United States Patent

Banjavich et al.

[15] **3,641,777**

[45] **Feb. 15, 1972**

[54] **METHOD AND APPARATUS FOR WORKING ON SUBMERGED CONDUIT MEANS**

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[21] Appl. No.: **841,777**

[52] **U.S. Cl.** **61/69,** 61/72.3
[51] **Int. Cl.** **B63c 11/40**
[58] **Field of Search** 61/69, 72.3, 81, 82

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Primary Examiner—J. Karl Bell
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[57] **ABSTRACT**

A method and apparatus for working on submerged conduits entailing the use of a conduit manipulating and aligning frame and a working chamber.

The aligning frame straddles independently movable conduit portions. A plurality of clamps engages each conduit portion and the clamps are manipulated to bring the conduit portions into an appropriate alignment.

The working chamber straddles the aligned conduit portions and provides a controlled, relatively dry atmosphere within which conduit repairing, connecting or other operations may be performed.

20 Claims, 28 Drawing Figures

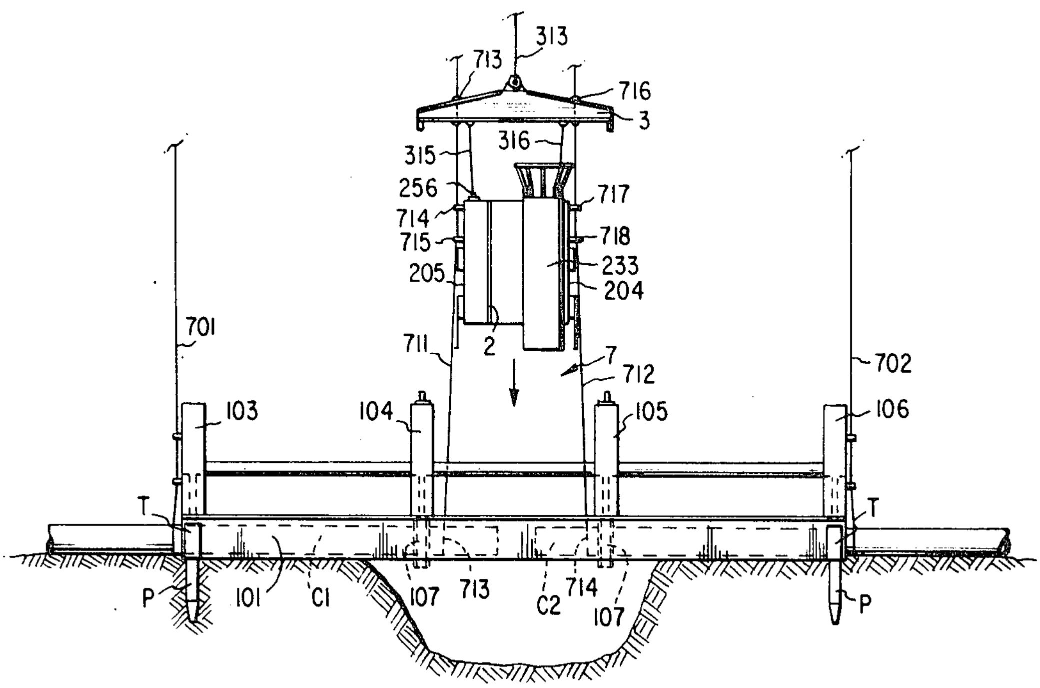

FIG. 1

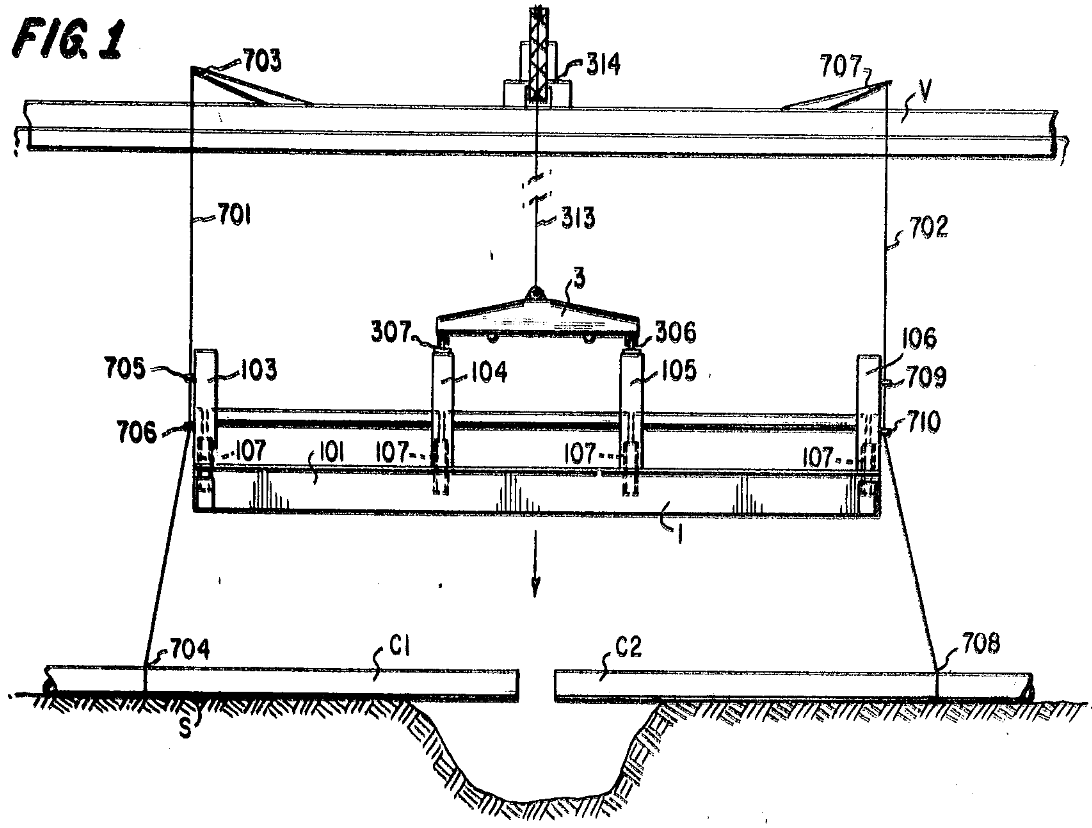

FIG. 2

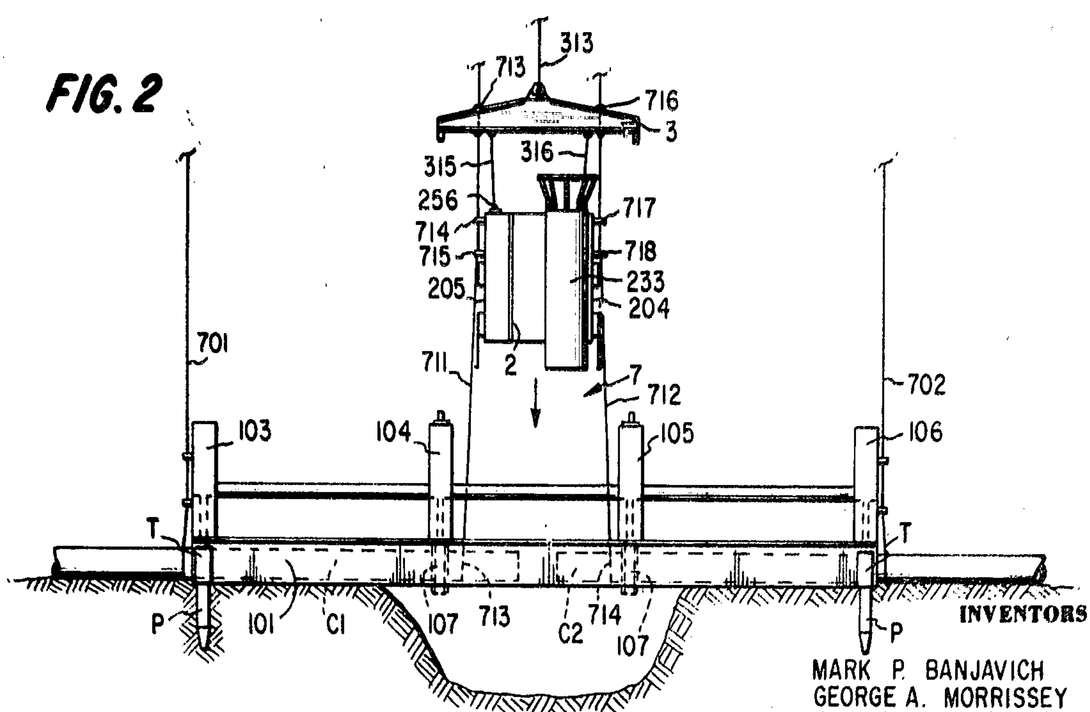

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FIG. 3

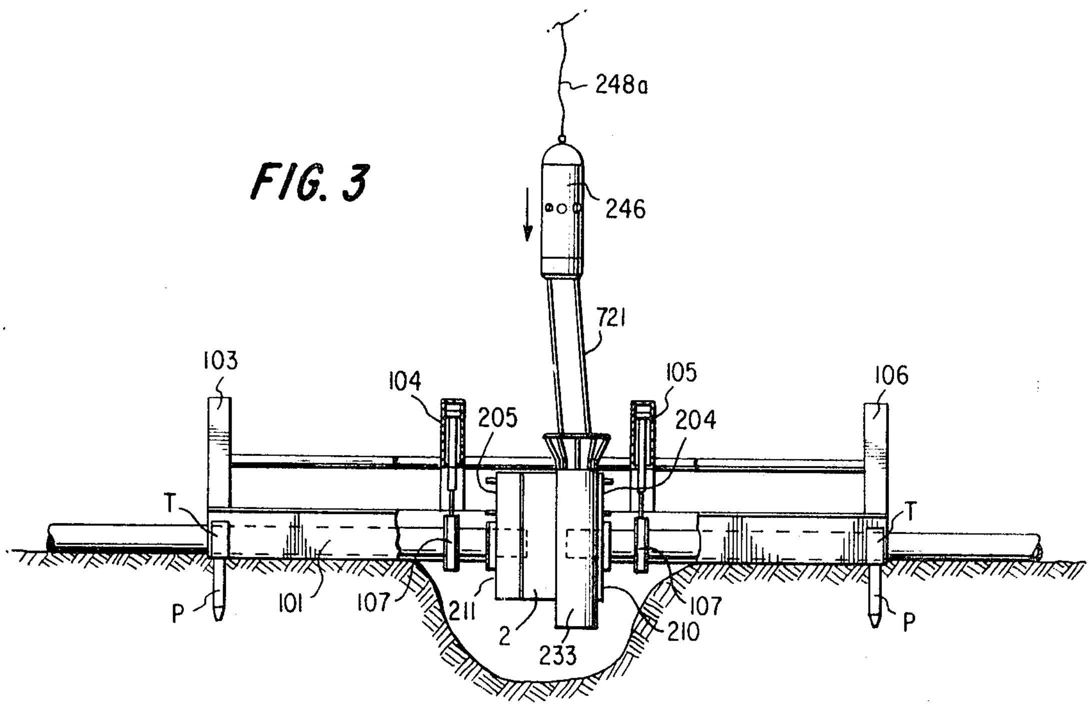
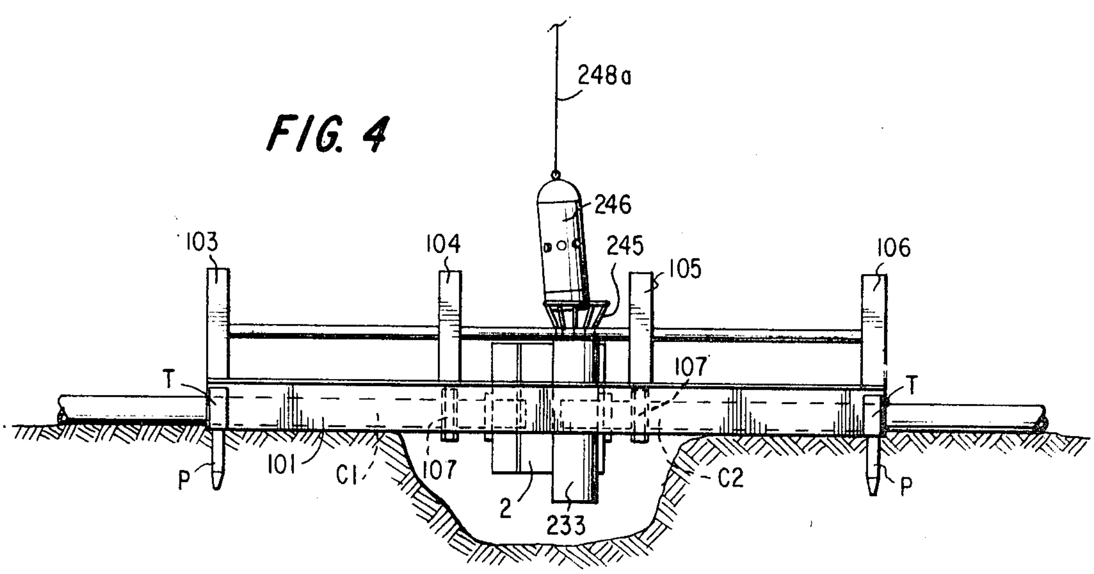


FIG. 4



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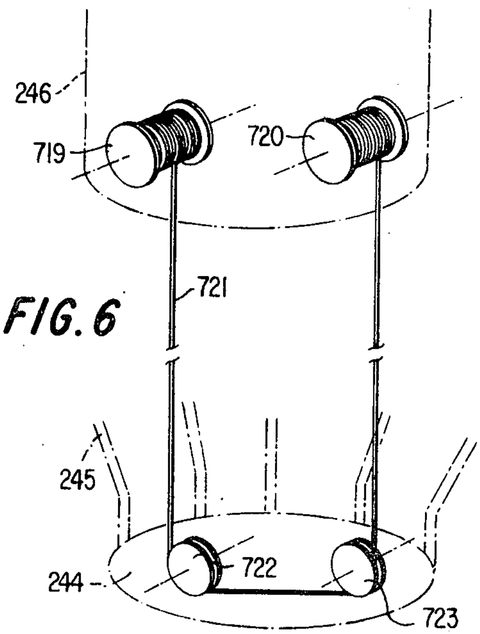

FIG. 6

FIG. 5

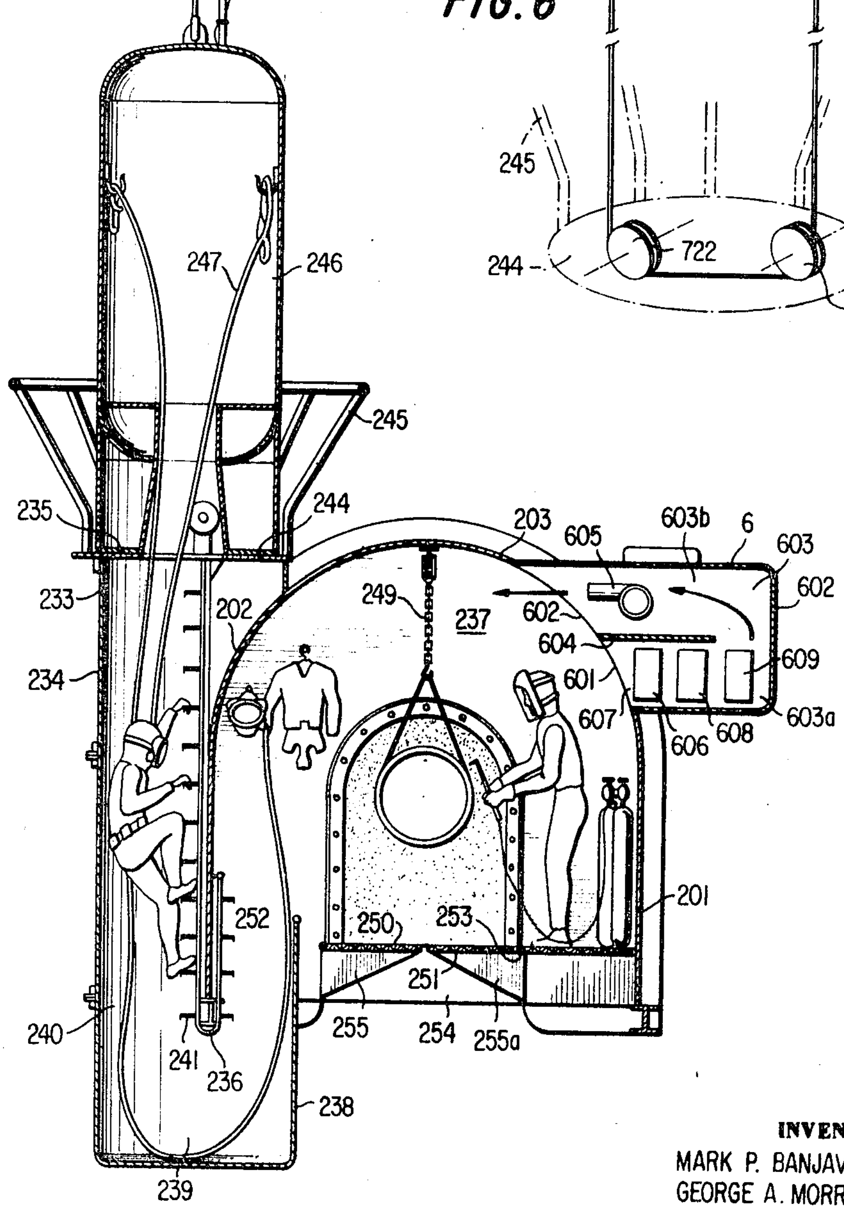

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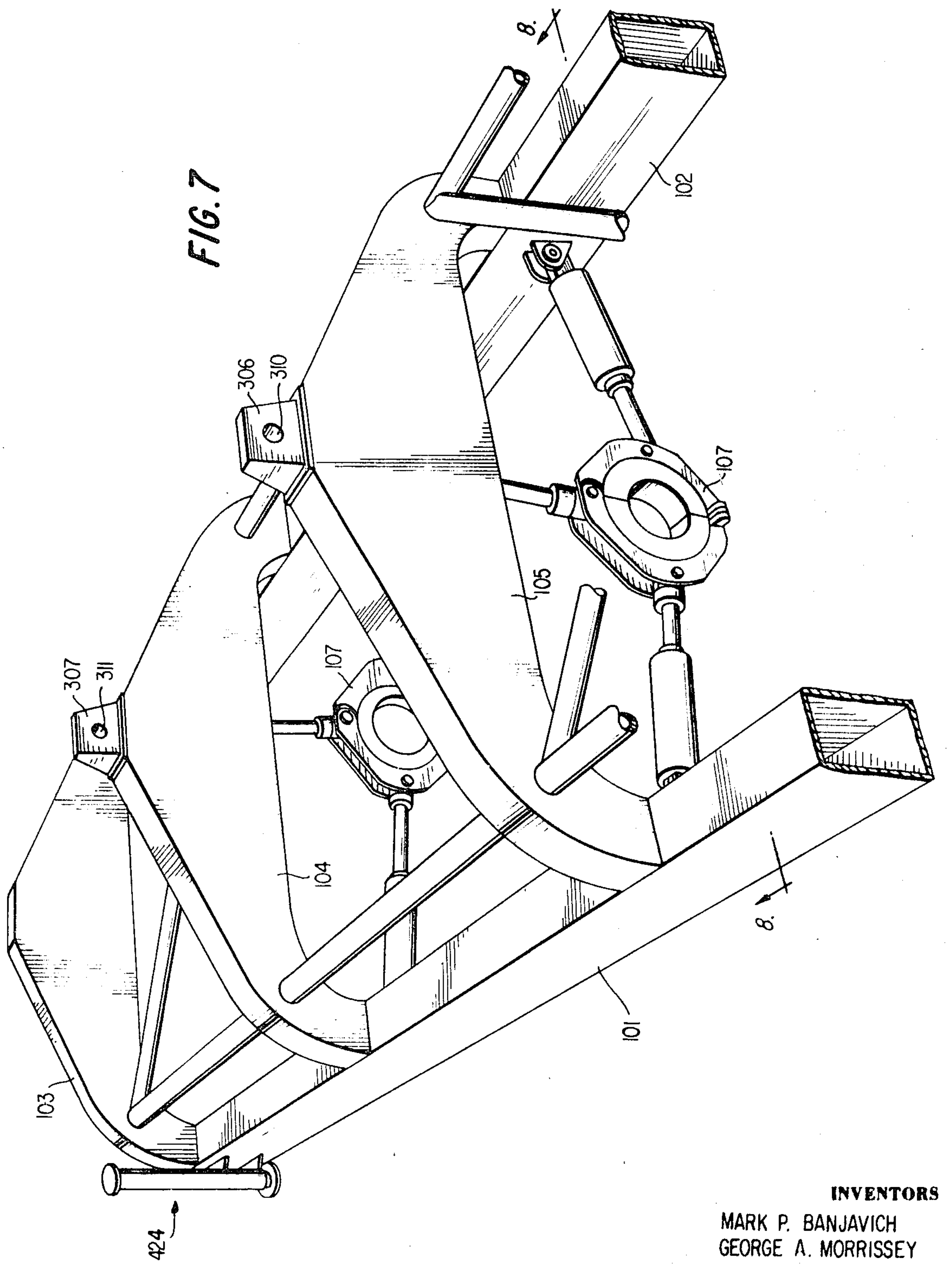
FIG. 7



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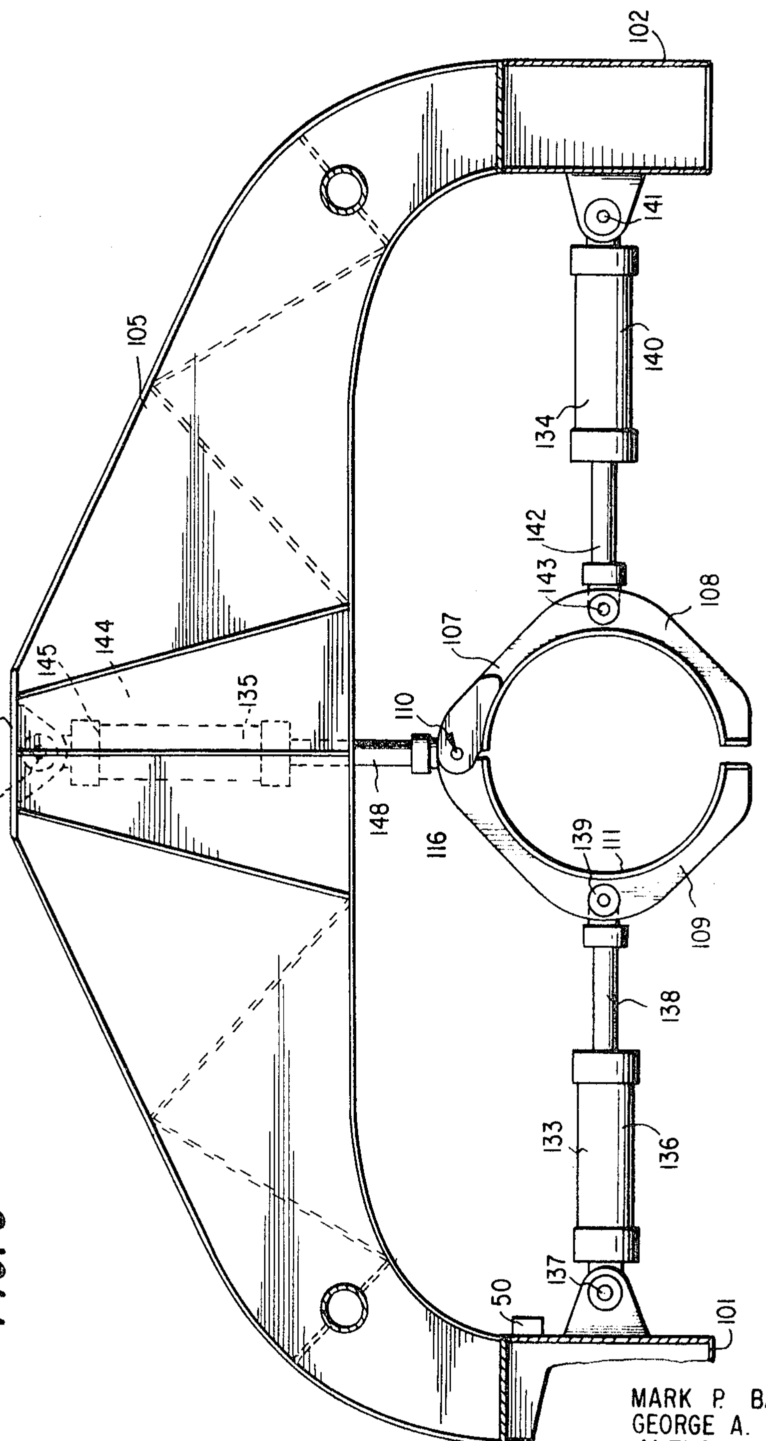

FIG. 8

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FIG. 9

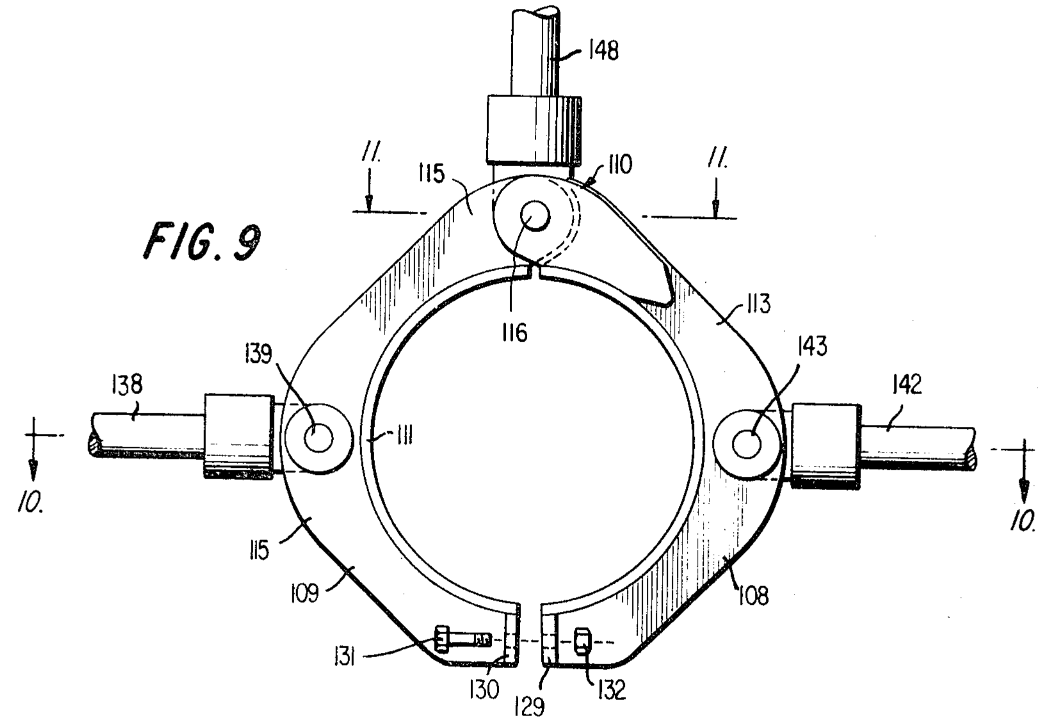
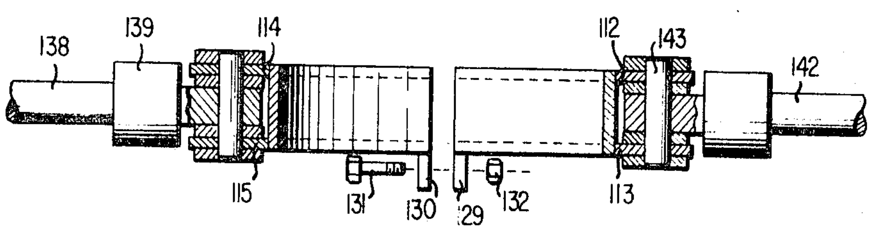


FIG. 10



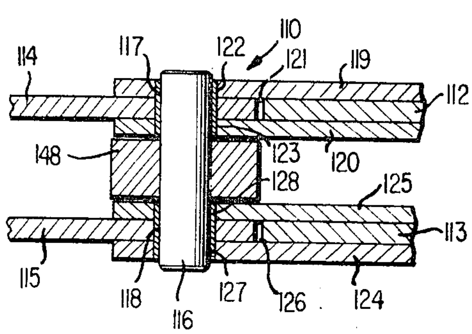


FIG. 11

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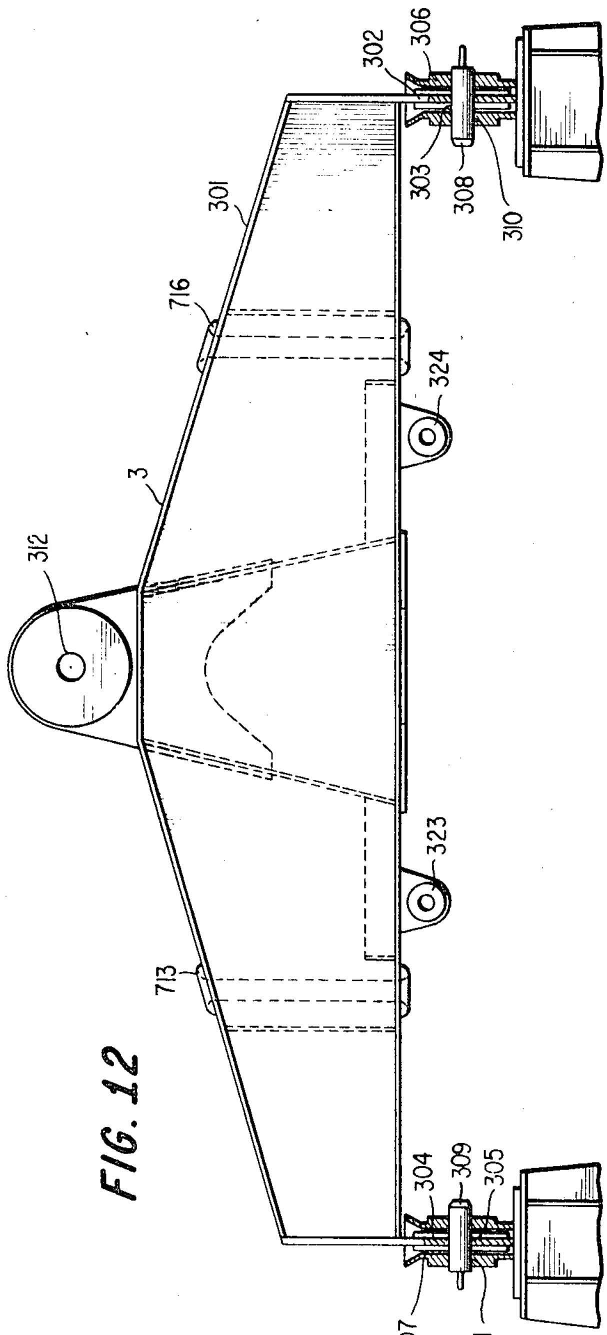
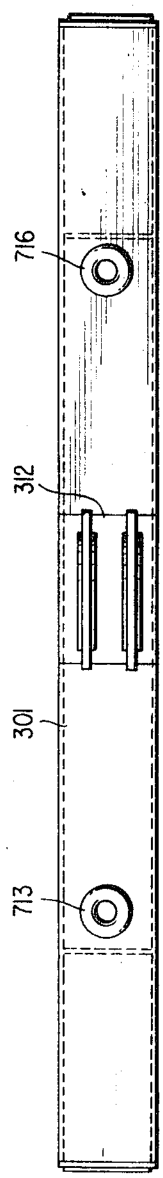


FIG. 12



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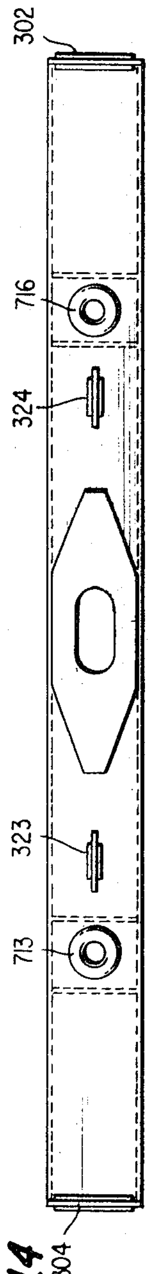

FIG. 14

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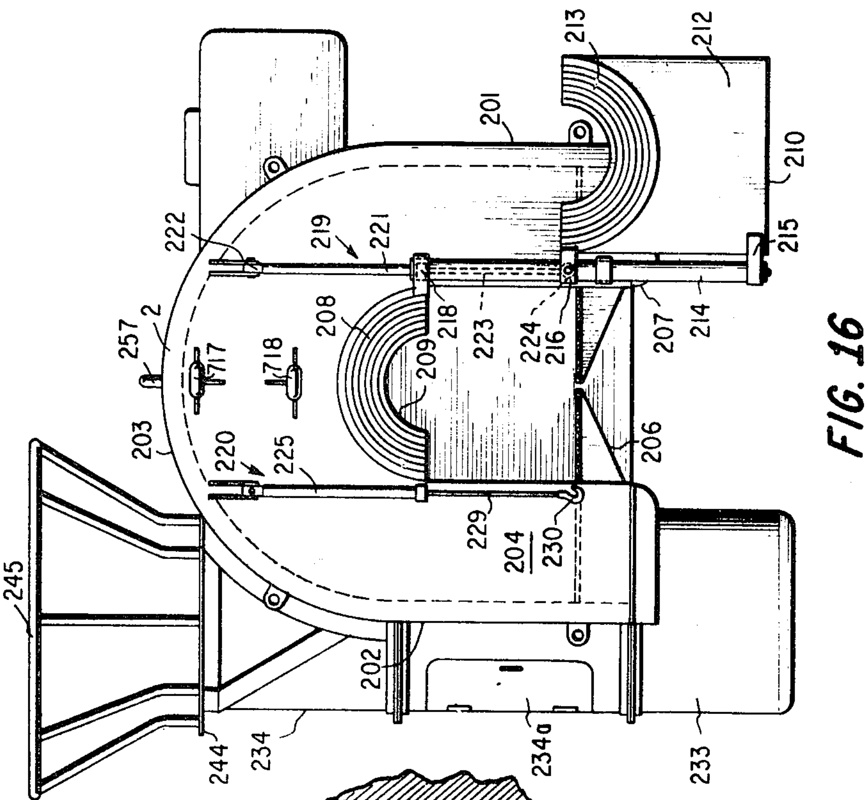

FIG. 16

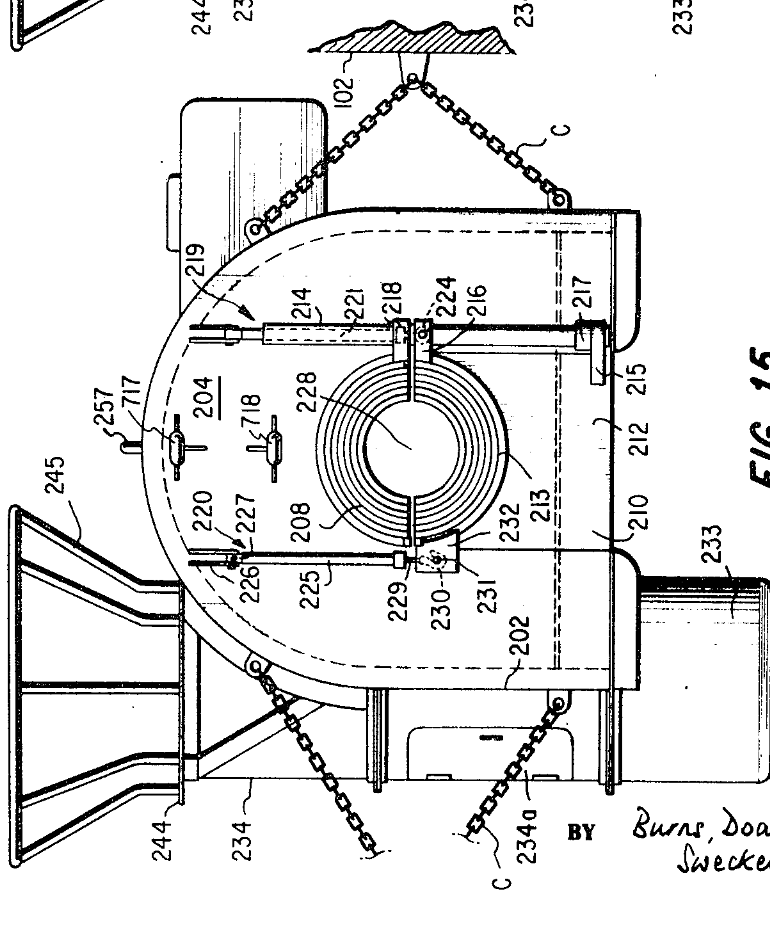

FIG. 15

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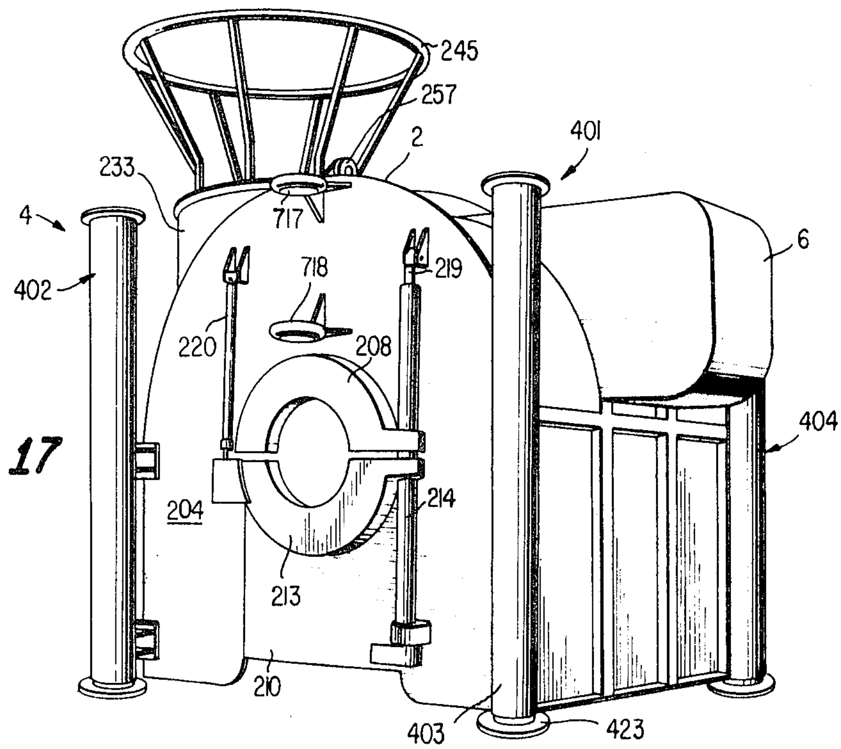

FIG. 17

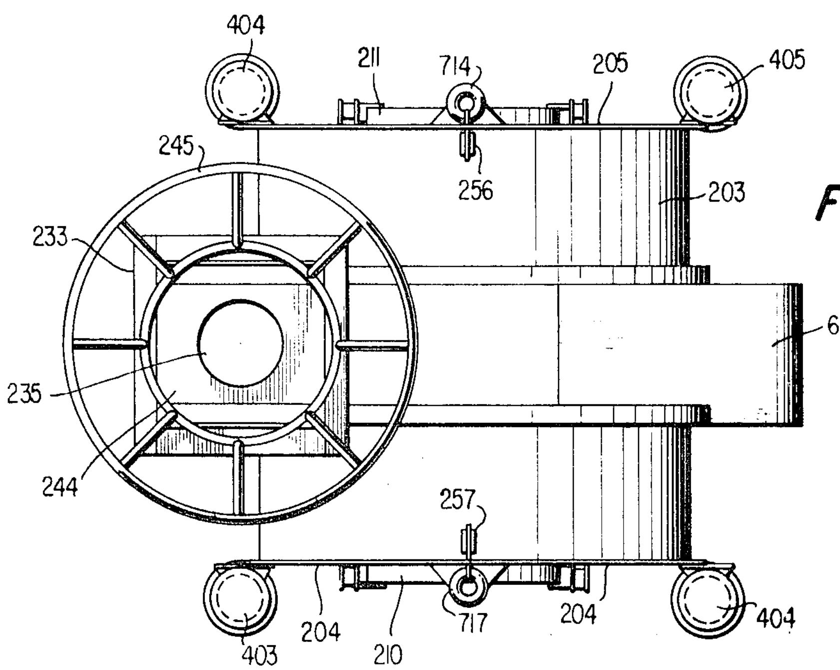

FIG. 18

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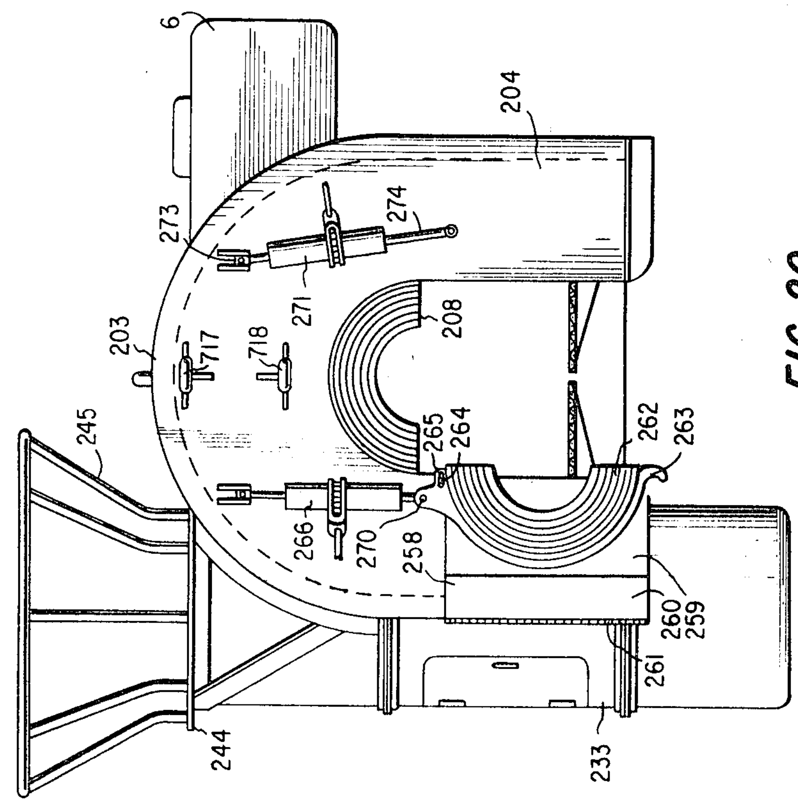

FIG. 20

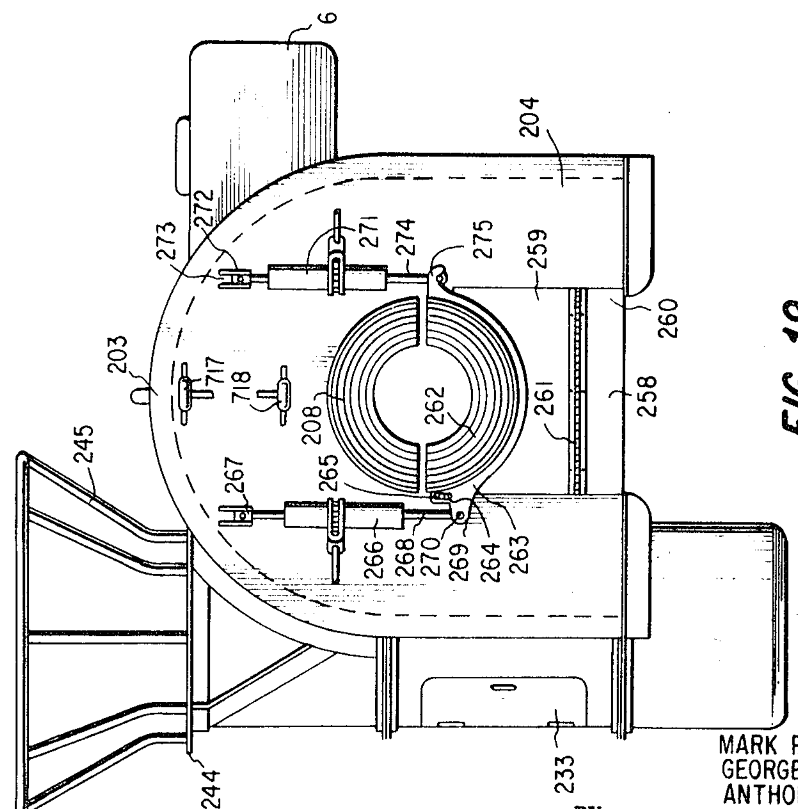

FIG. 19

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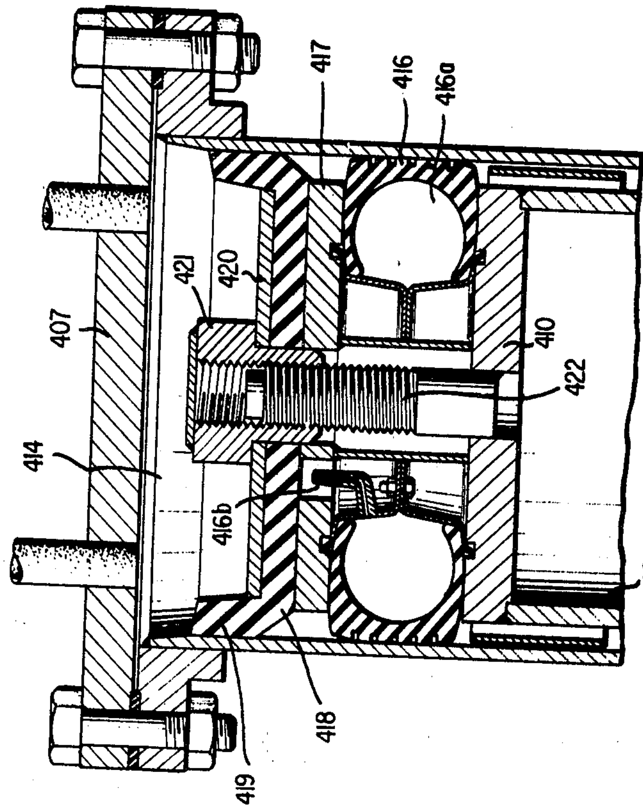

FIG. 22

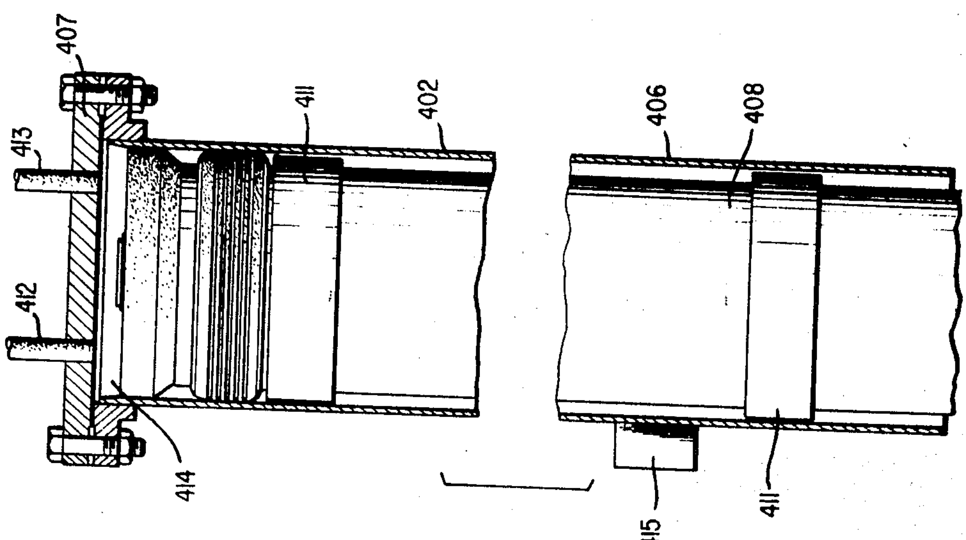

FIG. 21

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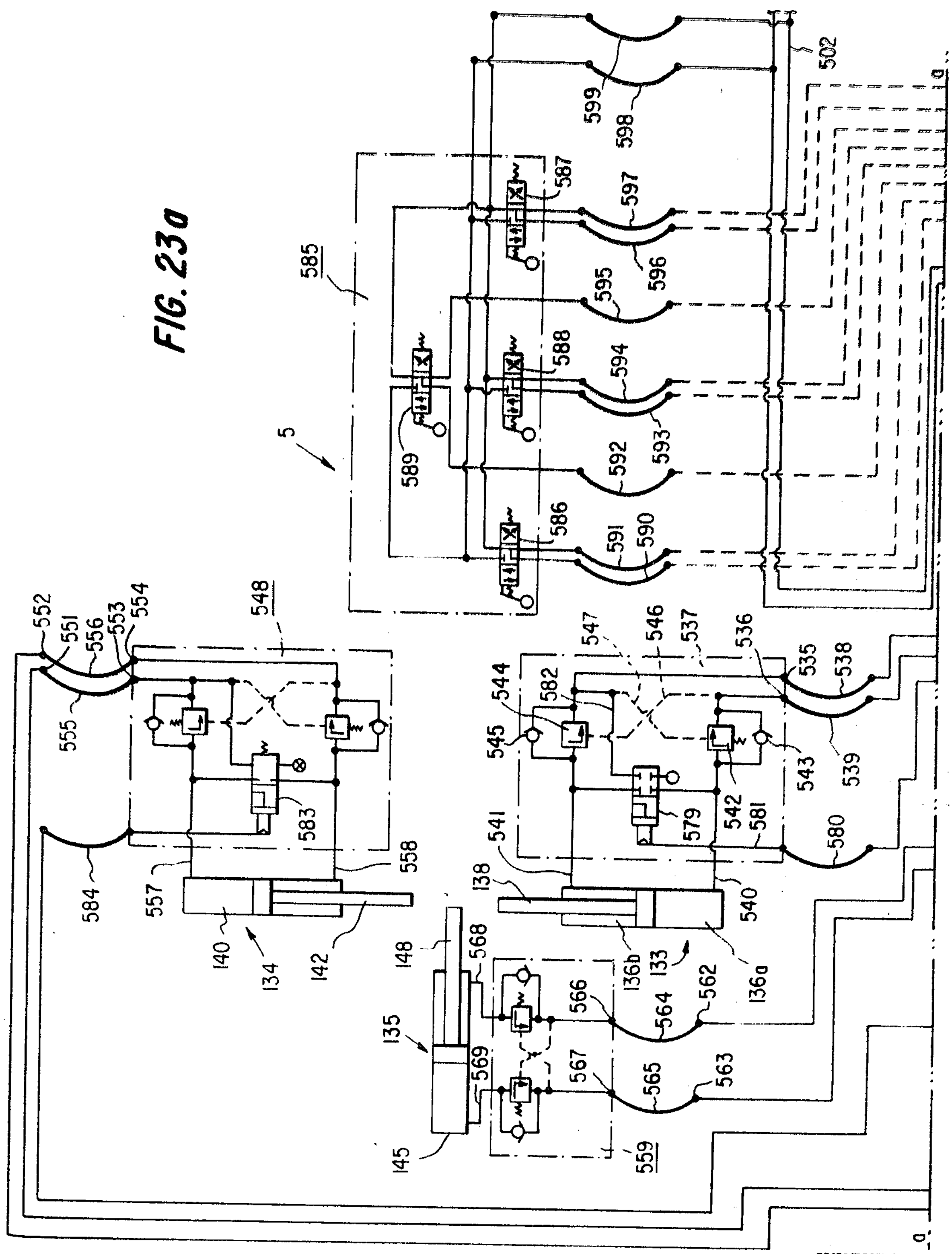

FIG. 23a

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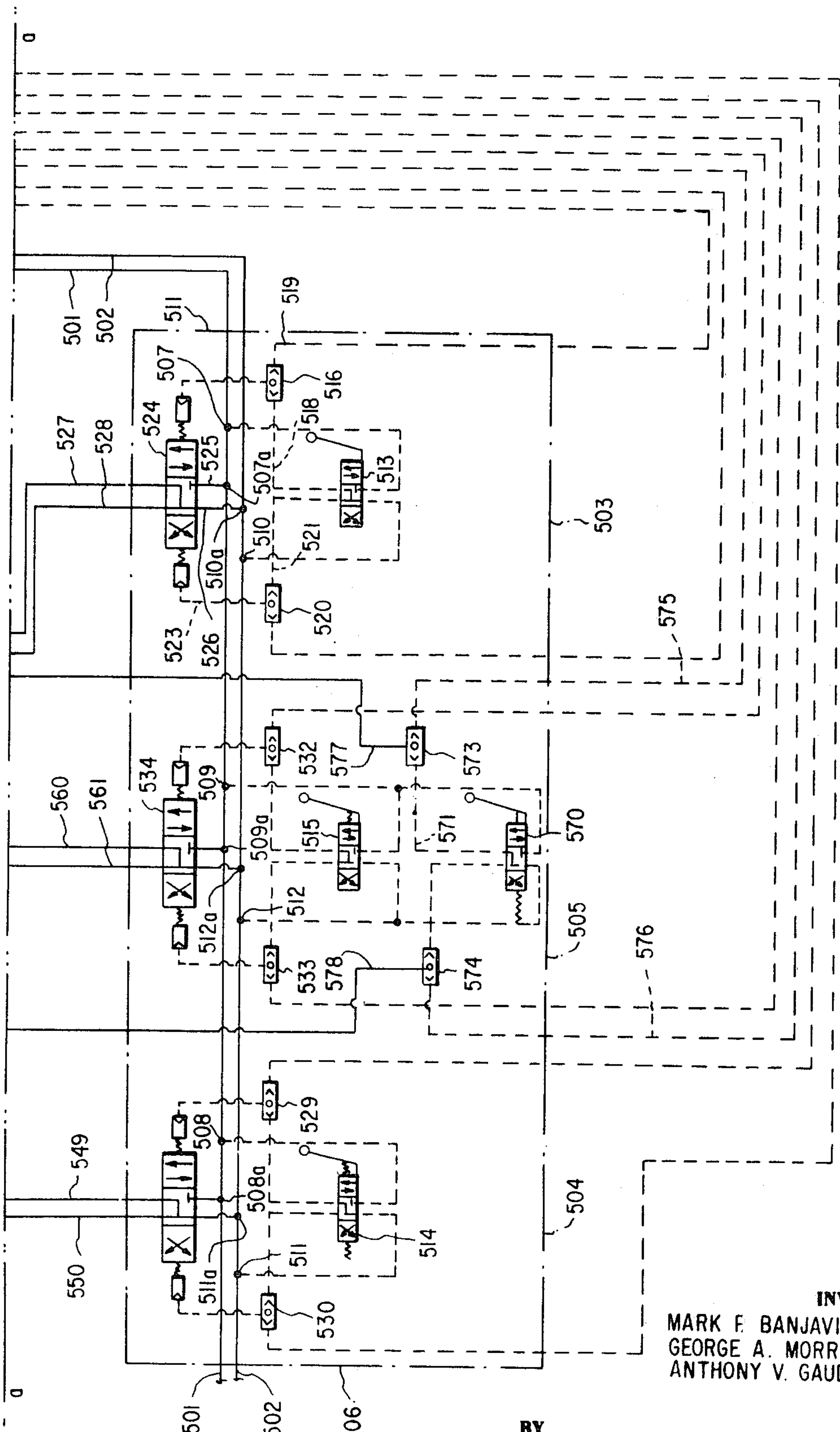

FIG. 23b

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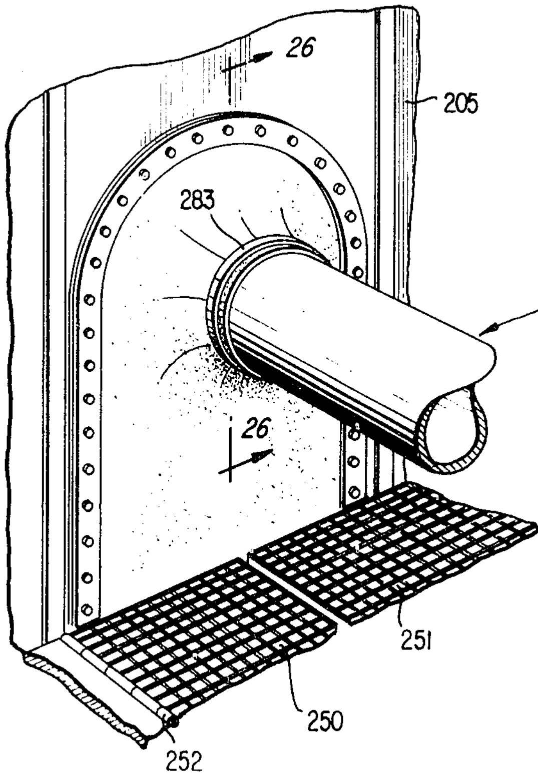


FIG. 24

FIG. 26

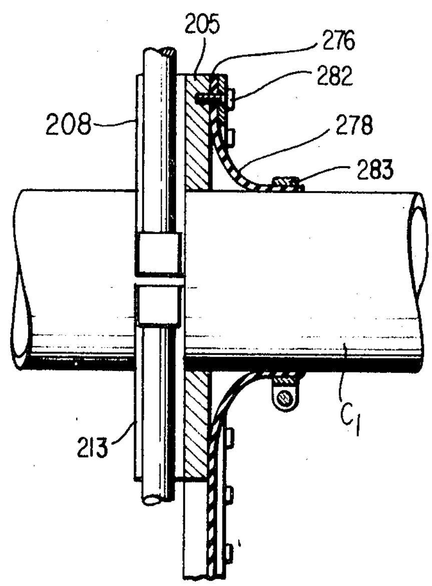
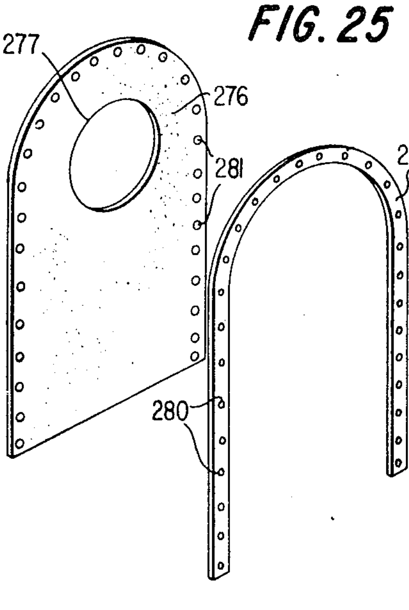


FIG. 25



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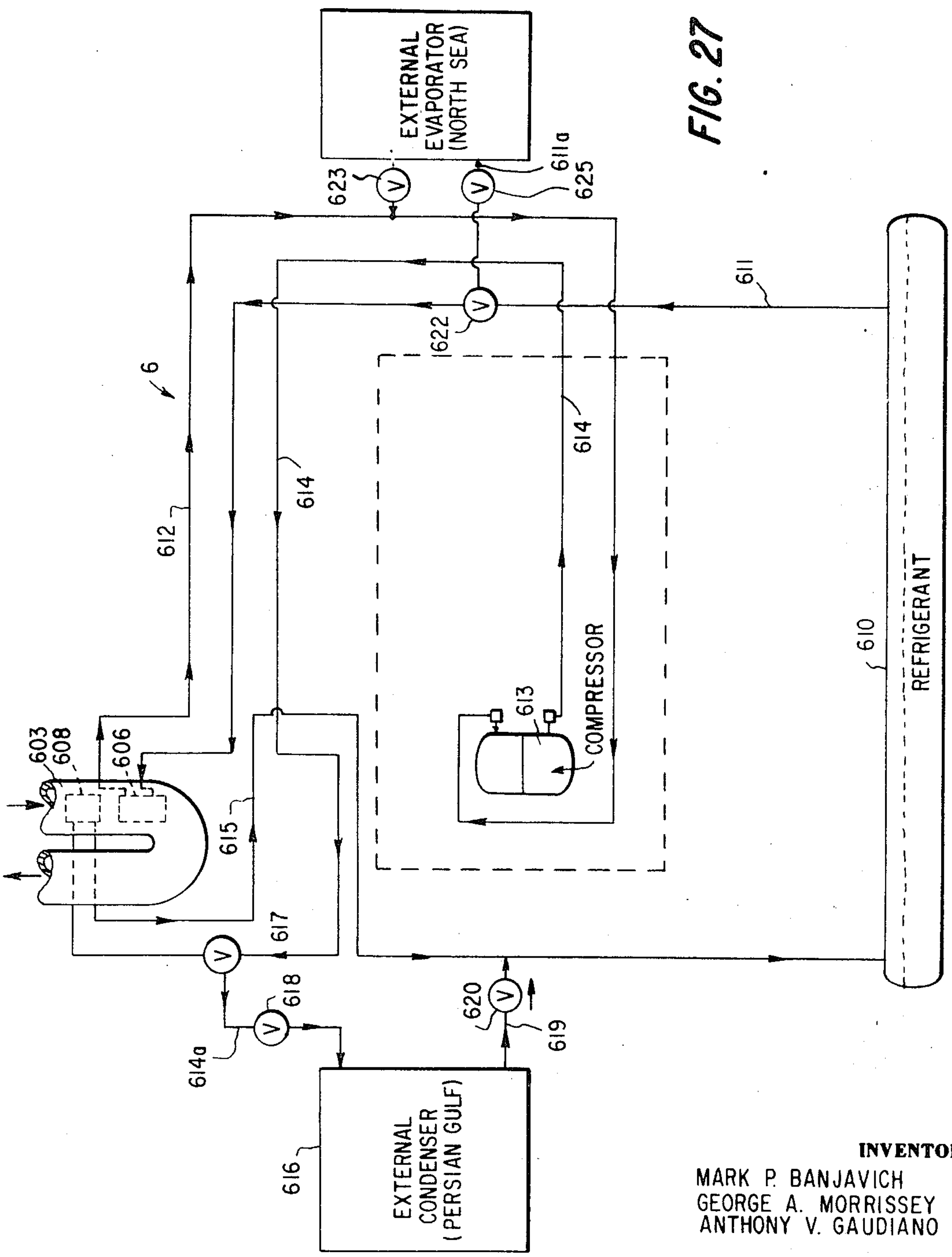

FIG. 27

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METHOD AND APPARATUS FOR WORKING ON SUBMERGED CONDUIT MEANS

GENERAL BACKGROUND, OBJECTS AND SUMMARY OF INVENTION

For some time, it has been recognized that underwater working chambers may be advantageously employed to provide a relatively dry atmosphere surrounding a submerged conduit, where conduit work operations are to be performed.

For example, when it is desired to interconnect two adjacent ends of submerged conduit portions, a working chamber may be located over the adjacent portions so as to provide a relatively dry and isolated work zone. This zone permits operations such as the welding of the conduit ends to be performed.

However, as offshore operations are projected into progressively more difficult operating environments, it becomes clear that more is necessary than merely an underwater working chamber.

From the standpoint of the safety of divers and the efficiency and feasibility of operations, it would be desirable to effectively stabilize the conduit upon which operations are to be performed and provide reliable means for insuring the appropriate alignment of conduit portions.

It would also be highly desirable to provide a conduit stabilizing arrangement which would insure that the conduit means upon which operations are to be performed are effectively secured in position.

Since, in many instances, operations may be performed where strong currents are present and where such currents may contain substantial amounts of suspended silt or sand, it would be desirable to provide an underwater work chamber, the operability of which would not be destroyed in the event that solid materials were deposited in substantial quantities adjacent the exterior of the working chamber.

It is particularly necessary of course to insure that any working chamber affords optimum diver safety conditions and permits divers to leave the working chamber, regardless of adverse conditions in the vicinity of the exterior of the working chamber.

From the standpoint of insuring an effective working environment, it is desirable that the working chamber should provide for both humidity and temperature control.

Since the working chamber may be conditioned by a particular gaseous environment, it is desirable that simple but effective means be provided for preventing the escape of such a special gaseous environment from the working chamber interior.

Where a conduit stabilizing and aligning frame is utilized in conjunction with a working chamber, the efficiency of the conduit end alignment operation could be facilitated by the provision of alignment control means operable either from the exterior or interior of the working chamber.

These and other objects of the invention are accomplished, at least in part, by an apparatus including frame means operable to be lowered from floating vessel and be positioned over submerged conduit means. This frame means includes a first plurality of clamp means spaced longitudinally of a first portion of the conduit means and clampingly engageable therewith. A second plurality of clamp means, carried by the frame means, spaced longitudinally of a second portion of the conduit means, is clampingly engageable with this second portion. Clamp-actuated means enable the clamp means of the first and second plurality to be independently manipulated to selectively exert independent conduit portion manipulating force on the conduit means.

The apparatus may also include a working chamber means, or "habitat," including a closed diver passage providing communication between the exterior of the working chamber means and an upper exterior portion of its body means.

In a preferred arrangement, the working chamber means is provided with dehumidifying means operable to control both humidity and temperature within the working temperature means. This dehumidifying means preferably includes heat exchanger means disposed in heat exchanging relation with water surrounding the working chamber means.

The apparatus may also include sequentially operable guide means operable to guide the frame means and working chamber means between a floating vessel and the conduit means site. The guide means may also enable a diver transfer chamber to be guided from the floating vessel to the diver passage of the working chamber means.

It is also contemplated that both the frame means and the working chamber means may be provided with a plurality of independently controllable jack means. Such jack means will exert selective lifting force on a submerged surface adjacent the work site.

The installation of the frame means and working chamber means may be facilitated by the use of a bar means which is operable to stabilize and transmit lifting and lowering force between a floating vessel and the frame means or working chamber means, depending upon which of these means the bar means is connected with.

The control means included in the apparatus preferably includes alternately operable control stations, some mounted on the frame means exterior of the working chamber and some mounted on the interior of the working chamber means. Such control means enable the clamp means to be actuated and controlled by divers from the exterior of the working chamber means prior to the installation of the working chamber means and from the interior of the installed working chamber means.

The invention also contemplates a method of working on conduits wherein a plurality of forces are independently exerted at longitudinally spaced locations on each of two independent conduit portions. These forces are exerted so as to insure the appropriate alignment of the conduit portions. A working chamber is positioned over the conduit portions and its interior atmosphere is selectively dehumidified and temperature adjusted.

DRAWINGS

In describing the invention, reference will be made to preferred embodiments shown in the appended drawings.

In the drawings:

FIG. 1 schematically illustrates the guiding of an alignment frame downwardly from a floating vessel toward two independently movable conduit portions;

FIG. 2 illustrates the positioning of the alignment frame so as to straddle the two conduit portions, and further illustrates the guiding of a working chamber into position over the conduit portions;

FIG. 3 illustrates the guiding of a diver transfer chamber toward a diver passage of the working chamber, which chamber is disposed so as to straddle the two conduit portions;

FIG. 4 illustrates the arrival of the diver transfer chamber at the diver passage of the working chamber;

FIG. 5 provides an enlarged, transverse, cross-sectional view of the FIG. 4 disposition of the system, illustrating the completed alignment of the diver transfer chamber and the diver passage of the work chamber, and further illustrating the manner in which divers may safely move from the diver transfer chamber through the diver passage to the interior of the working chamber;

FIG. 6 schematically illustrates a power arrangement which may be used to facilitate the guided movement of the diver transfer chamber toward the working chamber;

FIG. 7 provides a fragmentary, perspective view of the alignment frame illustrated in FIG. 1;

FIG. 8 provides a representative, end elevational view of one of four clamping assemblies included in the FIG. 7 alignment frame, with this clamping assembly being viewed along the view direction 8—8 of FIG. 7;

FIG. 9 provides an enlarged view of an articulated, conduit clamp incorporated in the representative FIG. 8 assembly;

FIG. 10 provides a transverse sectional view of the FIG. 9 assembly as viewed along the section line 10—10;

FIG. 11 provides an enlarged transverse sectional view of a clamp hinge as viewed along the section 11—11 of FIG. 9;

FIG. 12 provides an enlarged, side elevational view of the lifting bar shown in FIG. 1 in supporting engagement with the FIG. 7 alignment frame;

FIG. 13 provides a top, plan view of the FIG. 12 lifting bar;

FIG. 14 provides a bottom, plan view of the FIG. 12 lifting bar;

FIG. 15 provides an end elevational view of one embodiment of the working chamber as shown in FIG. 2, illustrating a door associated with a working chamber end wall in a closed door position;

FIG. 16 illustrates the FIG. 15 chamber, with the door in an open position so as to define a recess of the reception of a conduit during the working chamber lowering operation shown in FIG. 2;

FIG. 17 illustrates a modified form of the working chamber shown in FIGS. 15 and 16, wherein the working chamber is provided at each of its four corners with a selectively operable jack;

FIG. 18 provides a top plan view of the FIG. 17 embodiment of the working chamber;

FIG. 19 provides an end elevational view of a modified form of the FIG. 15 working chamber wherein the end wall door is provided with a modified actuating arrangement;

FIG. 20 illustrates the FIG. 19 embodiment, with the end wall door in an open position for the reception of a conduit during the working chamber lowering operation;

FIG. 21 provides a vertically sectioned elevational view of a representative jack which may be associated with either the working chamber, as shown in FIG. 17, or the alignment frame, shown in FIG. 7;

FIG. 22 provides a fully sectioned and enlarged view of the upper portion of the FIG. 21 jack, illustrating in vertical section, the arrangement of the jack piston and its seal components;

FIGS. 23*a* and 23*b*, when joined along the dividing line *a*—*a*, illustrate hydraulic circuitry employed to selectively control the actuation of the alignment frame clamps from either the frame or the interior of the working chamber;

FIG. 24 provides a perspective view of the interior of the working chamber, in any of its embodiments, illustrating a diaphragm seal disposed between a conduit portion and the end wall of the working chamber in the vicinity of an end wall door;

FIG. 25, in a perspective, "exploded" format, illustrates components of the FIG. 24 diaphragm seal;

FIG. 26 provides a transverse sectional view of the FIG. 24 diaphragm seal, as viewed along the section line 26—26 of FIG. 24; and

FIG. 27 provides a schematic illustration of a dehumidifying and temperature controlling system for regulating the humidity and temperature of the working environment within any of the various embodiments of the working chamber.

MAJOR COMPONENTS

Major components of the apparatus of this invention are schematically illustrated in FIGS. 1 through 4.

As shown in these figures, the apparatus includes an aligning frame 1, a working chamber or habitat 2, and a lifting and lowering bar 3.

The function of the aligning frame 1 is to provide a stable base, weighing possibly over a hundred tons, on a submerged surface S adjacent a work site. This work site, as shown in FIG. 1, may involve a submerged location beneath a floating vessel V. At this work site, by way of example, two conduits C1 and C2 may be located in generally adjacent positions and be supported by the submerged surface S. The mutually facing ends of the first and second conduit portions C1 and C2 are intended to be connected together as, for example, by a welded-in-place, connecting conduit portion or "pup."

Preliminary to the conduit connecting operation, divers may jet or dig away the submerged surface S beneath adjacent end portions of the conduits C1 and C2 to facilitate the conduit joining operation.

The aligning frame 1 is positioned so as to straddle the conduit portions C1 and C2. In a manner to be subsequently described, clamps carried by the aligning frame 1 are employed to exert aligning and manipulative forces on each of the conduit portions C1 and C2.

The function of the working chamber or habitat 2 is to provide a relatively dry gaseous atmosphere adjacent the mutually facing ends of the conduit portions C1 and C2. This atmosphere enables conduit connecting or working operations such as welding to be performed with relative facility, ease and efficiency.

The function of the lifting and lowering bar 3 is to facilitate the sequential positioning of the aligning frame 1 and working chamber 2.

Structural details of the frame 1, chamber 2, and bar means 3, and the mode of operation will be subsequently set forth in detail.

In describing the overall invention, principal components will be designated by reference numerals in a "hundreds" format, with the initial number corresponding to the principal component involved, i.e., details of the frame 1 will be designated by reference numerals in the 100 series, etc.

ALIGNING FRAME DETAILS

Structural details of the massive aligning frame 1 are shown in FIGS. 7 through 11.

As shown in FIGS. 7 and 8, the frame is defined, in part, by two box girders or base stringers 101 and 102. Box griders 101 and 102 are mutually parallel and are operable to engage the submerged surface S on opposite sides of the conduit means C1–C2.

Box girders or base stringers 101 and 102 are transversely interconnected by archlike trusses 103, 104, 105 and 106. The trusses are interconnected by tubular framing, as shown generally in FIG. 7.

Base member connecting, trusses 103 through 106 are substantially identical in structure. Trusses 103 and 106, as shown in FIG. 1, are disposed at the end extremities of the base stringers 101 and 102. Intermittent trusses 104 and 105 are positioned so as to provide generally equal spacing between adjacent ones of the trusses 103 through 106.

Each of the trusses 103 through 106 is provided with conduit-engaging clamp means 107.

Representative details of a clamp means 107 associated with the truss 105 are shown in FIGS. 8 through 11.

Thus, clamp 107 includes a first, semicylindrical clamp component 108 and a second, semicylindrical clamp component 109. Components 108 and 109 are pivotally interconnected by an articulation or pivot joint 110 having a pivot axis extending longitudinally of, and parallel to, the base stringers 101 and 102.

Clamp segments 108 and 109 are provided with generally cylindrical conduit engaging faces 110 and 111 respectively. The generally cylindrical conduit engaging faces 110 and 111 are intended, in a closed position, to define a generally cylindrical clamp having an axis of curvature extending longitudinally of and parallel to base stringers 101 and 102 and parallel to the pivot axis at articulation joint 110.

As is further shown in FIGS. 9 through 11, clamp-engaging face 110 is reinforced by longitudinally spaced and radially extending, arcuate webs 112 and 113. Similarly, in segment 109, conduit engaging face 111 is reinforced by longitudinally spaced and radially extending, arcuate webs 114 and 115.

As is shown in FIG. 11, articulation joint 110 is defined by a pivot pin 116. Pivot pin 116 is journaled in apertured portions 117 and 118 of plates 114 and 115 respectively. A pair of spaced, platelike webs 119 and 120 welded on the upper extremity of reinforcing web 112 defining a socket 121 within which the upper end of web 114 is received. Pin 116 is journaled in apertured portions of webs 119 and 120, as shown in FIG. 11.

Similarly, spaced platelike webs **124** and **125** are welded to web **113** defining a socket **126**, receiving web **115**. Pin **116** is journaled in apertured portions **127** and **128** of webs **124** and **125**, respectively.

Longitudinally extending lugs **129** and **130** carried by segments **108** and **109** respectively, provide clamp segment securing means. A threaded bolt **131** is operable to pass through apertured portions of lug means **130** and **129** and engage a threaded nut **132**. The nut and bolt **131** and **132** manipulated by a diver at the work site, thus engage the lugs **130** and **129** to hold the clamp segments **108** and **109** in a closed position.

In the closed clamp position, it is contemplated that the conduit engaging faces **110** and **111** would be somewhat larger than the outer periphery of the engaged conduit so as to permit relative rotation between the conduit and the closed clamp. Even though such relative rotation would be permitted, in the preferred embodiment, there still would be substantially contiguous and conforming engagement between the faces **110** and **111** and the conduit means preferably.

Each clamp **107** is also provided with clamp actuating means. As shown in FIG. **8**, this clamp-actuating means comprises a first piston and cylinder assembly **133**, a second piston and cylinder assembly **134**, and a third piston and cylinder assembly **135**.

First piston and cylinder assembly includes a cylinder **136** pivotably connected to base stringer **101** by a longitudinally extending pivot pin mounting **137**. Piston rod **138** projecting from the cylinder **136** is pivotably connected with segment **109** by a longitudinally extending pivot pin connection **139**.

Similarly, cylinder component **140** of the second piston and cylinder assembly **134** is connected with base stringer **102** by a longitudinally extending pivot pin connection **141**. A piston rod **142** of assembly **134** is pivotably connected to clamp segment **108** by a longitudinally extending pin connection **143**.

Third piston and cylinder assembly **135** is mounted within an upwardly converging recess **144** in the apex of the truss or arch **105**. Cylinder component **145** of the assembly **135** is pivotably mounted to an upper plate portion **146** of recess **144** by a longitudinally extending pivot pin connection **147**. A piston pin component **148** of assembly **135** is pivotably connected to the pivot pin **116** as generally shown in FIG. **11**.

As will be apparent by reference to FIG. **8**, coordinated operation of the assemblies **133** and **134** is effective to exert laterally directed force on the conduit engaged by the clamp **107**. Extension of the piston rod **138** of assembly **133** will exert a force on the clamp **107**, directed to the right as shown in FIG. **8**, while extension of the piston rod **142** will exert force on the clamp **107** directed to the left as shown in FIG. **8**.

Similarly, upward movement of the piston rod **148** will exert a lifting force on the clamp **107** while downward movement of the piston rod **148** will tend to depress the clamp **107**.

It is contemplated that each of the assemblies **133**, **134**, **135** is "double acting" in nature so that changes in force may be selectively exerted in either axial direction of each assembly.

The manner in which the various assemblies **133–135** may be independently manipulated in a diver-coordinated fashion to effect the desired application of force to a conduit portion engaged by the clamp **107** will be subsequently described.

As will also be apparent by reference to FIG. **2**, the clamp segments **107** associated with the trusses **103** and **104** provide first and second, longitudinally spaced clamps clampingly engageable with the conduit portion **C1**. Either one of the clamps of the trusses **103** and **104** may function as a fulcrum, while the other clamp functions to apply a conduit flexing or moving force to the conduit portion **C1**. These clamps may also function to apply force in the same general direction to conduit **C1**.

Similarly, the clamps **107** associated with the trusses **105** and **106** define a second plurality of clamp means spaced longitudinally of the conduit portion **C2** and clampingly engageable with this conduit portion.

In this second plurality of clamp means, either clamp **107** may serve as a fulcrum while the other clamp applies a flexing or conduit moving force to the conduit means **C2**. Here again, these clamps may function in unison to apply force in the same general direction to conduit **C2**.

The weight or mass of the frame **1** provides a stable base from which clamp forces may be exerted on the conduit means **C1** and **C2** so as to induce movement of the conduit means **C1** and **C2** relative to the relatively immovable base **1**. Such conduit means movement will serve to adjust the position and/or orientation of conduit portions **C1** and **C2** so as to bring them into an appropriate degree of alignment for a conduit connecting or other conduit working operation.

In view of the foregoing discussion, it will be clear that the piston and cylinder assemblies associated with the clamp means of the trusses **103** and **104** may be viewed as first clamp-actuating means operable to selectively exert independent force on the conduit means **C1**, selectively directed generally transversely of the longitudinal axis of the conduit portion **C1**. Since the resultant thrust or force vector may be varied by selective operation of the various piston or cylinder assemblies, the applied force is selectively orientable about the cylinders of the conduit portion **C1**.

In other words, the force applied by any clamp assembly may be adjusted so as to be horizontal, vertical, or inclined, with respect to horizontal and vertical directions. In short, the resultant force applied to the conduit portion **C1** by either of the clamp assemblies associated with the trusses **103** and **104**, although generally radial in nature, may be oriented to conform to virtually any circumferential alignment.

The piston and cylinder assemblies associated with the clamp of the trusses **105** and **106** provide second clamp actuating means including all of the characteristics of the first clamp actuating means, but operable in connection with the second conduit portion **C2**.

WORKING CHAMBER DETAILS

Structural details of the working chamber or habitat **2** are set forth in FIGS. **15** through **26**.

FIGS. **15** and **16** illustrate one embodiment of the working chamber **2**.

In this embodiment, the chamber **2** is defined by sidewall means **201** and **202** which are interconnected by a generally semicylindrical stop wall **203**.

The ends of the working chamber **2** are closed by end walls **204** and **205**. Each of the end walls is provided with a downwardly opening recess. The end wall recesses are substantially identical. Thus, representative recess **206** of end wall **204** extends upwardly from the base **207** of the working chamber and terminates in a downwardly facing, arcuate upper end or conduit-engaging terminus **208**. Upper end **208** is preferably fabricated from a series of independently removable cylindrical segments. The cylindrical segments of the upper end portion **208** may be sequentially removed to provide an exposed segment **209** having a cylindrical curvature conforming to the conduit periphery to be engaged, in this case the periphery of conduit means **C2** shown in FIG. **1**.

The various segments of the recess top defining wall means **208** may be interconnected by removable screws. The screw arrangement may be such so as to permit the sequential removal of segments, moving progressively upwardly from small diameter segments to large diameter segments.

Each end wall is also provided with a door which is mounted for pivotal movement about a generally vertical axis and which is also operable to move toward and away from the recess terminus **208**. Thus, the wall **204** is provided with a door **210**, while the wall **205** is provided with an equivalent door **211**.

Representative door **210**, as shown in FIG. **15**, is defined in part by wall means **212**. At the upper end of the wall means **212** a conduit-engaging terminus **213** is provided. Terminus **213** is structurally and functionally the same as recess end defining means **208**. However, terminus **213** is mounted in a mirror-image relation with respect to means **208** when the door **210** is disposed in a closed position as shown in FIG. **15**.

Door **210** supports a cylindrical sleevelike member **214** on one edge, i.e., the right edge as viewed in FIG. **15**. Sleeve **214** is fixedly connected to the door **212** by vertically spaced bracket means **215** and **216**. Sleeve **214** is slidably journaled in vertically apertured brackets **217** and **218** carried by the end wall **204**.

As is shown in FIG. **16**, brackets **216** and **215** are disposed on opposite sides of the mounting bracket **217** so as to limit movement of the sleeve **214** relative to the end wall **204**. However, the mounting brackets **217** and **218** journal the sleeve **214** for rotational movement about its longitudinal axis so as to define a door hinge having a generally vertical hinge axis.

A pair of piston and cylinder door jack assemblies **219** and **220** serve to induce vertical movement of the door **210** relative to the end wall **204**.

The cylinder portion **221** of assembly **219** is connected to end wall **204** by a mounting bracket **222**. The piston **223** of assembly **219** is connected to an anchor point **224** fixedly positioned within the interior of sleeve **214**.

As is shown in FIG. **15**, when the piston rod **223** is retracted so as to position the door **210** in an upper or closed position, the piston rod **223** as well as the cylinder **221** are telescopically received within the interior of sleeve **214**.

Cylinder **25** of assembly **220** is pivotably connected to end wall **204** by mounting bracket **226**. Mounting bracket **226** provides a pivot pin connection **227** having a pivot axis extending longitudinally of chamber **2**, i.e., parallel to the axis of curvature **228** of the converged terminus means **208** and **213**.

Piston rod **229** of assembly **220** is provided at its lower extremity with a hook **230**. Hook **230** is detachably engageable with a pin **231** connected by bracket means **232** to door **210**.

During the lowering of working chamber **2** the doors **210** and **211** are each disposed in a lowermost and open position corresponding to the position of door **210** shown in FIG. **16**. These doors are each moved, in an identical fashion, from the arrangement shown in FIG. **16** to the FIG. **16** position. This door lowering and opening is accomplished, with reference to door **210**, by extending piston rod **229** while assembly **219** remains in its contracted position. Thus, assembly **219** holds the door in the upper position shown in FIG. **15** while the extension of rod **229** frees the hook **230** from the latch pin **231**. The assembly **220** may then be pivoted clockwise, from the FIG. **15** position, about the pivot pin **227** to free the assembly **220** from the door **210**. The door **210** may then be pivoted about the pivoted joint defined by sleeve **214** and mounting brackets **217** and **218** to an open position. The door may then be lowered by extending piston rod **223** so that the door assumes the lower and open position shown in FIG. **16**.

With the working chamber doors both disposed as generally shown in FIG. **16**, they are operable to be pivoted to a closed position beneath submerged conduit means C1 and C2, engaging the upper portions **208** of the wall recesses in the FIG. **3** arrangement. The thus pivoted doors may then be rehooked with the extended piston rods **229**. Both piston rods **223** and **229** of each door may then be raised to cause the doors **210** and **211** to move upwardly and clampingly engage the underside of the conduit means C1 and C2. In the FIG. **3** arrangement, door means **210** would clampingly engage conduit means C2, while door means **211** would clampingly engage conduit means C1. This clamping engagement, of course, involves the clamping action of the terminus means **208** and **213** on the top and underside of the conduit means. As will be apparent, the closing of doors **210** and **211** at the submerged work site is facilitated by the previously jetted away, or otherwise removed, portions of surface S beneath the site of chamber **2**.

Working chamber **2** is provided with a diver passage means **233** as shown generally in FIGS. **15, 16** and **5**.

Diver passage **233** is defined by a generally vertical, closed conduitlike, wall means **234** extending generally vertically along the sidewall **202** of the working chamber **2**. Diver passage means **233** is thus located externally of the working chamber **2**. Wall **234** may be provided with a door **234***a* to enable diver movement into and out of passage **233** from the side of chamber **2**.

The upper end **235** of diver passage means **233** is open so as to provide an entry and exit point for divers.

The lower end of passage means **233** is provided with an enlarged portion, extending in a generally U-shaped fashion about a lower edge **236** of wall means **202** and upwardly into the interior **237** of the working chamber **2**. This enlarged portion **238** provides a U-shaped, diver transfer passage portion **239** permitting divers to move from the vertical passage portion **240** into the interior **237** of the working chamber **2**. The movement of divers through passage portions **240** and **239** may be facilitated by ladder-defining, rungs **241** as shown in FIG. **5**.

The upper end **235** of diver passage means **233** may be provided with a landing base **244** which in turn supports an upwardly diverging, guide cone assembly **245**.

Guide cone assembly **245** is designed to guidingly receive a downwardly moving diver transfer chamber **246**. Transfer chamber **246** may correspond, for example, to a diver transfer chamber or vehicle as described in U.S. Banjavich Pat. No. 3,323,312.

With diver transfer chamber **246** guided onto platform **244** by guide cone **245**, divers may move through the passage means **240** and **239** while utilizing a life support system (air supply, etc.) **247** operated from the transfer vehicle **246**. System **247** is supplied by an umbilical system **248** extending upwardly to the support vehicle or floating vessel V.

Once a diver has entered the interior **237** of working chamber **2**, he may utilize a life support system, possibly including masks, operated from the working chamber **2**. The life support system or working chamber **2** would be substantially independent of that associated with the transfer vehicle **246**. However, the life support system of working chamber **2** would most probably be supported by an umbilical arrangement extending again from the service vessel V.

It is contemplated that the atmosphere within the interior space **237** would be regulated and adjusted from the standpoint of humidity, temperature, and gaseous content.

The temperature and humidity control arrangements will be subsequently described. The gas atmosphere supplied to the interior of space **237** from the vessel V is preferably abnormally high in nitrogen so as to reduce the relative percentage of oxygen present. It is desirable that the oxygen content should be reduced to a minimum level necessary to sustain life. In so reducing the oxygen content, the likelihood of fire or combustion in the working space **237** is appreciably reduced.

As will be appreciated, the relative ratios of nitrogen and oxygen will vary substantially with the depth of the working chamber **2**, i.e., with the pressure within the space **237**.

Working chamber **2** may be provided with means to facilitate working operations such as the hoist unit **249** illustrated in FIG. **5**. The hoist unit **249** could be used to support a conduit portion being cut away or support a conduit portion being welded in place between the space conduit ends C1 and C2.

The moving of articles such as replacement conduit portions, etc., between the exterior and interior of the working chamber is facilitated by pivotably mounted, perforate or gridlike decks **250** and **251**. Deck **250**, and for that matter, deck **251**, may each comprise a perforate or gridlike floor plate pivotably mounted on which hinge means **252** and **253** extend longitudinally of the working chamber. Such hinge means will enable the floor plates **250** and **251** to be pivoted upwardly and leave a relatively unobstructed opening **254** in the base of the working chamber **2**. When the floor plates **250** and **251** are pivoted downwardly to the position shown in FIG. **5**, they are secured in this position by abutment means **255** and **255***a* carried by the floor plates **250** and **251**, respectively, and engageable with upright frame or wall portion of the working chamber interior.

Of course, opening **254** provides direct fluid communication between space **237** and the water surrounding chamber **2**.

Working chamber **2** is provided with lifting eyes **256** and **257** spaced longitudinally of and connected with upper wall means **203** as shown in FIGS. **17** and **18**. These lifting eyes provide means operable to support the chamber 2 from the lifting and lowering bar 3 for installation and removal purposes, in a manner to be subsequently described.

A modified arrangement for actuating the working chamber doors is shown in FIGS. 19 and 20. The arrangement shown in FIGS. 19 and 20 is, of course, equally applicable to the doors associated with each of the end walls 204 and 205. Thus, the representative door 258 associated with end wall 204 includes door plates 259 and 260 pivotably interconnected by a generally horizontal hinge 261. Door plate 259 supports a segmental, conduit-engaging terminus 262 corresponding to terminus 213 of the FIG. 15–16 embodiment.

An arcuate bracket 263 interconnecting plate 259 and terminus 262, provides an elongate slot 264 extending generally vertically in the closed door position of FIG. 19. This slot 264 receives a pin 265 extending longitudinally of chamber 2 which pin is carried by end wall 204. Pin 265 defines a pivot pin, engageable with the bracket 263 by way of slot 264 and operable to permit the door 258 to pivot downwardly to the open door position shown in FIG. 20.

During this pivoting movement of the door to the open position, the plate 260 may be folded about hinge 261, up against the plate 259, so as to minimize the vertical space required for the door hinging action.

Pivoting action of the door 258 may be effected by a manually actuatable ratchet jack of the so-called "steamboat ratchet jack" type. A representative jack of this nature is described on page 74 of the general catalog of *Templeton, Kenlye & Company* of Broadview, Ill.

As shown in FIG. 19, a steamboat ratchet jack 266 is connected at one end, through a bracket 267, to end wall 204. An actuating rod portion 268 of jack 266 is pivotally connected to a lever arm portion 269 of bracket 263. The pivot connection 270 between arm 269 and rod 268 provides a pivot axis parallel to the pivot axis defined by pin 265. Thus, contraction or expansion of the jack means 266 will induce pivot action of the door 258 in door opening and door closing directions respectively.

Vertical movement of door 258 for conduit clamping and releasing purposes is facilitated by another steamboat ratchet jack 271 identical to jack 266. Jack 271 is connected to wall 204 by a bracket 272 providing a pivot axis 273. Pivot axis 273 extends longitudinally of working chamber 2, i.e., parallel to the pivot axis of pivot pin 265 and pivot pin 270.

The lower, rod portion 274 of jack assembly 271 is engageable with a hooklike portion 275 of bracket 263.

Thus, the door 258 may be moved from the FIG. 19 closed door position to the FIG. 20 open door position by maintaining the jack 266 in its contracted position and extending the jack 271 so as to free the rod 274 from the hook 275. The assembly 271 may then be pivoted counterclockwise, as viewed in FIG. 19, about the pivot mount 273 to move the jack out of the way of the door assembly 258. The jack 266 may then be contracted to permit the door 258 to pivot clockwise about the pivot pin 265 and thus move to the open door position of FIG. 20.

A reversal of this sequence will serve to restore the door 258 to the closed-door position of FIG. 19. In the FIG. 19 disposition of components, the terminus 262 is operable to be moved upwardly and converge with the recess terminus 208 for conduit clamping action. This vertical, linear clamping movement of the door means 258 may be effected by simultaneously contracting and jack assemblies 266 and 271.

As will be apparent from the foregoing discussion, the open bottom 254 of the working chamber 2 of necessity means that the pressure in working space 237 will be substantially the same as the pressure of the surrounding water at the submerged work site.

This relatively high pressure work environment, coupled with the provision of special high nitrogen atmosphere, dictates the necessity of preventing the escape of substantial quantities of the relatively expensive nitrogeneous atmosphere.

A uniquely simple arrangement for conserving the nitrogen atmosphere in space 237 is shown in FIGS. 24, 25, and 26.

Once the working chamber 2 has been lowered in position over the conduit portions C1 and C2, the doors of the recessed end walls are pivoted so as to be positioned beneath the conduit portions. The doors are then raised to clampingly engage the conduit portions and thus stabilize the working chamber 2 with respect to the conduit portions C1 and C2.

With the doors closed and clampingly engaged with the conduit portions, the pressurized nitrogeneous atmosphere will not escape out of the open lower end 254 of the working chamber since the nitrogen atmosphere must pressure balance the hydrostatic pressure of the water in order to maintain the dry cavity or working space 237. However, with the atmosphere balancing the water pressure at base zone 254, it of necessity follows that the gas pressure at the location of the conduit portions C1 and C2, which is elevated a few feet above the base 258, will exceed the pressure of water surrounding the work chamber at this location.

In order to prevent an outflow of nitrogen from the working chamber 237 between the working chamber doors and the conduits, due to this pressure differential, a diaphragm arrangement shown in FIGS. 24 through 26 may be employed in conjunction with either of the end walls. For purposes of discussion, the diaphragm used at end wall 205 will be described.

This diaphragm arrangement may comprise a diaphragm-like sheet 276 of elastomeric or rubber material. Diaphragm 276 is provided with an aperture 277 somewhat smaller than the outer diameter of conduit portion Cl.

A diver within the space 237 will force the end of conduit means Cl through the aperture 277 and move the diaphragm 276 into a position adjacent the end wall 205, overlapping the terminus 208 and the closed door 211. Since aperture 277 is slightly smaller than the outer diameter of conduit means Cl there will be an interference bit between aperture 277 and the exterior of conduit means Cl, producing a generally frustoconical junction 278 shown in FIG. 26. Gas pressure acting on this junction will tend to intensify the diaphragm sealing action.

Diaphragm 276 is secured to end wall 205 by a generally U-shaped mounting rim 279. Rim 279 and diaphragm 276 may be provided with preformed apertures 280 and 281, respectively, to facilitate the reception of mounting bolts 282. Bolts 282 pass consecutively through rim 279 and diaphragm 276 to engage threaded recesses in wall 205.

The installation of diaphragm 276 may be completed by applying a band or strip 283 to clamp the edge of aperture 277 about conduit Cl as shown generally in FIG. 26.

LIFTING AND LOWERING BAR DETAILS

Structural details of the lifting and lowering bar means 3 are shown in FIGS. 12, 13, and 14.

The manner in which the lifting and lowering bar 3 is employed to sequentially lower the aligning frame 1 and working chamber 2 is illustrated in FIGS. 1–3.

As is shown in FIG. 12, bar 3 includes a trusslike body means 301, defined by welded together platelike components.

At each end of the truss 301 a downwardly extending apertured mounting ear is provided. Thus, truss 301 includes mounting ear 302 at the right side as shown in FIG. 12, which ear 302 is provided with an aperture 303 extending longitudinally of the truss 301. At the left end of the bar means 3, as viewed in FIG. 12, a mounting ear 304 projects downwardly and is provided with an aperture 305. Aperture 305 is coaxially aligned with aperture 303.

Mounting ears 302 and 304 are intended to be slidably received within upwardly facing sockets 306 and 307 of frame 1. Socket 206 is mounted on the upper portion of truss 105 of frame 1, as shown in FIG. 7. Socket 307 is mounted on the upper portion of truss 104 of frame 1, as is also shown in FIG. 7.

With the ears **302** and **304** received in sockets **306** and **307**, respectively, the bar means **3** may be connected with the frame means **1** by connecting pins **308** and **309**.

Pin **308** passes through aperture means **310** of socket **306** and aperture **303** of mounting ear **302**. Connecting pin **309** passes through aperture means **311** of socket **307** and aperture **305** of mounting ear **304**.

With the pins thus installed, as shown in FIGS. **1** and **12**, the bar means **3** is fixedly connected with the truss portions **104** and **105** of the aligning frame **1**.

A lifting and lowering eye **312** is mounted at the apex of truss **301**. Eye **312** provides a connecting point for a cable **313** extending upwardly to conventional raising and lowering means, such as a winch mechanism **314** on the vessel V, as shown in FIG. **1**.

A pair of symmetrically arranged mutually parallel, generally vertically extending guide passages **713** and **716** are formed in, and spaced longitudinally of, the truss **301**.

Each of the guide passages **713** and **716** is conduitlike in nature and defines an elongate aperture through which a guide cable slidably passes.

On the underside of truss **301** a plurality of downwardly facing lifting eyes may be provided. Two such lifting eyes **323** and **324** are spaced longitudinally of the truss **301** and symmetrically arranged with respect to the truss midpoint. These eyes provide a mechanism for attaching cables **315** and **316** between the lifting bar **3** and the working chamber **2**. As shown schematically in FIG. **2**, cable **315** may be extended between eye **323** of lifting bar **3** and eye **256** of working chamber **2**. Similarly, cable **316** extends between eye **324** of bar **3** and eye **257** of working chamber **2**.

It is also contemplated that in lieu of eye **313** and eye **314**, remotely operable winch or hoisting means, under the control of divers at the worksite, may be substituted for the lifting eyes **323** and **324**. Such winch or hoisting means would enable the working chamber to be controllably lowered or raised with respect to the frame **3** at the work site.

JACK SYSTEM

The aligning frame unit **1** as well as the working chamber unit **2** may be provided with a plurality of jack units. Each such jack unit may be individually operable and remotely operably by divers at the work site. The jacks may be operated by pressurized fluid delivered through flexible conduit means from the floating vessel V.

The function of such jack units is to enable force to be selectively exerted between the jacks and the unit with which they are associated so as to adjust the inclination or orientation of the unit and maintain it at a desired position and elevation relative to a submerged surface. An overall system **4** may include jacks operable to adjust both frame **1** and chamber **2**.

Thus, as is shown schematically in FIG. **17**, the working chamber **2** may be provided with a jack system **401** comprising four vertical jacks **402**, **403**, **404** and **405**, each mounted at a corner of the work chamber **2**.

The four jacks **402–405** are substantially identical in structure.

FIGS. **21** and **22** illustrate representative details of the interior of a representative jack unit **402**.

Jack unit **402** is defined by a generally tubular cylinder **406** having an upper closed end or cylinder head **407**. A piston **408** is reciprocably mounted within the cylinder wall **406**. Piston **408** may be defined by a cylindrical wall **409** terminating in a closed upper end **410** as shown in FIG. **22**.

One or more annular rims **411** may be mounted on the exterior of piston body defining wall **408** to center the piston during its reciprocating travel and provide bearing surfaces between the piston **408** and the cylinder **406**.

Flexible conduits **412** and **413** may intersect the cylinder head **407** and communicate with the working cavity **414** interposed between the piston head **410** and the cylinder head **407**. A conventional, diver accessible control unit may be mounted on cylinder **406** to enable a diver to control flow through conduits **412** and **413**.

Conduits **412** and **413** extend upwardly, possibly joined with the umbilical life support package of the working chamber **2** to the floating vessel V. One of the conduits **412** will serve to supply pressurized piston actuating fluid, possibly sea water. The other conduit **413** will function as an exhaust conduit to permit the contraction of the piston and cylinder assembly **402**. This contraction may be facilitated by a winch and cable, piston contracting system.

FIG. **22** illustrates a dual seal which may be provided between the piston head **410** and the cylinder **406**.

This dual-seal assembly comprises a conventional pneumatic tire **416** secured between the piston head and a mounting plate **417** as generally shown in FIG. **22**. Tire **416** is disposed in wiping or slidable and sealing engagement with the interior of cylinder **406**.

Superposed above the seal, defined by tire **416**, is an upwardly facing cup-type seal **418**. Seal **418** may be fabricated of elastomeric or composition material in a conventional fashion. The rim **419** of cup seal **418** is biased into wiping or slidable and sealing engagement with the cylinder wall **406**.

Cup seal **418** is retained by a mounting plate **420**. Plate **420** is secured by a mounting nut **421**. Mounting nut **421** threadably engages a mounting stud **422** which is fixedly anchored to baseplate **410** as, for example, by welding.

It is contemplated that the interior **416*a*** of the tire **416** may be filled with a mixture of air and water to provide a seal biasing effect. Inflating fluid or seal biasing fluid may be injected into the space **416*a*** through a conventional check valved or valve control filling nozzle **416*b***. In the arrangement shown in FIG. **22**, such fluid would be injected into the space **416*a*** either prior to or subsequent to the insertion of the piston **408** into the cylinder **406**. The removable nature of the cup **418**, plate **420**, nut **421**, and cylinder head **407** would provide access to the filling nozzle **416*b*** after the piston **408** had been positioned within the cylinder **406**.

It is possible, of course, that in certain instances a single seal assembly may be employed, possibly comprising the cup seal **418** alone.

As is generally and schematically illustrated in FIG. **17**, each piston **408** terminates at its lower end in a load distributing plate or pad **423**. Each such pad **423** provides a downwardly facing, and generally horizontally extending, load distributing face. The dimension and structure of each such load distributing pad **423** will vary in accordance with the nature of the submerged surface S. However, each such pad **423** should be capable of interacting with the surface S without merely sinking into the surface S as jacking force is applied. In other words, each pad **423** should enable effective jacking action to take place between the surface S and the working chamber **2**.

Jacks similar or identical to that described in connection with FIGS. **21** and **22**, provided with force-distributing pads, may be mounted on the base stringers **101** and **102** of the aligning frame **1** as generally shown in FIG. **7**, to provide a frame jacking system **424**.

Jacks may be mounted at each corner of the aligning frame **1** and may also be disposed at intermediate locations along each of the stringers **101** and **102**.

Because of the uneven nature of submerged surfaces, it is contemplated that the jack system, when employed in conjunction with either the frame **1** or the working chamber **2**, or in conjunction with each of these components, will be individually controllable and operable. This will enable jacking force to be selectively applied to obtain the desired orientation and elevation of the component.

Further, the jack pistons may be extended prior to the engagement of the frame **1** with the surface S or prior to the engagement of the chamber **2** with the conduit portions **C1** and **C2**. The final lowering of the components may then be effected under the controlled action of the jack units.

In any event, it is contemplated that the operation of the jacks would be controllable by divers at the work site.

This control could be effected by valve control stations **415** at each of the jack units or could be effected from a common control site through conventional remote control circuitry.

DUAL-CONTROL SYSTEM FOR ALIGNMENT FRAME CLAMPS

As has been previously indicated the alignment frame **1**, shown in FIG. **1**, is provided with four clamp supporting truss stations **103, 104, 105** and **106**.

In the preferred embodiment of the invention, the three clamp-actuating piston and cylinder assemblies associated with each clamp at each truss station, as shown in FIG. **8**, are independently operable. However, a flexible conduit supplying pressurized hydraulic fluid and another flexible conduit functioning as an exhaust or return line may extend from the floating vessel V to the frame **1** and serve to supply pressurized fluid and vent capabilities to the clamp operating piston and cylinder assemblies at each of the four truss stations. It is contemplated that the fluid circuit for the entire alignment frame would entail the various clamp stations being connected in "parallel" relation to the main conduit supplying pressurized fluid and the main vent or return conduit.

It is also contemplated that the control mechanism for the clamps would be two-stage or dual in nature.

Rough positioning of the clamps and the conduit means engaged by the clamps will be effected by diver-induced manipulation of the clamps from control stations on the alignment frame, before the working chamber **2** is lowered.

After the working chamber **2** is lowered, auxiliary control stations within the working chamber are connected with the frame circuitry by conventional flexible conduit couplings of "jumpers" to enable divers or workmen within the interior space **237** to operate the clamp actuating piston and cylinder assemblies and obtain a fine or precision alignment of the clamps. This precision alignment is facilitated with the divers being in a dry environment and able to directly observe the ends of the conduit portions C1 and C2 which are to be aligned.

The dual control circuit associated with each of the clamp mechanisms at the four truss stations is identical to the control circuitry for the other clamp stations. Thus, by reference to FIGS. **23***a* and **23***b* representative control circuitry **5** associated with the clamp **107** at truss **105** will be described.

In the circuit schematically illustrated in FIGS. **23***a* and **23***b*, pressurized hydraulic fluid is supplied from a remote source, i.e., the vessel V, through flexible conduit means **501**. A flexible return conduit **502** extends from the worksite upwardly to the floating vessel V.

Representative control means **5** includes three principal control units **503, 504** and **505**. These control units may be contained in a unitary control panel **506** mounted, for example, on base stringer **101** in the vicinity of truss **105**.

Supply conduit **501** supplies pressurized fluid to stations **503, 504** and **505** at pilot valve junctions **507, 508** and **509**, respectively. Conduit **501** supplies pressurized fluid to stations **503, 504** and **505** at control valve junctions **507***a*, **508***a*, and **509***a*, respectively. Similarly, return conduit **502** is connected with control units **503** through **505** at pilot valve junctions **510, 511** and **512**, respectively, and at main control valve junctions **510***a*, **511***a*, and **512***a* respectively. Junction points **503, 504, 505, 510, 511** and **512** serve to provide a flow path through conventional manually operated, convention spool-type pilot valves **513, 514** and **515**, respectively. The spool valves **513** through **515** are identical.

Thus, if the spool of representative valve **513** is shifted from the illustrated neutral position to the left, pressurized fluid will flow from junction **507** to a shuttle valve **516**. Shuttle valve **516** comprises a conventional two-way check valve including an outlet conduit **517** to which fluid is to be supplied through two check valve controlled conduits **518** and **519**. Conduit **518** extends from spool valve **513** while conduit **519** extends from an auxiliary control station, with each of the lines **518** and **519** being check valved to prevent flow away from valve **516**.

As is schematically shown in FIG. **23***b*, fluid flowing through the conduit **518** will cause the check valve to close conduit **519** and permit flow outwardly through conduit **517**. Similarly, pressurized fluid supplied by conduit **519** will cause the check valve or shuttle valve **516** to close passage **518** and divert flow into conduit **517**. As will be apparent, and as is shown schematically in FIG. **23***b*, the check valve arrangement in shuttle valve **516** involves a single ball of other type valve body interposed between two valve seats in the conduits **518** and **519**, respectively.

If the spool in valve **513** is shifted from the illustrated neutral position to the right, pressurized fluid will flow to a shuttle valve **520** which is identical to the shuttle valve **516**. Shuttle valve **520** provides check valve control over flow through conduits **521** and **522** and permits flow out through conduit **523**. Conduit **522** extends to an auxiliary control station and conduit **521** extends to valve **513**.

Conduits **517** and **523** communicate with opposite ends of a spring, centered fluid actuable spool-type main control valve **524**. Pressurized fluid supplied through conduit **517** will shift the spool of valve **524** to the left. Pressurized fluid supplied through conduit **523** will shift the spool of valve **524** to the right.

As is shown in FIG. **23***b*, spool valve **524** communicates with pressure line **501** by connecting conduit **525** extending from junction **507***a*. Spool valve **524** communicates with vent line **502** by a connecting conduit **526** extending from junction **510***a*. Two output lines **527** and **528** extend away from the spool valve **524**.

Thus, when the spool of valve **524** is shifted to the left, pressurized fluid will flow through conduit **527**. When the spool of this valve is shifted to the right, pressurized fluid will flow through conduit **528**.

Each of the control units **504** and **505** include circuitry identical to that previously described. Thus, pilot valve at control unit **504** includes shuttle valves **529** and **530** controlling flow to a fluid-actuated spool valve **531**.

At control unit **505**, shuttle valves **532** and **533** and pilot valve **515** control flow to a spool valve **534**.

Turning again to control unit **503**, the output lines **527** and **528** communicate at junctions **535** and **536** to a "hold and motion control" valve **537**. This hold and motion control valve may comprise a hold and motion control valve manufactured by Racine Hydraulics & Machinery Inc. of Sarasota, Fla. and identified with a catalog marking ME 8.53.

It is contemplated that the hold and motion control valve **537** may be mounted directly on cylinder **136**. It is also contemplated that conduit means **527** and **528** may comprise conduit means secured to various frame portions of the aligning frame **1**. Such being the case, flexible connecting conduits **538** and **539** or "jumpers" may be employed to interconnect the conduit means **527** and **538** with the junctions **535** and **536**, respectively. Flexible conduits **538** and **539** would be positioned in the vicinity of the hinge **137** to accommodate for the vertical hinge or pivot action of the assembly **133**.

A conduit **540** connects valve assembly **537** with one end of the cylinder **136**. Another conduit **541** connects the valve assembly **537** with the other end of the cylinder **136**.

A pressure responsive, relief valve **542** and a check valve **543** are connected in parallel between conduit **540** and junction **536** as shown in FIG. **23***a*. A pressure responsive, relief valve **544** and a check valve **545** are connected in parallel between conduit **541** and junction **535**. A fluid signal transmitting conduit **546** provides fluid communication between junction **536** and a valve actuating portion of the pressure responsive relief valve **544**. Another signal conduit **546** provides fluid communication between junction **535** and a valve actuating portion of relief valve **542**.

In the manner described in the aforesaid catalog entry of Racine Hydraulics & Machinery, Inc., pressurized fluid supplied to line **539** will pass through check valve **543** and pressurize the chamber portion **136***a* of cylinder **136**. Fluid will leave the other chamber portion **136***a* of cylinder **136** through conduit **541** and be blocked, in part, by the check valve **545**.

This flow will pass through open pressure relief valve **544**. The pressure relief valve will have been opened by a conventional pilot mechanism operated by the conduit **546**, as described in the aforesaid Racine Hydraulics & Machinery Inc. catalog entry. Similarly, when pressurized fluid is supplied to conduit **538**, the check valve **545** will permit the transmittal of this fluid to the chamber **136*b***. Fluid expelled from chamber **136*a*** will flow through conduit **540** and open relief valve **542** to the conduit **539**, now functioning as a return line. The opening of valve **542** will have been effected by pressurized fluid supplied by conduit **547**.

When pressurized fluid is supplied to neither conduit **538** nor conduit **539** the unopened pressure relief valves **542** and **544**, in cooperation with the check valves **543** and **545**, will in essence lock the piston **138** in position within the cylinder **136**.

A hold and motion control valve **548**, identical to valve **537**, serves to interconnect control unit **504** with piston and cylinder assembly **134**.

Conduits **549** and **550** extend from the outlet side of valve **531** to frame junctions **551** and **552**, respectively. Junctions **551** and **552** are connected with junctions **553** and **554** of hold and motion control valve **548**, mounted on cylinder **140**, by flexible and detachable conduit couplings or jumpers **555** and **556**. Detachable, flexible coupling conduits **555** and **556** are structurally and functionally identical to the previously discussed coupling conduits **538** and **539** and accommodate the pivot action of junction **141**.

Thus, hold and motion control valve **548** is connected with opposite ends of cylinder **140** by conduits **556** and **558**, with flow from the junctions **553** and **554** to the conduits **557** and **558** being controlled by a hold and motion control valve identical in structure and function to the hold and motion control valve **537**.

Similarly, a third hold and motion control valve **559** is connected with conduits **560** and **561** extending from the valve **534** of control station **505**. Conduits **560** and **561** are frame mounted and terminate at frame junctions **562** and **563**. Flexible and selectively releasable coupling conduits or jumpers **564** and **565**, similar to conduit couplings **538** and **539**, interconnect junctions **562** and **563** with junctions **566** and **567** of hold and motion control valve **559**. Here again, it is contemplated that valve **559** would be mounted directly on cylinder **545** so that the couplings **564** and **565** would accommodate the pivot action at pivot joint **147**.

Hold and motion control valve **559**, which is identical in structure and function to the previously described hold and motion control valve **537**, is connected with opposite ends of cylinder **145** by conduits **568** and **569**.

Control unit **5** is also provided with a "float" control system enabling either of the pistons **138** or **140** to be "floated" or rendered freely axially movable while one or both of the other of the three piston and cylinder assemblies is being actuated. Such floating, of course, may be necessary to permit displacement of the clamp **107** in the desired direction.

This flat valve structure includes a spool valve **570** which may be located at station **505**. Spool valve **570** is disposed in fluid communication with junctions **509** and **512**, as shown in FIG. 23*b*.

Two output conduits **571** and **572** lead to shuttle valves **573** and **574**, respectively. These shuttle valves are identical to the previously described shuttle valve **516** and serve to selectively block flow from valve **570** into a nonpressurized input conduit.

Thus, shuttle valve **573** is served by input conduit **571** and an auxiliary input conduit **575** leading to an auxiliary control station. Shuttle valve **574** is served by input conduit **572** and an auxiliary input conduit **576** leading to the auxiliary control stations. An output conduit **577** leads from shuttle valve **573**, while another output conduit **578** leads from shuttle valve **574**.

Thus, when conduit **571** is pressurized, conduit **575** will be blocked and fluid will flow into line **577**. Similarly, when line **572** is pressurized, line **576** will be blocked and fluid will flow through conduit **578**.

Conduit **577** communicates with a spool-type flow valve **579** incorporated with the hold and motion control valve **537**. A flexible and detachable jumper conduit **580** may serve the same function as conduits **538** and **539** in interconnecting conduit **577** with an actuating conduit **581**. Pressurized fluid transmitted to conduit **581** is operable to bias the spool of valve **579** and move it to the right so as to displace it from its spring centered or neutral position shown in FIG. 23*a*.

When the spool of valve **579** is shifted to the right, from the position shown in FIG. 23*a*, by moving the spool of valve **570** to the left from its FIG. 23*b* position, opposite ends of the chambers **136*b*** and **136*a*** are placed in fluid communication so as to permit a floating or free movement of the piston **138**. It should also be noted that the spool in valve **579** when shifted to the right, provides a dump passage or conduit **582** communicating with junction **535**. When piston **138** is to be floated, the diver actuated valve **513** would be in the illustrated neutral position, thereby permitting fluid to flow from junction **535** through conduit **527** and valve **524** to vent line **502**.

A float valve **583** is associated with hold and motion control valve **548**, in exactly the same manner that float valve **579** is associated with valve **537**. Float valve **583** is actuated to permit the floating of piston **142**, when the spool of valve **570** is moved to the right so as to supply pressurized fluid to conduits **571** and **578**. Conduit **578** is placed in fluid biasing communication with the spool valve **583** by a jumper or flexible detachable conduit **584** which is both structurally and functionally equivalent to jumper conduits **555** and **556**.

With this arrangement, when the control valve **515** is actuated so as to induce movement of the piston **148**, the float control valve **570** should be concurrently actuated so as to permit floating of either the piston **138** or the piston **142** at the option of the diver. Obviously, if the piston **148** is being manipulated, a diver may choose to alternate the floating action between the pistons **138** and **142** so as to maintain a desired positioning of the clamp **107**.

The auxiliary control station **585** includes four, spool-type control valves **586**, **587**, **588** and **589**. These manually or diver-operated, control valves **586–589** are positioned at the control station **585** located within the interior space **237** of the working chamber **2**.

Control valve **586** is functionally and structurally the same as control valve **513** and is placed in fluid communication with the conduits **522** and **519**. Because of shuttle valves **516** and **520**, this enables valve **586** to control the operation of valve **524** to the exclusion of valve **513**.

In a similar manner, valve **587** is intended to provide automatic control, from space **237**, over valve **531** at station **504**, while valve **588** provides automatic control from space **237** over valve **534** at station **505**. Valve **589** is a float control valve which supersedes valve **570** from space **237** in providing control over the flow of fluid through conduits **577** and **578**.

As will be apparent, the control unit **585** must be placed in fluid communication with appropriate conduits in the control panel **506** after the working chamber **2** has been lowered into place in engagement with the conduit portions C1 and C2. This may be accomplished by having divers install flexible and detachable, jumper conduits or coupling conduits **590**, **591**, **592**, **593**, **594**, **595**, **596** and **597** between the conduit system of chamber **2** and that of frame **1**.

The main supply conduit **501** and the associated vent conduit **502** are interconnected with a conduit network at auxiliary control station **505** which provides pressurized fluid to the various valves **586** through **589** by detachable, flexible jumper conduits or coupling units **598** and **599**.

As will be appreciated, conventional conduit and control valve arrangements may be associated with the control station **585** and employed, for example, to control the operation of the hydraulic, piston and cylinder, jack units employed to manipulate the working chamber doors in the FIG. 15–FIG. 16 embodiment.

HUMIDITY AND TEMPERATURE CONTROL FOR INTERIOR OF WORKING CHAMBER

FIGS. 5 and 27 illustrate a system which may be employed to control the temperature and humidity in the working space **237** of the working chamber **2**.

As shown in the cross-sectional view of the working chamber presented in FIG. **5**, air from the working space **237** is withdrawn from the interior space and caused to enter an intake **601** of an atmosphere control unit **6**.

Atmosphere control unit **6** comprises a housing **602** mounted on the exterior of the wall **203** and defining a U-shaped flow passage **603**. Passage **603**, including leg portions **603***a* and **603***b* separated in part by a divider plate **604**, extends from the inlet **601** to an outlet **602** located in an uppermost portion of the working space **237**.

Air drawn to the inlet **601** is circulated in a generally counterclockwise fashion by a conventional blower **605** positioned in passage portion **603***b*.

Air is circulated through passage **603** under the influence of blower **605** located in leg portion **603***b*. This air, upon entering the inlet **601**, passes through and/or around a conventional evaporator **606**. Evaporator **606** is included in a refrigeration circuit shown schematically in FIG. **27**. The function of evaporator **606** is to cool the air entering the passage **603** and also, in effecting this cooling, remove moisture so as to reduce the humidity of the air. The condensed moisture may fall into a collecting receptacle **607** and be transmitted, if desired, through an isolated condensate flow path to the ambient water surrounding the working chamber.

After the air has been cooled by the evaporator **606**, it continues its movement through passage **603** and passes through and/or around a condenser **608** of the FIG. **27** refrigeration circuit. The function of the condenser **608** in conduit **603** is to at least partially restore heat to the air which was removed, as the air moved through and/or around the evaporator **606**.

In cold working environments, it may be desirable to heat the air flowing through the passage **603** so as to heat the working passage **237**. If such heating is desired, a self-contained heating unit **609** may be incorporated in the passage **603**, downstream of the condenser **608**. Heater **609** may comprise a closed-circuit hot-water, circulation-type heater.

The humidity and temperature controlled air may now flow from passage leg **603***a* to passage leg **603***b* where it is impelled by blower **605** through the inlet **602**, back into the working space **237**.

It is contemplated that the temperature and humidity control circuit **6** may be fabricated so as to provide unique versatility in temperature control.

Thus, as shown in FIG. **27**, the refrigeration system of atmosphere control unit **6** comprises a closed sump or reservoir **610** containing a refrigerant material such as Freon. A conduit **611** extends from sump **610** to the evaporator **606** to supply condensed refrigerant to the evaporator.

The at least partially gasified refrigerant leaving the evaporator **606** passes through a conduit **612** leading to a conventional refrigeration circuit, compressor means **613**. Compressed gaseous refrigerant leaves the compressor means **613** through conduit **614** and passes to the condenser **608**. At least partially condensed refrigerant produced in the condenser unit **608** leaves the condenser through conduit **615** and returns to the sump **610**.

Compressor means **613** may be provided with conventional pressure equalizing means, check valve means, dryer means, and other circuitry conventional in refrigeration circuitry.

The entire compressor means package, including its related components, may be positioned on the exterior of the working chamber **2** and possibly be located immediately beneath the passage **603** on wall **201**.

In order to provide maximum flexibility in temperature control, it may be desirable to provide a condenser unit **616** mounted on the exterior of the working chamber in heat exchanging relation with the ambient water. This external condenser may be connected with conduit **614** through branch portion **614***a*. A three-way valve **617** determines whether refrigerant flows to condenser **608** or condenser **616** or simultaneously to both of these condensers. A selectively operable flow control valve **618** may be incorporated in line **614***a*.

External condenser **616** is connected with return conduit **615** by a branch conduit means **619**. A manually operable flow control valve **620** may be incorporated in conduit **619** to control refrigerant flow therethrough.

Thus, in the event that excessive heating should take place within the atmosphere **237**, the valves **617**, **618** and **620** may be adjusted so as to cause gaseous refrigerant from the compressor **613** to flow through the external condenser **616** rather than through the internal condenser **608**. In this event, the cooling action of the evaporator **606** would not be offset by the condensing action of the condenser **608**, such that the net result of the circuit **6** would be to cool the atmosphere **237**.

Obviously, the valves **617**, **618** and **620** may be adjusted so as to allow some flow of refrigerant through each of the condensers **608** and **616** so as to obtain only partial rewarming of air flowing through the passage **603**.

Where the atmosphere **237** is excessively cold, it may be desirable to employ an evaporator **621** located externally of the working chamber **2** in heat exchanging relation with ambient water.

Such an external evaporator **621** may be connected by branch conduit **611***a* with conduit **611**. A three-way control valve **622** may be employed to determine whether refrigerant from sump **610** flows through the branch conduit **611***a* leading to the external evaporator **621**, or through conduit **611** leading to the internal evaporator **606**, or concurrently to each of the evaporators **606** and **621**.

Evaporated refrigerant from the unit **621** may return to conduit **612** by way of a branch conduit **623**. Flow through conduit **623** may be regulated by a manually operable valve **624**, with flow through branch conduit **611***a* being regulated by a manually operable flow control valve **625**. By adjusting valves **624** and **625**, the relative ratios of refrigerant flow to units **606** and **621** may be selectively adjusted. Obviously, where humidity control is necessary, the evaporator **606** will be utilized at least to some extent. However, by selectively regulating the relative degree of evaporative action of the internal evaporator **606** and the external evaporator **621**, the degree of cooling of the atmosphere **237** may be modulated or regulated.

GUIDE SYSTEM

In utilizing the apparatus of the invention, it is contemplated that a guide system **7** may be employed to sequentially control the lowering and positioning of the frame **1**, the working chamber **2** and the divers transfer vehicle **246**.

Structural details of the guide system are set forth in FIGS. **1–6** and **12–14**.

Guide system **7** includes guide cables **701** and **702** which are employed at the outset to control the lowering of guide frame **1**.

Guide cable **701** is supported at an anchor point **703** on vessel V, and extends downwardly to an anchor point **704** which is detachably secured on conduit means **C1**. Guide cable **701** passes slidably through guide eyes **705** and **706** carried on the outer face of truss **103** as generally indicated in FIG. **1**.

Similarly, guide cable **702** is supported at its upper end by an anchor point **707** on vessel V. The lower end of guide cable **702** may be secured to conduit means **C2** by detachable anchor point **708**.

As is shown in FIG. **1**, guide cable **702** passes slidably through guide eyes **709** and **710** formed on the outer face of truss **106**.

Preferably, anchor points **704** and **708** are symmetrically arranged with respect to the facing ends of conduit means **C1** and **C2**, but are longitudinally spaced by a distance exceeding the longitudinal distance between the guide eyes on truss **103** and the guide eyes on truss **106**. This spacing provides a progressive tightening of the guide cables **701** and **702**, as the guide frame is lowered, so as to ensure optimized alignment during the terminal stage of the guide frame lowering operation.

Obviously, the spacing between the guide cables **704** and **708** will be such as to permit the complete desired lowering of the guide frame **1**, the increased tightness in the guide cables **701** and **702** notwithstanding.

After the guide frame has been guided into position, the working chamber **2** is lowered as generally shown in FIG. **2**.

The guided lowering of working chamber **2** may be implemented by guide cables **711** and **712** extending upwardly from anchor points **713** and **714** on the ends of conduit means **C1** and **C2** to the floating vessel V.

Possibly, the guide cables **711** and **712** may merely comprise repositioned guide cables **701** and **702**.

As is shown in FIG. **2**, guide cable **711** passes vertically through a generally tubular guide passage **713** in frame **3** and passes slidably downwardly through guide eyes **714** and **715** which are formed on end wall **205** of chamber **2**. The guide eyes **714** and **715** are positioned in vertical alignment with the guide aperture **713**, which guide aperture **713** is illustrated in FIG. **12**.

Guide cable **712** passes through a generally tubular and vertical guide passage **716** in frame **3**, and continues slidably downwardly through guide eyes **717** and **718** formed on end wall **204** of working chamber **2**. Guide eyes **717** and **718** are illustrated, for example, in FIGS. **15** and **17**, with identical guide eye **714** also being shown in FIG. **18**. Guide eyes **717** and **718** are positioned so as to be vertically beneath the guide passage **716** when the frame **3** is supporting the working chamber **2** by cables **315** and **316** as previously discussed.

Anchor points **713** and **714** may be longitudinally spaced by a distance somewhat exceeding the longitudinal spacing between guide passages **713** and **716** so as to induce a tightening of the guide cables during the terminal portion of the guided working chamber lowering operation.

A third phase of the guide system **7** is illustrated in FIGS. **3**, **4** and **6**.

During this third phase of the guiding operation, the diver transfer vehicle **246** is suspended from a support cable **248***a* extending upwardly to hoisting and lowering gear on the vessel V, along with the umbilical package **248**.

Controlled guiding of the diver support vehicle **246** may be effected through a guide cable arrangement, as previously described, extending between the vessel V and the guide cone **245**.

It is also contemplated that a power type of guide system may be employed as shown in FIG. **6**.

In this arrangement a pair of concurrently or independently operable winch units **719** and **720** would be mounted on the underside of the diver transfer vehicle **246**. A cable **721** would pass downwardly from winch **719** to a sheave **722** mounted on plate **244** within guide cone **245**. Cable **721** would continue across plate **244** to a companion sheave **723** and pass upwardly to the winch **720**. Cable **721** may be installed with the aid of divers, with one or both of the cables **711** facilitating the guided lowering and reraising of the cable **721** for installation purposes.

With this guide arrangement, concurrent actuation of the winches **719** and **720** would serve to power or motivate the guided convergence of the vehicle **246** and the guide cone **245**, with the guiding and lowering operation being controllable from within the chamber **246** by divers controlling the operation of the winch units **719** and **720**.

The concurrent action of the two winch units would facilitate the maintenance of the vehicle **246** in a fully upright or vertical position during the lowering operation.

Even if one winch **719** or **720** should fail, the other winch would be available for the guiding and controlled lowering operation.

As will be appreciated, the winch controlled guide system shown in FIG. **6** is particularly significant where a buoyant transfer vehicle **246** is employed. Where such a buoyant transfer vehicle is utilized, the winches **719** and **720** enable the vehicle buoyancy to be overcome so as to induce the guided lowering of the vehicle **246** into nested engagement with he guide cone **45**.

As will be appreciated, the winches **719** and **720**, as well as the sheaves **722** and **723**, will be mounted to permit the complete nested convergence of the vehicle **246** and guide cone **245** and also permit divers to move from the vehicle **246** into the water-filled passage **240**.

The operation of the guide system has been described in connection with the lowering of the aligning frame **1**, the working chamber **2** and the diver transfer vehicle **246**.

During the retrieval or raising of these components, the guide systems may again be utilized, but in a reverse fashion, to control the movements of the system components and avoid injury to personnel.

In many instances, however, it may be possible to dispense with the guide cables during the raising of the frame **1** and the working chamber **2**.

Where a buoyant transfer vehicle **246** is employed, it may be desirable to utilize the winch system **719–720–721** to insure controlled raising of the vehicle **246** to the vicinity of the floating vessel means V.

OVERALL METHOD OF INVENTION

The basic method aspects of the invention are illustrated in a schematic and sequential format in FIGS. **1** through **4**.

As will be apparent from the foregoing discussion, the invention entails a first step where the alignment frame **1** is engaged with the conduit portions **C1** and **C2** as shown in FIG. **2**. The four clamps at the truss stations **103** through **106** and then closed, locked, and selectively manipulated to bring the facing ends of the conduit portions **C1** and **C2** into appropriate alignment, generally entailing a coaxial alignment.

This alignment may be facilitated with respect to the conduit **C1**, for example, by locking the clamp **107** of truss **103** in position and using the clamp as a fulcrum to facilitate the flexing of the free end of conduit **C1** by the clamp at truss **104**.

Obviously the clamp at truss **104** could function as a fulcrum while the clamp at truss **103** was manipulated to change the inclination of the face of conduit **C1** at its free end.

It is also apparent that the clamps **107** at stations **103** and **104** may be manipulated in unison or in opposite directions or in any mode of interrelationship to effect the desired orientation of the conduit means **C1**.

This same versatility in conduit means manipulation applies with respect to the manner in which the clamps **107** at truss stations **105** and **106** may be employed to manipulate the conduit means **C2**.

With the conduit means **C1** and **C2** at least roughly aligned, the facing ends of the conduit means are isolated in a controlled gaseous environment by the working chamber **2**, installed as shown in FIGS. **3** and **4**. In the installed position, of course, the working chamber doors clampingly engage the ends of the conduits **C1** and **C2** so as to secure the conduit ends and anchor the working chamber **2** with respect to the conduits **C1** and **C2**.

Through the operation of the temperature and humidity control system described in connection with the FIGS. **25** and **27**, the humidity and temperature of the interior space **237** of the chamber **2** may be selectively regulated. In certain instances an external condenser and/or an external evaporator may be disposed in heat exchanging relation with he surrounding water to facilitate temperature regulation in the working space **237**.

The jacking structures which may possibly be associated with the working chamber, as described in connection with FIGS. **17** and **18**, and possibly incorporated with the frame **1** as described in FIG. **7**, enable the frame and working chamber to be independently adjusted relative to the submerged surface S so as to obtain and maintain a desired elevation and orientation of these components.

With the working chamber installed, the divers or workmen in the interior space **237** may manipulate the control valves at the alternative control station **585** so as to effect a fine or terminal adjustment in the positions of the conduit means **C1** and **C2**. With the divers being in a relatively dry atmosphere and able to visually observe the ends of the conduit means projecting into the atmosphere, this final alignment step may be effected with great precision and relative ease.

Turning again to the sequence illustrated in FIGS. **1** through **4**, it is appropriate to review the manner in which the frame **1** is installed.

The frame **1** may be lowered, with its clamps in an open position, into the general vicinity of the conduits **C1** and **C2**. With the frame and open clamps superposed slightly above the conduits **C1** and **C2**, the guide cables **701** and **702** may be lifted so as to raise the conduits **C1** and **C2** into the open clamps. The clamps may then be closed and the frame lowered to the submerged surface.

In this connection, it will be noted that as shown in FIG. **1**, divers would have jetted away or removed subsurface material in the vicinity of the ends of the conduits **C1** and **C2** so as to provide door-closing room and working space in he vicinity of the working chamber **2**.

It is also possible that the diving frame may be lowered, with the clamps open, to a position superposed above the conduits **C1** and **C2** and the clamps adjusted in position so as to be superposed immediately above the conduit portions **C1** and **C2**. This adjustment in clamp position could be effected by divers at the control stations **506**, adjacent each of the trusses **103**, **104**, **105** and **106**, with the clamps located laterally so as to be engageable with the conduit portions **C1** and **C2** during the terminal lowering of the frame **1**. The support cable **313** would then be slacked off to allow the frame to come to rest on the submerged surface with he clamps open and engaging the conduits **C1** and **C2**. The clamps **107** would then be closed by divers at the frame control stations, and the closed clamps secured by the locking arrangement shown, for example, in FIG. **9**. The closed and locked clamps could then be manipulated to effect the desired rough alignment of the conduits **C1** and **C2**. During this adjustment operation, the ability of the conduits to rotate within the closed clamps would prevent the clamps from exerting torsional force on the conduits and thus damaging the conduits during the aligning operation.

After the frame has been installed, and before the clamps have been manipulated to effect the conduit aligning operation, it may be appropriate in certain instances to more positively secure the frame to the surface S by installing conventional piles P. such piles P may pass downwardly through mounting tubes T. Such tubes would each define a vertical, pile-receiving passage. A plurality of such pile receiving tubes T may be spaced longitudinally of each of the base stringers **101** and **102**.

Where the frame is provided with jack units **406**, the frame may be lowered with the jack pistons **408** in extended position. The frame may then come to rest superposed above the conduits **C1** and **C2**, with the extended jacks engaging the surface S and supporting the frame. With this arrangement, final lowering of the frame may be effected by controlled jack convergence under the control of divers in the work site.

Once the frame has been installed the work chamber **2** may be lowered directly by a cable **313**, or by the guide bar **3**, in guided cooperation with the guide cables **711** and **712** as generally shown in FIG. **2**.

During the lowering operation the work chamber doors will be in an open position so as to enable the end wall recesses of the work chamber to slidably receive the ends of the conduit portions **C1** and **C2** during the terminal part of the working chamber lowering operation.

Various techniques may be employed for installing the work chamber **2**. For example, if the length of the cables **315** and **316** is sufficient, the working chamber **2** will come to rest with the recessed ends **208** in engagement with the conduits **C1** and **C2** before the bar **3** engages the center trusses **104** and **105**. When the invention is thus practiced, the lifting bar may then be disconnected from the working chamber **2** and raised to the surface.

If the cables **315** and **316** are sufficiently short and connected with winch means, the bar may be lowered into socketed engagement with the trusses **104** and **105**, as shown in FIG. **12**, with the cables **315** and **316** holding the working chamber **2** somewhat above the conduit portions **C1** and **C2**. With this arrangement winches associated with the cables **315** and **316** may be manipulated under diver control to effect the final lowering of the work chamber **2** into engagement with the conduits **C1** and **C2**.

Regardless of the working chamber installation procedure, once the working chamber is resting on the conduits **C1** and **C2**, the doors will be moved to a closed position and elevated into clamping engagement with the conduits **C1** and **C2**.

While such clamping engagement in many instances will adequately stabilize the working chamber **2**, anchor chains or cables C, as shown in FIG. **15**, may extend from mounting eyes on the sides of the working chamber **2** to anchor eyes on the base stringers **101** and **102** to more positively secure the working chamber relative to the frame **1**.

With the working chamber installed, divers may move into the interior space **237** either through the base opening **254**, or through the passage **234**. With the divers or workmen positioned inside the space **237**, the controls at station **585** may be manipulated to effect the final alignment of the conduit means **C1** and **C2**.

Of course, prior to actuation of the controls at station **585**, the various jumper or connecting conduits described in connection with the circuit of FIGS. **23*a*** and **23*b*** would be installed.

Workmen may perform various operations within the working space **237**. Conduit portions or debris may be moved out of the chamber **237** through the base opening **254**, with one or more of the floor grids **250** and **251** raised to an upper position.

The raised grids would also permit working material or conduit replacement sections to be moved into the interior of the space **237**, if such materials had not been lowered with the working chamber **2**.

Divers may move between the vessel V and the working chamber **2** through the diver transfer vehicle movement control arrangement, described in connection with FIGS. **3** and **6**.

FIG. **4** illustrates the manner in which the nearly lowered transfer vehicle **246** is guided by the guide cone **245** into fully nested engagement with the cone **245** and seated cooperation with the floor **244** of the diver access passage **233**. The final seated positioning of the chamber **246**, and the movement of a diver through the passage **233** from the interior of the vehicle **246** to the working space **237** is illustrated in FIG. **5**.

SUMMARY OF ADVANTAGES AND SCOPE OF INVENTION

In describing the invention several of its advantages have been made apparent.

For example, the massive diving frame **1** provides a stable base from which clamps may function as fulcrums or force applying means to adjust the orientation of conduit means.

The manner in which this clamp actuation may be effected, first from the frame for rough adjustment purposes and then from the interior of the working chamber, provides for optimum diver control and maximum safety during the alignment operation.

The controlled atmosphere in the working chamber **2**, from the standpoint of gas content, temperature and humidity, is significant in reducing the hazard of fire and in providing a submerged high pressure atmosphere within which conventional welding operations may be effectively employed. Absent the control of humidity, and possibly in the absence of gas content control, welding operations at submerged locations of substantial depth would tend to be significantly impaired.

The use of raising and lowering bar **3** provides for increased stability and safety in connection with the positioning of the frame and possibly in connection with the positioning of the chamber **2**, if the frame is utilized as shown in FIG. **2**.

The hold and motion valve system, in conjunction with the floating valve system set forth in the FIGS. **23***a* and **23***b* circuit, enables workmen to effect precision adjustment with respect to the clamps **107** while maintaining the clamps in a locked or immobilized position when adjusting operations are not taking place. This, of course, contributes to safety and stability during the overall operation.

The bottom surface, engageable jacks which may be utilized in conjunction with the working chamber **2** and/or the frame **1** provide a technique for effectively controlling terminal lowering movements of these components and also provide a technique for effectively orienting the frame and working chamber regardless of subsurface irregularities and adverse load bearing characteristics.

The diaphragm seals described in connection with FIGS. **24–26**, provide a highly effective arrangement for conserving the special gaseous atmosphere within the working space **237**. Significantly, the diaphragms provide a seal arrangement independent of the door structure. The concave nature of the installation seal, as shown in FIG. **26**, produces the desirous result that gaseous pressure in the working chamber will tend to augment or improve the diaphragm seal action.

Those familiar with the diving art and familiar with this disclosure will recognize that the invention may be practiced with substantial variations. For example, the structure, form, and mode of operation of the frame **1** and habitat **2** and clamps **107** may be significantly altered, as may the circuitry of the FIGS. **23***a* and **23***b*. Hydraulic, pneumatic, or electrical circuitry may be employed in certain instances differing substantially from that described.

The lifting bar structure and temperature and humidity control circuitry may also be substantially altered within the purview of the invention.

Arrangements for moving divers to and from the working site may be employed which differ significantly from the described utilization of the transfer vehicle **246**.

Jack structures, as employed, need not necessarily involve the advantageous arrangement shown in FIGS. **21** and **22**.

It is also contemplated that the frame **1** may be provided with self-propulsion means such as motor driven (or freely rotatable) wheels or caterpillar tracks, corresponding in general to submerged vehicle propulsion arrangements as set forth in U.S. Gretter et al. Pat. No. 3,434,297. The disclosure of this Gretter et al. patent is incorporated herein by reference.

It is also possible that such a propulsion system might utilize oversize, balloon-type wheel units, of the type employed in connection with the so-called "marsh buggies," or spiral vane wheel type units.

With such a self-propulsion capability, a frame could be manipulated along a submerged surface from one worksite to the other.

Advantageously, such a self-propelled frame would also include a working chamber. This working chamber could, for all practical purposes, be unitized with the self-propelled frame so as to provide a self-propelled apparatus, including a working cavity, and having the capacity to move from one submerged worksite to another along a submerged surface, with control over vehicle movement being effected by divers within the interior of the working chamber.

Obviously control over movement of the self-propelled form of the invention could be effected by divers or workmen on the frame or in the working chamber, or moving along with the submerged units on the exterior thereof while maintaining a control by suitable remote control means. Remote control of vessel movement could also be effected from a surface vessel. The frame could also be towed from a floating vessel, or "-winched" along a pipeline. Movement of the frame could be facilitated by selectively controllable buoyance tanks, so as to provide a semifloating action as set forth, for example, IN U.S. Collins Pat. No. 2,601,300. The disclosure of this Collins patent is incorporated herein by reference, including the utilization of the Collins trench forming equipment.

It is also possible that the frame **1**, possibly including the habitat **2**, could be propelled along a pipeline by utilizing a motor-driven, pipe-engaging wheel unit as described in U.S. Lawrence Pat. No. 3,390,532, the disclosure of which is herein incorporated by reference. In this form of drive arrangement, the frame components of the Lawrence pipeline tensioning device, illustrated in FIGS. 15, 16 and 17 of the Lawrence patent, could be secured to horizontally displaced components of the frame **1** of the present invention, such as the base stringers **101** and **102**. With this mounting arrangement, the wheel assemblies 1002 and 1007 shown in FIG. 17 of the Lawrence patent would engage opposite horizontal sides of the pipeline and be torqued to cause the frame to move along the pipeline. Obviously each of the wheel assemblies could be mounted on a base stringer for selective and controlled movement toward and away from its respective side of the pipeline. With an arrangement of this nature, the utilization of selectively controllable buoyancy tanks, as featured in the Collins U.S. Pat. No. 2,602,300, would enable the buoyancy of the frame **1** to be increased to facilitate the travel of the frame and habitat along a pipeline.

Obviously a self-propelled frame and habitat of this nature could be employed for a variety of purposes, including pipeline inspection, maintenance, and repair operations, and pipeline laying itself. Pipeline laying could be accomplished by enlarging the chamber of the habitat **2** and providing, within the interior space of the habitat, a pipe supporting ramp as generally described in the aforesaid Lawrence patent a nd pipeline welding or joining stations. Additional lengths of the pipeline could be lowered from a floating vessel to the self-propelled frame and habitat as the pipeline laying operation proceeded. The Collins trench-forming equipment could be attached to the aft end of such an assembly and used to bury the joined pipe sections extending aft of the habitat.

Variations, modifications, substitutions and deletions, exemplified to some extent by those provisionally discussed, fall within the purview of the invention as defined in the appended claims.

We claim:

1. An apparatus to facilitate working on submerged conduit means, said apparatus comprising:

frame means operable to be lowered from floating vessel means and be positioned over submerged conduit means, said frame means including

a first plurality of independently operable clamp means carried by said frame means, spaced longitudinally of a first portion of said conduit means, and clampingly engageable therewith,

a second plurality of independently operable clamp means carried by said frame means, spaced longitudinally of a second portion of said conduit means, and clampingly engageable therewith,

first clamp-actuating means connected with said first plurality of clamp means and operable to cause each clamp of said first plurality of clamp means to independently and selectively exert independent force on said first portion of said conduit means selectively directed generally transversely of the longitudinal axis of said first portion and

second clamp actuating means connected with said second plurality of clamp means and operable to cause each clamp of said second plurality of clamp means to independently and selectively exert independent force on said second portion of said conduit means independently and selectively directed generally transversely of the longitudinal axis of said second portion.

2. An apparatus as described in claim **1** including, in at least one of said plurality of clamp means:

first clamp means defining selectively positionable fulcrum means; and second clamp means operable to flex a portion of said conduit means about said fulcrum means.

3. An apparatus as described in claim 1
wherein each of said clamp means includes
articulated conduit-engaging means; and
wherein each of said clamp actuating means includes
first piston and cylinder means pivotally mounted on said frame means and operable to exert force on a clamp means in one, generally horizontal, direction;
second piston and cylinder means pivotally mounted on said frame means and operable to exert force on said clamp means in a second, generally horizontal, direction generally opposite to said one direction; and
third piston and cylinder means pivotally mounted on said frame means and operable to exert force on said clamp means in a generally vertical direction.

4. An apparatus as described in claim 3 wherein each of said plurality of clamp means includes:
first clamp means defining selectively positionable fulcrum means; and
second clamp means operable to flex a portion of said conduit means about said fulcrum means.

5. An apparatus to facilitate working on submerged conduit means, said apparatus comprising:
frame means operable to be lowered from floating vessel means and be positioned over submerged conduit means; said frame means including
a first plurality of independently operable clamp means carried by said frame means, spaced longitudinally of a first portion of said conduit means, and clampingly engageable therewith,
a second plurality of independently operable clamp means carried by said frame means, spaced longitudinally of a second portion of said conduit means, and clampingly engageable therewith,
first clamp-actuating means connected with said first plurality of clamp means and operable to cause each clamp of said first plurality of clamp means to independently and selectively exert independent force on said first portion of said conduit means selectively directed generally transversely of the longitudinal axis of said first portion and
second clamp-actuating means connected with said second plurality of clamp means and operable to cause each clamp of said second plurality of clamp means to independently and selectively exert independent force on said second portion of said conduit means selectively directed generally transversely of the longitudinal axis of said second portion and
working chamber means including,
body means having a downwardly facing open portion,
recessed first and second end walls operable to receive said first and second portions of said conduit means,
first and second door means pivotally mounted on said first and second end walls, respectively, and operable to engage said first and second portions of said conduit means, respectively, to at least partially close the recess portions of said first and second end walls, respectively,
diver passage means having an open end at an upper exterior portion of said body means, and wall means extending from said open end downwardly along the exterior of said body means and terminating in an opening disposed within the interior of said body means, and
means operable to support said working chamber means from lifting means.

6. An apparatus as described in claim 5 further comprising:
first and second diaphragm means carried by said working chamber means and providing flexible diaphragm seals engageable with said first and second portions of said conduit means, respectively.

7. An apparatus as described in claim 5 further comprising:
dehumidifying means mounted on said working chamber means and operable to remove moisture from the interior thereof and selectively vary the temperature of said interior.

8. An apparatus to facilitate working on submerged conduit means, said apparatus comprising:
frame means operable to be lowered from floating vessel means and be positioned over submerged conduit means; said frame means including
a first plurality of independently operable clamp means carried by said frame means, spaced longitudinally of a first portion of said conduit means, and clampingly engageable therewith,
a second plurality of independently operable clamp means carried by said frame means, spaced longitudinally of a second portion of said conduit means, and clampingly engageable therewith,
first clamp-actuating means connected with said first plurality of clamp means and operable to cause each clamp of said first plurality of clamp means to independently and selectively exert independent force on said first portion of said conduit means selectively directed generally transversely of the longitudinal axis of said first portion and
second clamp-actuating means connected with said second plurality of clamp means and operable to cause each clamp of said second plurality of clamp means to independently and selectively exert independent force on said second portion of said conduit means selectively directed generally transversely of the longitudinal axis of said second portion, and
a plurality of jack means carried by said frame means, each jack means of said plurality being engageable with a submerged surface adjacent said frame means to exert a lifting force on said frame means.

9. An apparatus to facilitate working on submerged conduit means having first and second positions, said apparatus comprising:
working chamber means including, lifting bar means;
body means having a downwardly facing open portion,
recessed first and second end walls operable to receive said first and second portions of said conduit means,
first and second door means pivotally mounted on said first and second end walls, respectively, and operable to engage said first and second portions of said conduit means, respectively, to at least partially close the recess portions of said first and second end walls, respectively,
diver passage means having an open end at an upper exterior portion of said body means, and wall means extending from said open end downwardly along the exterior of said body means and terminating in an opening disposed within the interior of said body means, and
means operable to support said working chamber means from said lifting bar means; and
a plurality of jack means carried by said working chamber means, each jack means of said plurality being independently operable and engageable with a submerged surface adjacent said working chamber means to exert a lifting force on said working chamber means and adjust the elevation of said chamber door means.

10. An apparatus to facilitate working on submerged conduit means, said apparatus comprising:
frame means operable to be lowered from floating vessel means and be positioned over submerged conduit means; said frame means including
a first plurality of clamp means carried by said frame means, spaced longitudinally of a first portion of said conduit means, and clampingly engageable therewith,
a second plurality of clamp means carried by said frame means, spaced longitudinally of a second portion of said conduit means, and clampingly engageable therewith,
first clamp-actuating means connected with said first plurality of clamp means and operable to cause each clamp of said first plurality of clamp means to selectively exert independent force on said first portion of said conduit means selectively directed generally transversely of the longitudinal axis of said first portion, and

second clamp-actuating means connected with said second plurality of clamp means and operable to cause each clamp of said second plurality of clamp means to selectively exert independent force on said second portion of said conduit means selectively directed generally transversely of the longitudinal axis of said second portion

a first plurality of jack means carried by said frame means, each jack means of said first plurality being independently operably and engageable with a submerged surface adjacent said frame means to exert a lifting force on said frame means; and

a second plurality of jack means carried by said working chamber means, each jack means of said second plurality being independently operable and engageable with a submerged surface adjacent said working chamber means to exert a lifting force on said working chamber means.

11. An apparatus to facilitate working on submerged conduit means, said apparatus comprising:

frame means operable to be lowered from floating vessel means and be positioned over submerged conduit means; said frame means including

a first plurality of independently operable clamp means carried by said frame means, spaced longitudinally of a first portion of said conduit means, and clampingly engageable therewith,

a second plurality of independently operable clamp means carried by said frame means, spaced longitudinally of a second portion of said conduit means, and clampingly engageable therewith,

first clamp-actuating means connected with said first plurality of clamp means and operable to cause each clamp of said first plurality of clamp means to independently and selectively exert independent force on said first portion of said conduit means selectively directed generally transversely of the longitudinal axis of said first portion, and

second clamp-actuating means connected with said second plurality of clamp means and operable to cause each clamp of said second plurality of clamp means to independently and selectively exert independent force on said second portion of said conduit means selectively directed generally transversely of the longitudinal axis of said second portion, and

diver-operable control means for controlling said first and second clamp-actuating means, said control means including,

control means mounted on said frame means and operable by divers to cause said first and second plurality of clamp means to clampingly engage said conduit means and exert force thereon.

12. An apparatus as described in claim 11 further comprising:

working chamber means including,

body means having a downwardly facing open portion,

recessed first and second end walls operable to receive said first and second portions of said conduit means,

first and second door means pivotally mounted on said first and second end walls, respectively, and operable to engage said first and second portions of said conduit means, respectively, to at least partially close the recess portions of said first and second end walls, respectively,

diver passage means having an open end at an upper exterior portion of said body means, and wall means extending from said open end downwardly along the exterior of said body means and terminating in an opening disposed within the interior of said body means; and

auxiliary control means mounted in the interior of said body means of said working chamber means and operable by divers to cause said first and second clamp means to selectively vary force applied to said first and second portions of said conduit means to adjust the axial alignment thereof.

13. An apparatus to facilitate working on submerged conduit means, said apparatus comprising:

frame means operable to be lowered from floating vessel means and be positioned over submerged conduit means; said frame means including

a first plurality of independently operable clamp means carried by said frame means, spaced longitudinally of a first portion of said conduit means, and clampingly engageable therewith,

a second plurality of independently operable clamp means carried by said frame means, spaced longitudinally of a second portion of said conduit means, and clampingly engageable therewith,

first clamp-actuating means connected with said first plurality of clamp means and operable to cause each clamp of said first plurality of clamp means to independently and selectively exert independent force on said first portion of said conduit means selectively directed generally transversely of the longitudinal axis of said first portion and

second clamp-actuating means connected with said second plurality of clamp means and operable to cause each clamp of said second plurality of clamp means to independently and selectively exert independent force on said second portion of said conduit means selectively directed generally transversely of the longitudinal axis of said second portion, and

guide means extending between said floating vessel means and said conduit means and operable to guide said frame means into longitudinal alignment with said first and second portions of said conduit means.

14. An apparatus to facilitate working on submerged conduit means, said apparatus comprising:

frame means operable to be lowered from floating vessel means and be positioned over submerged conduit means; said frame means including:

a first plurality of clamp means carried by said frame means, spaced longitudinally of a first portion of said conduit means, and clampingly engageable therewith,

a second plurality of clamp means carried by said frame means, spaced longitudinally of a second portion of said conduit means, and clampingly engageable therewith,

first clamp-actuating means connected with said first plurality of clamp means and operable to cause each clamp of said first plurality of clamp means to selectively exert independent force on said first portion of said conduit means selectively directed generally transversely of the longitudinal axis of said first portion, and

second clamp-actuating means connected with said second plurality of clamp means and operable to cause each clamp of said second plurality of clamp means to selectively exert independent force on said second portion of said conduit means selectively directed generally transversely of the longitudinal axis of said second portion;

bar means operable to be engaged with said frame means and engage longitudinally thereof;

said bar means being operable to be connected with raising and lowering means on said floating vessel means;

working chamber means including,

body means having a downwardly facing open portion,

recessed first and second end walls operable to receive said first and second portions of said conduit means,

first and second door means pivotally mounted on said first and second end walls, respectively, and operable to engage said first and second portions of said conduit means, respectively, to at least partially close the recess portions of said first and second end walls, respectively,

diver passage means having an open end at an upper exterior portion of said body means, and wall means extending from said open end downwardly along the exterior of said body means and terminating in an opening disposed within the interior of said body means, and means operable to support said working chamber means from said lifting bars means;

diver-operable control means for controlling said first and second clamp actuating means, said control means including,

first control means mounted on said frame means and operable by divers to cause said first and second plurality of clamp means of clampingly engage said conduit means and exert force thereon, and

second control means mounted in the interior of said body means of said working chamber means and operable by divers to cause said first and second clamp means to selectively vary force applied to said first and second portions of said conduit means to adjust the axial alignment thereof; and

first and second diaphragm means carried by said working chamber means and providing flexible diaphragm seals engageable with said first and second portions of said conduit means, respectively.

15. An apparatus to facilitate working on submerged conduit means, said apparatus comprising:

frame means operable to be lowered from said vessel means and be positioned over submerged conduit means; said frame means including

a first plurality of clamp means carried by said frame means, spaced longitudinally of a first portion of said conduit means, and clampingly engageable therewith,

a second plurality of clamp means carried by said frame means, spaced longitudinally of a second portion of said conduit means, and clampingly engageable therewith,

first clamp-actuating means connected with said first plurality of clamp means and operable to cause each clamp of said first plurality of clamp means to selectively exert independent force on said first portion of said conduit means selectively directed generally transversely of the longitudinal axis of said first portion, and

second clamp-actuating means connected with said second plurality of clamp means and operable to cause each clamp of said second plurality of clamp means to selectively exert independent force on said second portion of said conduit means selectively directed generally transversely of the longitudinal axis of said second portion;

bar means operable to be engaged with said frame means and engage longitudinally thereof;

said bar means being operable to be connected with raising and lowering means on said floating vessel means;

working chamber means including,

body means having a downwardly facing open portion,

recessed first and second end walls operable to receive said first and second portions of said conduit means,

first and second door means pivotally mounted on said first and second end walls, respectively, and operable to engage said first and second portions of said conduit means, respectively, to at least partially close the recess portions of said first and second end walls, respectively,

diver passage means having an open end at an upper exterior portion of said body means, and wall means extending from said open end downwardly along the exterior of said body means and terminating in an opening disposed within the interior of said body means, and

means operable to support said working chamber means from said lifting bar means;

a first plurality of jack means carried by said frame means, each jack means of said first plurality being independently operable and engageable with a submerged surface adjacent said frame means to exert a lifting force on said frame means;

a second plurality of jack means carried by said working chamber means, each jack means of said second plurality being independently operable and engageable with a submerged surface adjacent said working chamber means to exert a lifting force on said working chamber means;

diver-operable control means for controlling said first and second clamp actuating means, said control means including,

first control means mounted on said frame means and operable by divers to cause said first and second plurality of clamp means to clampingly engage said conduit means and exert force thereon, and

second control means mounted in the interior of said body means of said working chamber means and operable by divers to cause said first and second clamp means to selectively vary force applied to said first and second portions of said conduit means to adjust the axial alignment thereof; and

first and second diaphragm means carried by said working chamber means and providing flexible diaphragm seals engageable with said first and second portions of said conduit means, respectively.

16. An apparatus to facilitate working on submerged conduit means, said apparatus comprising:

floating vessel means;

frame means operable to be lowered from said floating vessel means and be positioned over submerged conduit means; said frame means including

a first plurality of clamp means carried by said frame means, spaced longitudinally of a first portion of said conduit means, and clampingly engageable therewith,

a second plurality of clamp means carried by said frame means, spaced longitudinally of a second portion of said conduit means, and clampingly engageable therewith,

first clamp-actuating means connected with said first plurality of clamp means and operable to cause each clamp of said first plurality of clamp means to selectively exert independent force on said first portion of said conduit means selectively directed generally transversely of the longitudinal axis of said first portion, and

second clamp-actuating means connected with said second plurality of clamp means and operable to cause each clamp of said second plurality of clamp means to selectively exert independent force on said second portion of said conduit means selectively directed generally transversely of the longitudinal axis of said second portion,

said first and second clamp means being operable to engage said first and second portions of said conduit means, respectively, while permitting relative rotation between said first and second clamp means and said first and second portions;

bar means operable to be engaged with said frame means and engage longitudinally thereof;

said bar means being operable to be connected with raising and lowering means on said floating vessel means;

working chamber means including,

body means having a downwardly facing open portion,

recessed first and second end walls operable to receive said first and second portions of said conduit means,

first and second door means pivotally mounted on said first and second end walls, respectively, and operable to engage said first and second portions of said conduit means, respectively, to at least partially close the recess portions of said first and second end walls, respectively,

diver passage means having an open end at an upper exterior portion of said body means, and wall means extending from said open end downwardly along the exterior of said body means and terminating in an opening disposed within the interior of said body means, and

means operable to support said working chamber means from said lifting bar means;

a first plurality of jack means carried by said frame means, each jack means of said first plurality being independently operable and engageable with a submerged surface adjacent said frame means to exert a lifting force on said frame means;

a second plurality of jack means carried by said working chamber means, each jack means of said second plurality being independently operable and engageable with a submerged surface adjacent said working chamber means to exert a lifting force on said working chamber means;

diver-operable control means for controlling said first and second clamp actuating means, said control means including,

first control means mounted on said frame means and operable by divers to cause said first and second plurality of clamp means to clampingly engage said conduit means and exert force thereon, and

second control means mounted in the interior of said body means of said working chamber means and operable by divers to cause said first and second clamp means to selectively vary force applied to said first and second portions of said conduit means to adjust the axial alignment thereof.

door jack means operable to cause the first and second door means of said working chamber means to clampingly engage said first and second portions of said conduit means respectively;

first and second diaphragm means carried by said working chamber means and providing flexible diaphragm seals engageable with said first and second portions of said conduit means, respectively,

dehumidifying means mounted on said working chamber means and operable to remove moisture from the interior thereof and selectively vary the temperature of said interior, said dehumidifying means including,

heat exchanger means disposed in heat exchanging relation with water surrounding said working chamber means; and

sequentially operable guide means including,

first guide means extending between said floating vessel means and said conduit means and operable to guide said frame means into longitudinal alignment with said first and second portions of said conduit means,

second guide means extending between said floating vessel means and said first and second portions of said conduit means, extending through said bar means and operable to guide said working chamber means supported by said bar means to cause said recessed wall portions thereof to receive said first and second portions of said conduit means; and

third guide means operable to guide a diver transfer chamber between said floating vessel means and said open end of said diver passage means.

17. A method of working on conduits in a submerged location, said method comprising:

independently exerting a series of longitudinally spaced, independent, and transversely direction forces on each of two spaced conduit means to adjust the alignment thereof;

on at least one of said conduit means,

exerting one force on one portion of said one of said conduit means to provide fulcrum means reacting transversely on said one portion of said one conduit means, and

exerting another force on another portion of said one of said conduit means, said other force being exerted on said other portion of said one of said conduit means to tend to move said other portion of said one of said conduit means generally transversely of the one portion of said one of said conduit means against which said fulcrum means is reacting;

isolating said aligned conduit means in a gaseous environment; and

selectively adjusting the humidity and temperature of the working environment.

18. A method of working on conduits in a submerged location, said method comprising:

independently exerting a series of longitudinally spaced, independent, and transversely directed forces on each of two spaced conduit means to adjust the alignment thereof;

on at least one of said conduit means,

exerting one force on one portion of said one of said conduit means to provide fulcrum means reacting transversely on said one portion of said one conduit means, and

exerting another force on another portion of said one of said conduit means, said other force being exerted on said other portion of said one of said conduit means to tend to move said other portion of said one of said conduit means generally transversely of the one portion fulcrum means is reacting;

isolating said aligned conduit means in a gaseous environment;

selectively adjusting the humidity and temperature of the working environment; and

during said working, exerting jacking force from a submerged surface on said conduit means to adjust and maintain the alignment.

19. A method of working on conduits in a submerged location, said method comprising:

independently exerting a series of longitudinally spaced independent and transversely directed forces on each of two spaced conduit means to adjust the alignment thereof;

isolating said aligned conduit means in a gaseous environment;

selectively adjusting the humidity and temperature of the working environment; and

during said working, sequentially exerting said forces on said conduit means under the control of divers located externally and the internally of said working environment.

20. A method of working on conduits in a submerged location, said method comprising:

independently exerting a series of longitudinally spaced independent and transversely directed forces on each of two spaced conduit means to adjust the alignment thereof;

isolating said aligned conduit means in a gaseous environment;

selectively adjusting the humidity and temperature of the working environment;

during said working, exerting jacking force from a submerged surface on said conduit means to adjust and maintain the alignment; and

during said working, sequentially exerting said forces on said conduit means under the control located externally and then internally of said working environment.

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