to anchor the pipeline P.

In the installation sled I-2 like structure to that of the installation sleds previously set forth, performing like functions to such structure bear like reference numerals. The installation sled I-2 is suspended from the marine vessel V by the bridle **12** and the cable C whose tension is controlled by the control system S to control

and regulate relative movement between the sled I-2 and the vessel, as has been previously set forth or towed as shown in I-1 (FIG. 2).

The upper support plate **30** is mounted with a lower support plate **222** by a plurality of support members **31** which are strengthened by supporting cross braces **221.** A plurality of additional anchoring augers R may be suspended from the upper support plate **30** or otherwise suitably stored in the space between the upper support plate **30** and the lower support plate **222** in order that anchoring operations may continue without requiring time to be consumed in order to lower additional augers from the vessel, as has been previously set forth.

The struts **134,** the runners **136,** the longitudinal support braces **136a,** the lateral support braces **137** and the angular support braces **138** mounted with the lower support plate **222** of the installation sled **I-2** are like in structure and function to the like numbered structure of the installation sled **I-1** (FIGS. 2–4).

An auger trough **240** which maintains the anchoring augers R in the proper position during insertion thereof into the earthen surface by the motor M and drive shaft **24** is mounted with the lower support plate **282** of the installation sled **I-2** by a mounting sleeve **241.** An elevation adjusting crank **241a** is mounted with the mounting sleeve **241** to adjust the elevation of the auger trough **240** with respect to the earthen floor and accordingly vary the angle or insertion of the anchoring augers R with respect to the earthen floor (as indicated by an arrow **249**) from an oblique to a substantially vertical angle.

The auger trough **240** is pivotally mounted at a mounting flange **242** by a pin **242*a*** to a sleeve **237.** The sleeve **237** is slidably movable with respect to the lateral support brace **37** as indicated by the arrow **250** (FIG. 7) in order to allow anchoring augers R to be inserted on either or both sides of the pipeline P to anchor such pipeline. The pivotal connection between the auger trough **240** and the sleeve **237** permits the angle of placement of the auger trough **240** with respect to the earthen surface to be varied by movement of the elevation adjusting crank **241*a*** and the mounting sleeve **241.**

A pivotally movable sleeve portion **240*a*** is formed at the lower end of the auger trough **240** and maintains the anchoring augers R in proper position within the auger trough **240** as such augers are being driven into the earthen surface by the motor M and drive shaft **24.** The sleeve portion **240*a*** is pivotally movable as indicated by the arrow **240*b*** (FIG. 7) to allow insertion of new anchoring augers R after completion of a preceding anchoring operation. Such anchoring augers would be removed from the storage space beneath the upper support plate **30** by the diver and inserted within the auger trough **240,** subsequent to which the sleeve portion **240*a*** would be closed (FIG. 7) to maintain the auger R in proper position during insertion.

In an installation platform **I-3** (FIG. **8**) of the present invention like structure performing like functions to the installation sled previously set forth bears like reference numerals to such structure previously set forth. The motor M is mounted between an upper support plate **30** and a lower support plate **320** which are spaced with respect to each other by a plurality of support members **322.** The motor M rotates the drive shaft **34** in order to drive the anchoring augers R into the earthen floor adjacent the pipeline P in order to anchor such pipeline to the earthen floor. Additional anchoring augers R may be suspended from and stored beneath the support plate **320,** for reasons previously set forth.

A bathysphere B is mounted with the upper support platform **30** on a plurality of support legs **321.** The bathysphere B provides submarine housing and life support for an equipment operator who may sit within the bathysphere B (as shown in phantom in FIG. **8**) and operate controls to control the motor M and the anchoring operations or other operations performed by the installation platform **I-3.** The bathsphere B has an entry tunnel or housing **340** formed at the upper surface thereof through which the operator may enter the bathysphere B. The entry tunnel **340** is subsequently closed after the operator enters, and the cable C is mounted with respect to the bathysphere B to lower the bathysphere B and installation platform I-3 into position adjacent the pipeline P. A front operating control window **341** mounted with the bathysphere B by a window housiong **341*a*** and side windows **342** formed with the bathysphere B in order that the operator may observe and control the equipment operations of the installation platform **I-3** from within the bathysphere B. The operator within the bathysphere B may thus observe and control and monitor the anchoring operations of other offshore operations being performed by the installation platform **I-3.**

In the operation of the present invention, the vessel V is moved into position adjacent the pipeline P to be anchored, and vessel V is anchored relative to such work piece, and the anchors **15*a*** and the positoning cables **15,** and the work body or work platform, any of the installation sleds previously set forth, is then lowered into the desired operating position adjacent the work piece pipeline P. The control and regulating system S, including the controlled tension winch **10** and cable C, control and regulate relative movement between the vessel V and the work body, installation sled I, for example, and the work piece, pipeline P, in order to provide safe and stable offshore operations on the floor of the body of water. The anchoring augers R are subsequently driven into the earth adjacent the pipeline P by the motor M and the drive shaft **34** in order to anchor a collar, belt, or other suitable attaching structure about the pipeline P to anchor such pipeline.

The foregoing disclosure and description of the invention are illustrative and explanatory thereof, and various changes in the size, shape, and materials, as well as in the details of the illustrated construction may be made without departing from the spirit of the invention.

We claim:

1. A method of anchoring a submarine pipeline beneath a body of water, comprising the steps of:

lowering a work platform from a transporting marine vessel to a submerged position adjacent the pipeline;

anchoring the pipeline with the earthen floor beneath the body of water;

automatically controlling relative movement between the work platform and the pipeline during anchoring; and

said step of controlling relative movement including:

a. sensing the position of the work platform relative to the pipeline; and

b. limiting movement of the work platform with respect to the pipeline in accordance with the results of said step of sensing, whereby a stable anchoring operation independent of transporting vessel movement may be performed.

2. The method of claim **1,** further including the step of:

monitoring the anchoring operations in order to determine if such operations are proceeding properly.

3. The method of claim **1,** further including the step of:

storing a plurality of anchoring augers with the work platform wherein such augers are available in the submerged position adjacent the pipeline for the next anchoring operation after a preceding operation is completed, permitting the performance of a second anchoring operation without returning the work platform to the transporting marine vessel.

4. The method of claim **1,** further including the step of:

entrenching the pipeline preceding said step of anchoring wherein the pipeline is anchored beneath the earthen floor of the body of water.

5. The method of claim **1,** further including the step of:

uncovering the pipeline preceding said step of anchoring wherein the pipeline is firmly anchored with the earthen floor of the body of water.

6. An apparatus for controlling offshore work operations beneath a body of water, comprising:

a. platform means for lowering from a transporting vessel to a submerged position adjacent the location of the work operation;

b. means mounted with said platform means for performing the offshore work operations; and

c. means for permitting relative movement between the transporting vessel and said work platform means comprising:

1. means for sensing the position of said platform means relative to an object or the floor of the body of water; and

2. means responsive to said means for sensing for regulating movement of said platform means with respect to the object or the floor of the body of water whereby said platform means is maintained in the desired position and movement of said transport vessel at the surface does not induce movement of the work platform relative to the pipeline.

7. The structure of claim **6,** further including:

means for monitoring the work operations in order to insure that such operations are proceeding properly.

8. The structure of claim **6,** wherein said means for performing offshore work operations comprises:

a. auger means for anchoring a pipeline with a submaring earthen surface; and

b. motor means for driving said auger means into the earthen surface.

9. The structure of claim **8,** wherein said platform includes:

means for storing a plurality of said auger means wherein said auger means are available without delay after completion of a prior anchoring operation to permit continuing anchoring operations.

10. The structure of claim **8,** further including:

means for entrenching the pipeline wherein the pipeline is anchored beneath the earthen floor of the body of water.

11. The structure of claim **8,** further including:

means for uncovering the pipeline wherein firm anchoring of the pipeline with the earthen floor is obtained.

12. The structure of claim **8,** further including:

means for positioning said auger means to be driven vertically into the earthen surface.

13. The structure of claim **8,** further including:

means for positioning said auger means to be driven obliquely into the earthen surface.

14. The structure of claim **8,** further including:

means for fluidizing the earthen surface beneath said auger means to facilitate uncovering and entrenching of the pipeline.

15. The structure of claim **6,** further including:

bathysphere means mounted with said platform means for permitting submarine control and observation of the work operations.

16. The structure of claim **6,** further including:

means for lowering said platform means from the vessel, comprising:

cable means for suspending said platform means;

winch means for adjusting the tension in said cable means; and

said means responsive to said means for sensing for regulating movement including:

adjustment means responsive to said means for sensing for controlling said winch means wherein relative movement between the vessel and said platform means is controlled to permit stabilized work operation.

17. The structure of claim **6,** further including:

a cable for supporting said work platform and piston means for stabilizing and controlling the position of said work platform with respect to the vessel to adjust the tension and torsion in the cable.

18. The structure of claim **6,** further including:

cable means movably supported by the transporting vessel and having weight means secured to one end and having the other end secured to the work platform for stabilizing said work platform with respect to the vessel to adjust tension in the cable means.

19. A method for controlling and stabilizing work operations beneath a body of water, comprising the steps of:

lowering a work platform from a transporting marine vessel to a position adjacent the location of the work operations;

performing the work operation;

controlling relative movement between the transporting vessel and the work platform for stabilizing the position of the work platform during the work operations; and

said step of controlling relative movement including:

sensing the position of the work platform relative to an object or the earthen floor beneath the body of water; and

regulating movement of the vessel with respect to the work platform in accordance with the results of said step of sensing, whereby stable and safe work operations may be performed.

20. The method of claim **19,** wherein said step of controlling further includes the step of:

controlling relative horizontal movement between the transporting vessel and the work platform.

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