Dec. 13, 1960 E. R. ARMSTRONG 2,963,868

SEADROME

Filed March 15, 1954 7 Sheets-Sheet 1

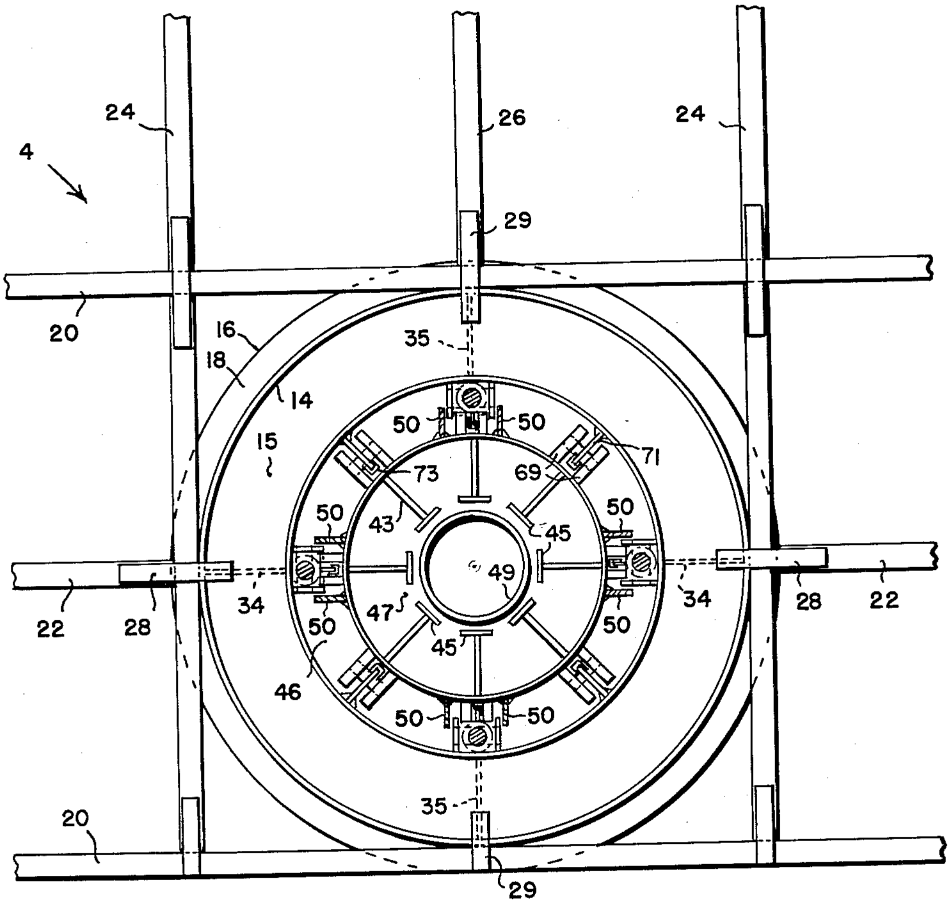

FIG. 3.

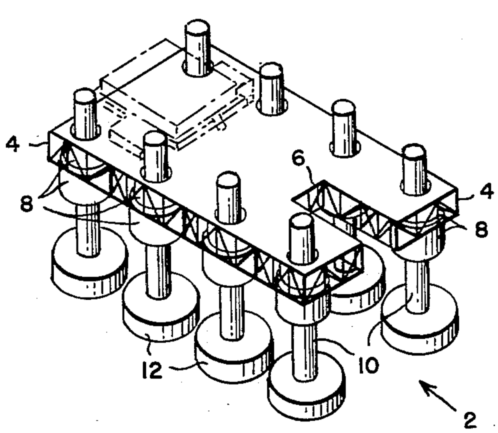

FIG. 1.

INVENTOR.

EDWARD R. ARMSTRONG

BY [signature]

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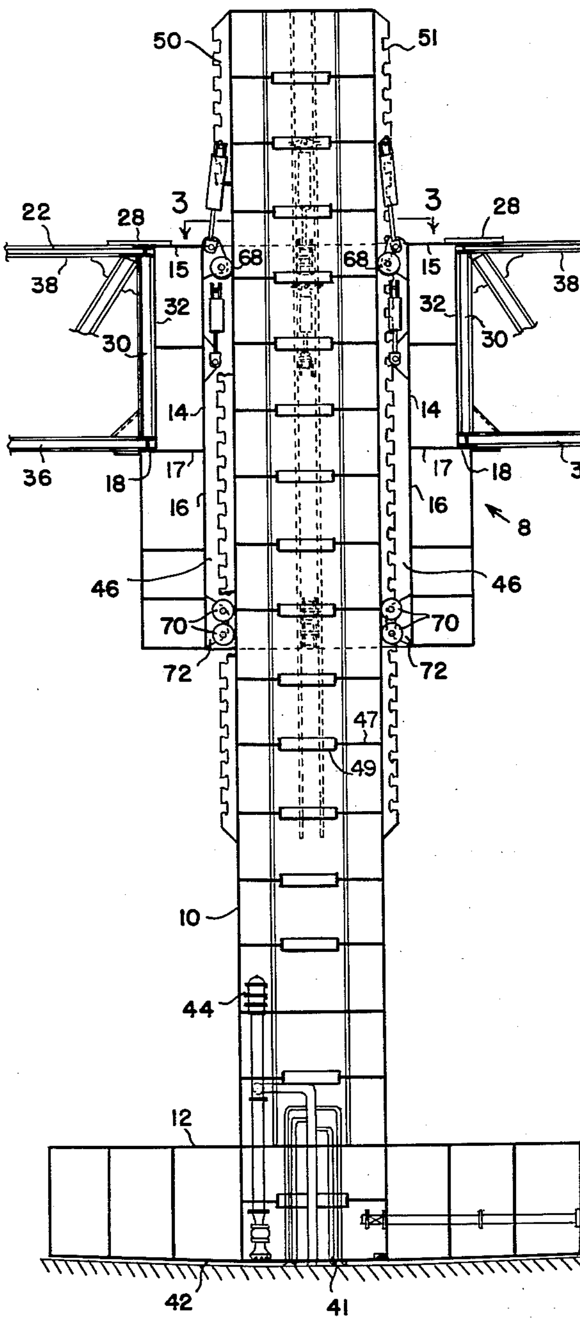

FIG. 2.

INVENTOR.
EDWARD R. ARMSTRONG
BY [signature]
ATTORNEYS

Dec. 13, 1960 E. R. ARMSTRONG 2,963,868

SEADROME

Filed March 15, 1954 7 Sheets-Sheet 3

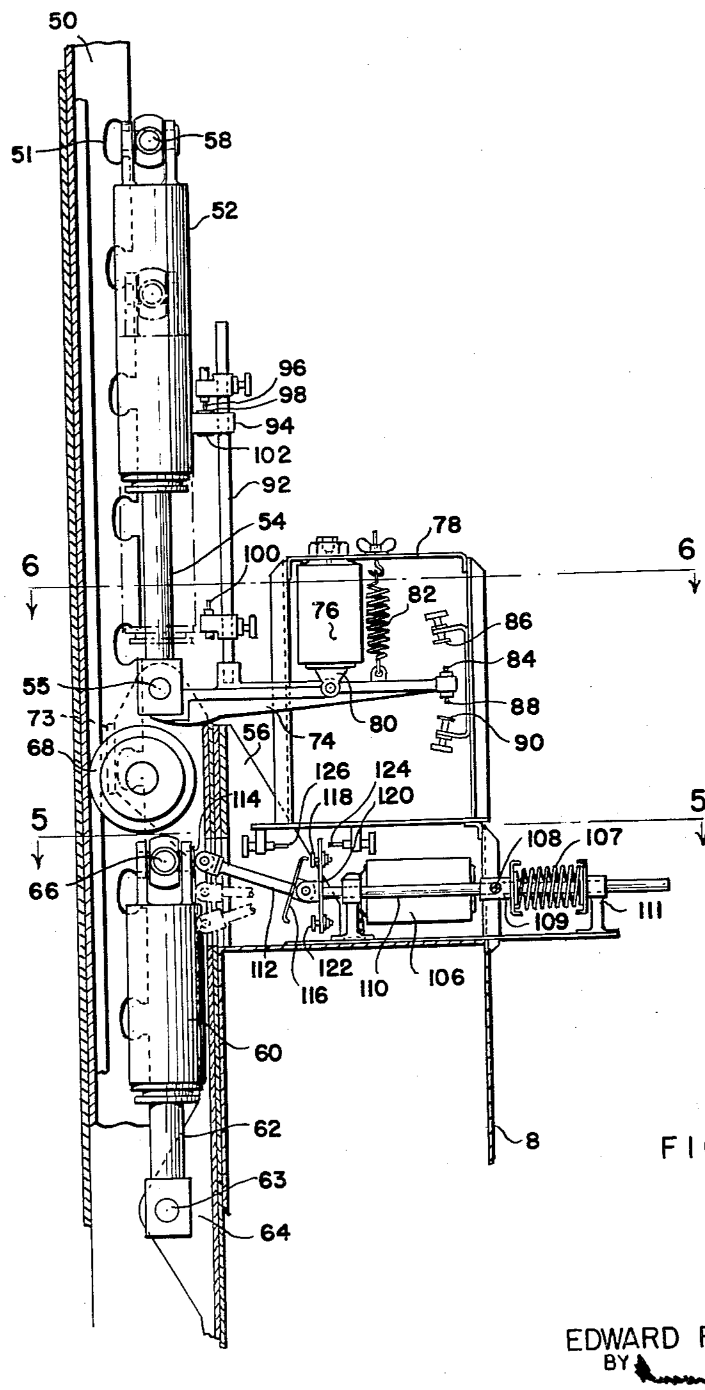

FIG. 4.

INVENTOR

EDWARD R. ARMSTRONG

BY

ATTORNEYS

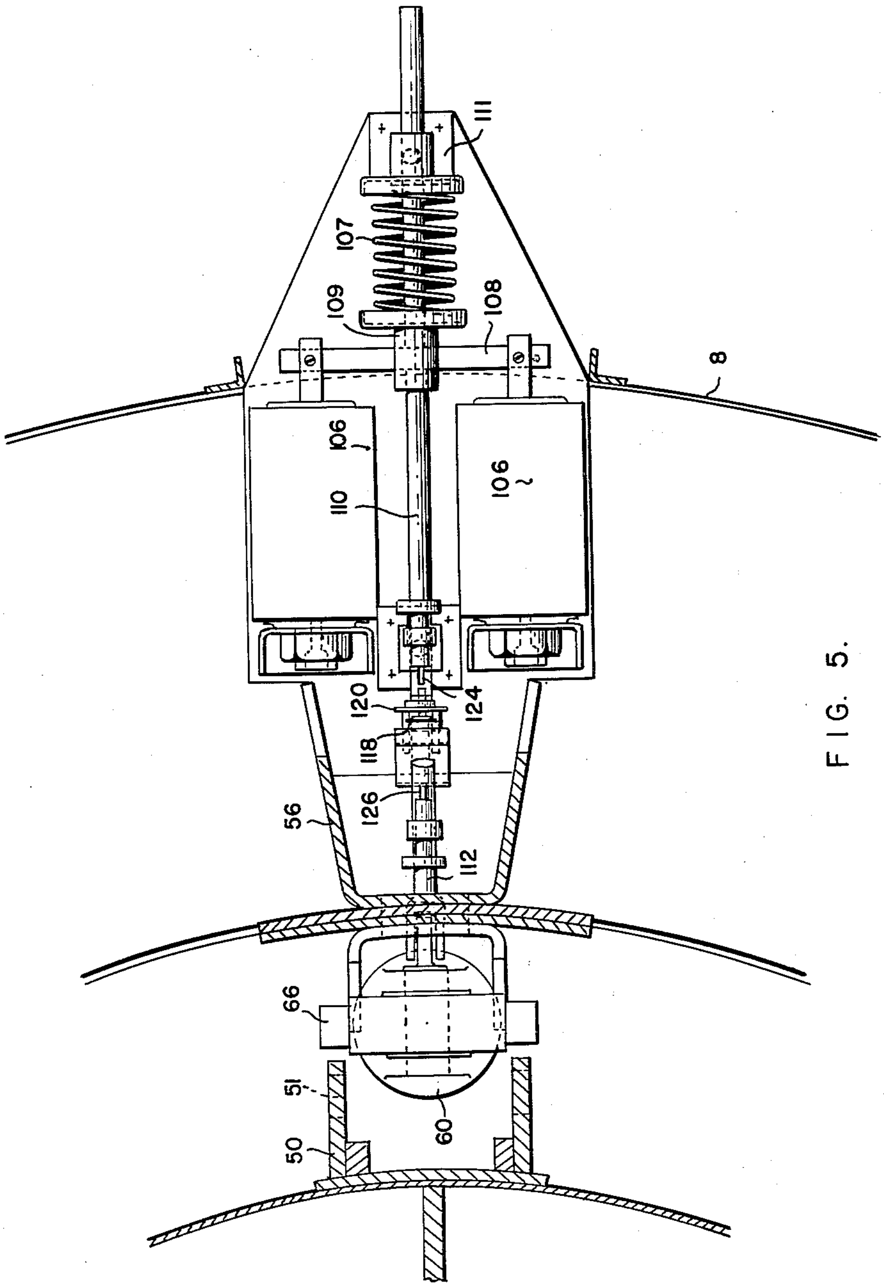

FIG. 5.

INVENTOR.
EDWARD R. ARMSTRONG
BY [signature]
ATTORNEYS

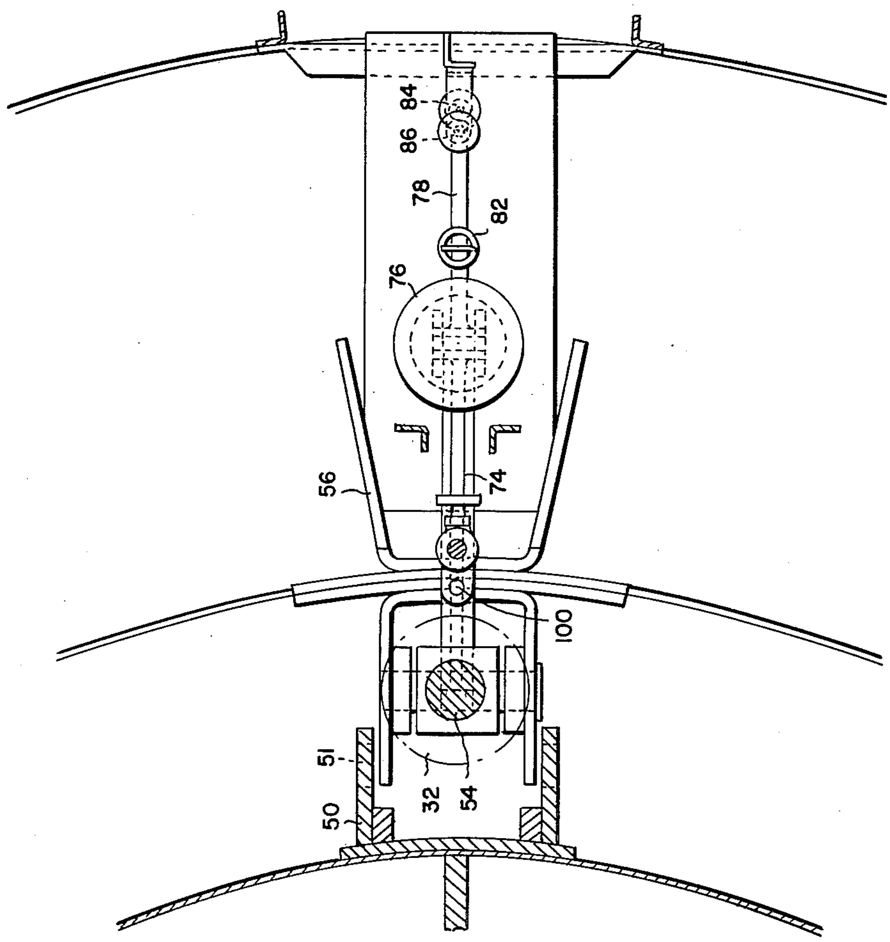

FIG. 6.

INVENTOR.
EDWARD R. ARMSTRONG
BY
ATTORNEYS

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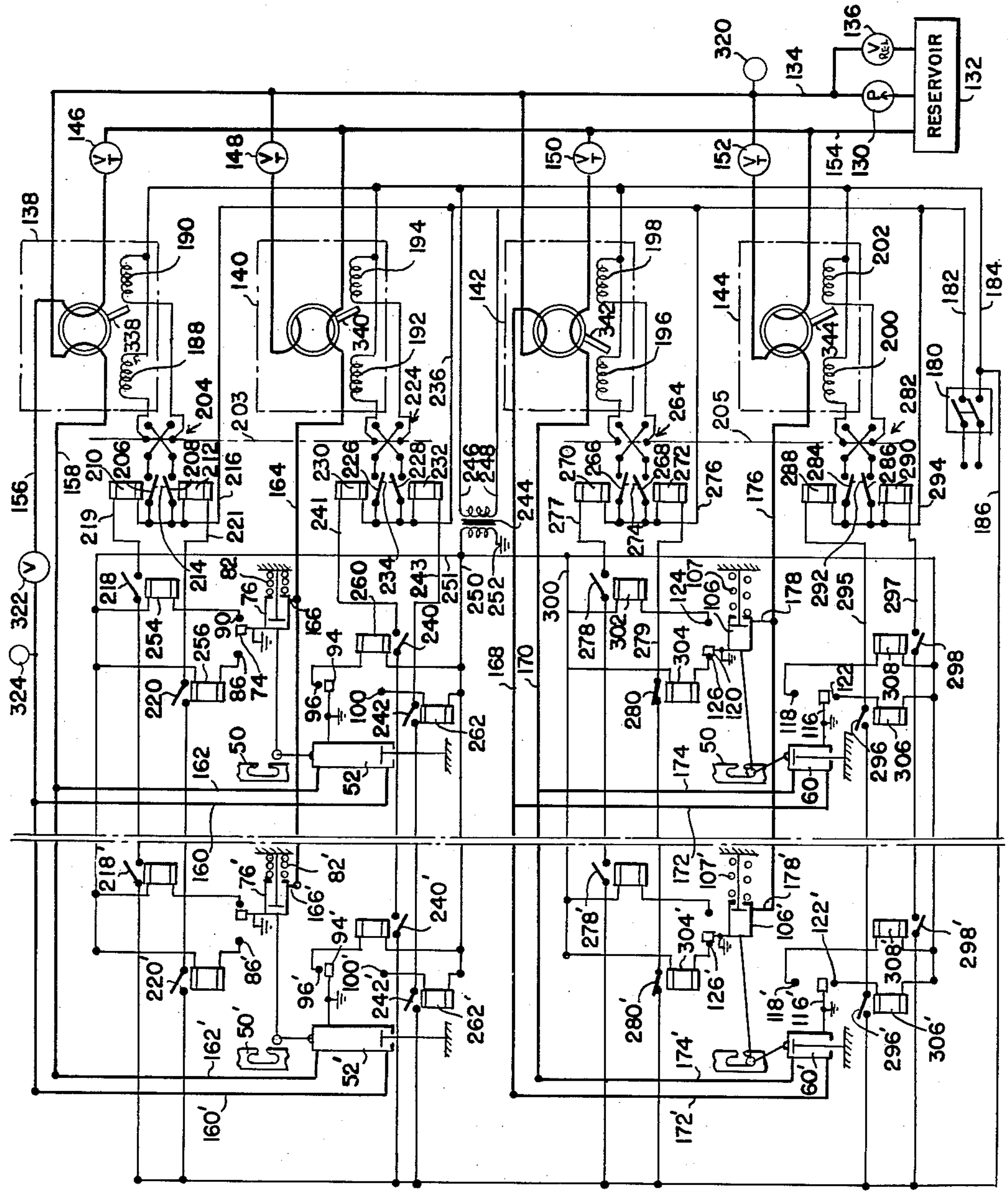

FIG. 7.

INVENTOR.
EDWARD R. ARMSTRONG
BY [signature]
ATTORNEYS

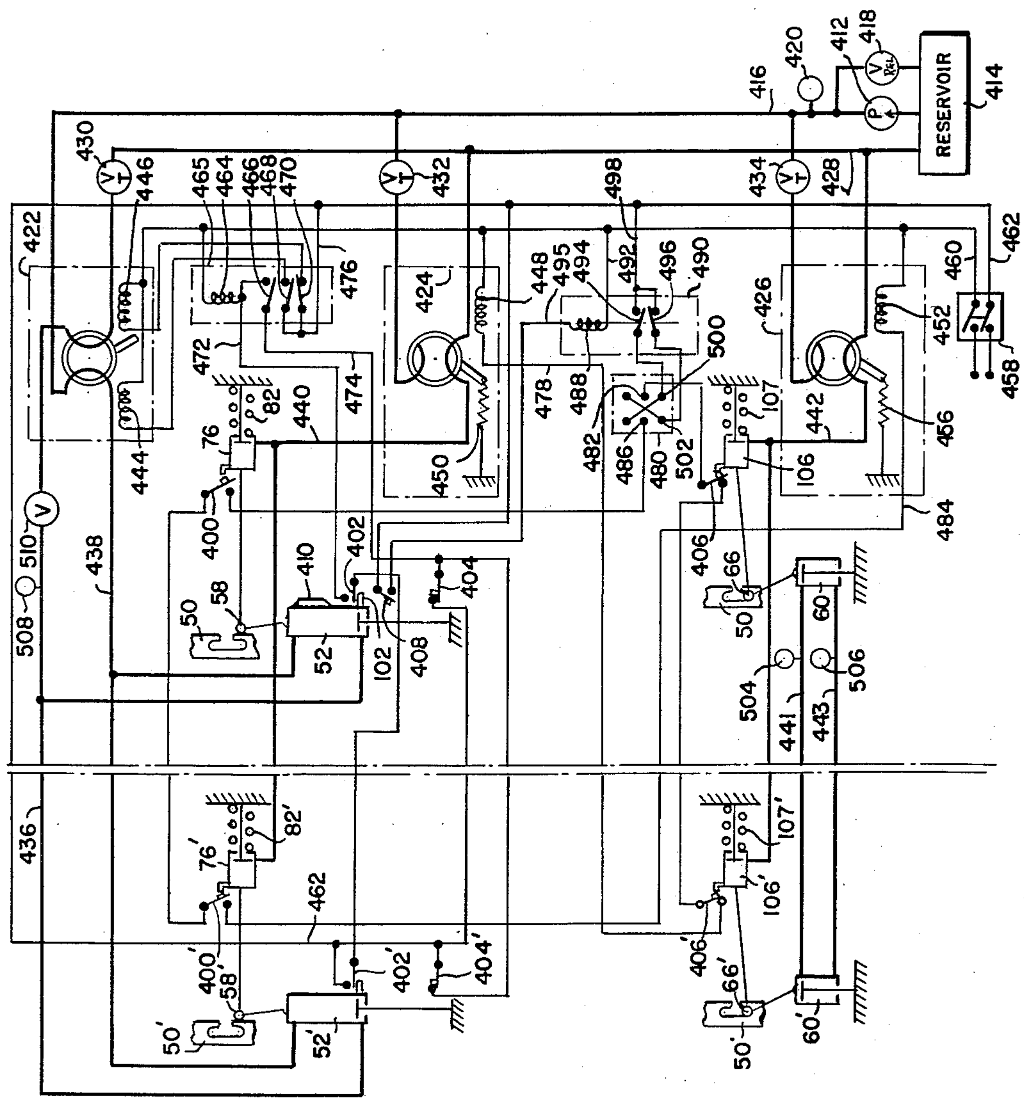

FIG. 8.

INVENTOR.

EDWARD R. ARMSTRONG

BY [signature]

ATTORNEYS

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SEADROME

Edward R. Armstrong, Monroeville, N.J., assignor to Sun Oil Company, Philadelphia, Pa., a corporation of New Jersey

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8 Claims. (Cl. 61—46.5)

This invention relates to a seadrome and, more particularly, to a self-docking floating apparatus from which operations such as well drilling operations may be carried out over water.

It is an object of the invention to provide a seadrome which may be moved from place to place over water and which, when positioned in a selected location, for example, where offshore well drilling is to be performed, may be solidly founded on the ocean bottom by self-docking apparatus in water of depths up to and exceeding eighty feet.

The seadrome includes a plurality of buoyancy tanks framed into a truss structure. A deck is mounted on the truss structure and is, for example, adapted to support facilities and equipment necessary for drilling operations such as drilling derrick and rig, living quarters, storage area, power plants, mud and other liquid storage vessels, and etc.

In addition to the buoyancy tanks, foundation columns are provided which are adapted to be jacked downwardly into engagement with the ocean bottom whereupon continued jacking will serve to raise the seadrome structure to a sufficient height above the surface of the water so that the deck thereof is above the level of waves normally encountered except during extreme storm conditions.

It is a further object of the invention to provide a structure of the type described in which the buoyancy tanks and the foundation columns may be dry-docked while the seadrome is solidly founded on the ocean bottom by raising the buoyancy tanks and truss structure upwardly on the foundation columns and raising individually foundation columns above the water level.

It is a further object of the invention to provide a seadrome which includes a slot or opening in the structure thereof extending inwardly from one side thereof. This slot is provided so that when well drilling operations are carried out the well casing, pilings and other support structure therefor, and the conventional "Christmas tree" affixed to the upper end of the casing may be conveniently erected and are conveniently accessible from the seadrome. Furthermore, the slot permits removal of the seadrome from this permanent structure at any time.

A drilling derrick will extend upwardly from above the platform over the slot as a fixed part of the seadrome. When the drilling has been completed, the well casing, the support structure and the conventional "Christmas tree" mounted on top of the casing will be left remaining and the seadrome carrying the drilling equipment may then be removed. In its place there may be substituted a second seadrome which is equipped as a pumping and storage station. Such a seadrome would pump and store oil which would be removed therefrom at intervals by sea-going tankers. Such a seadrome similar to the seadrome equipped for drilling could be removed from the well location at any time in the event of threatening extreme storm conditions.

2

Summarizing briefly, it is the object of this invention to provide a floating seadrome which is self-docking, which provides for dry-docking of all parts of the structure contained therein and which provides for a self-contained fixed base for continuous operations at sea.

These and other objects of the invention will become apparent from the following description when read in conjunction with the accompanying drawings, in which:

Figure 1 is a diagrammatic perspective showing of the entire seadrome structure;

Figure 2 is a diagrammatic vertical axial section through one of the seadrome foundation columns, its associated buoyancy tank and jacking apparatus and the truss structure adjacent thereto;

Figure 3 is a plan view of a buoyancy tank and the truss structure associated therewith;

Figure 4 is a fragmentary showing of a foundation column and its associated buoyancy tank showing the jacking apparatus in greater detail;

Figure 5 is a horizontal section through the jacking apparatus taken on the trace 5—5 of Figure 4;

Figure 6 is a horizontal section through the jacking apparatus taken on the trace 6—6 of Figure 4;

Figure 7 is a diagrammatic showing of electrical and hydraulic control circuits by means of which the jacking apparatus may be operated; and

Figure 8 is a diagrammatic showing of alternative electrical and hydraulic control circuits by means of which the jacking apparatus may be operated.

In Figure 1 there is shown generally at **2** a perspective diagrammatic showing of the complete seadrome structure. The seadrome structure includes an open supporting truss structure **4** into which buoyancy tanks **8** are framed. While the seadrome is shown as having four buoyancy tanks along each longitudinal side thereof, it will be evident that the number and arrangement of buoyancy tanks may be selected in accordance with the structural proportions of any particular seadrome involved. The buoyancy tanks **8** are of annular form and there is a foundation column **10** extending through each buoyancy tank. A foundation tank **12** is affixed to the lower end of each foundation column. As will be evident by viewing the figure, the seadrome truss structure may be supported above the surface of the water by the foundation columns with the foundation tank resting on the ocean bottom.

The seadrome struss structure is provided in one end with a slot **6** which is adapted to be positioned around or above a drilling location. A platform is mounted on the seadrome extending across the slot and is adapted to support a conventional type of drilling derrick. Alternatively, a separate drilling platform may be mounted on pilings or other suitable structure fixed to the bottom of the ocean and the slot **6** positioned around this platform while drilling operations are being conducted.

The structural arrangement of the foundation columns, the buoyancy tanks and the truss structure is shown more clearly in Figures 2 and 3. The annular buoyancy tanks **8** are each divided into an upper tank **14** and a lower tank **16**. The outer diameter of the lower tank is greater than the outer diameter of the upper tank, thus providing a step **18** between the upper and lower tanks. An annular plate **15** forms the upper surface of the upper buoyancy tank **14** and an annular plate **17** forms the lower surface of the upper buoyancy tank **14** and the upper surface of the lower buoyancy tank **16**.

The truss structure indicated at **4** in Figures 1 and 3 includes longtiudinally extending open truss members **20** and longitudinally extending open truss members **22** which are interrupted by the annular buoyancy tanks. The truss structure also includes transversely extending truss members **24** and transversely extending open truss members 26 which are interrupted by the annular buoyancy tanks. Vertically extending shear webs 34 are positioned within each upper annular buoyancy tank 14 on radially opposite sides thereof in plane alignment with the interrupted longitudinally extending truss member 22. Similar shear webs 35 are positioned within each upper buoyancy tank on radially opposite sides thereof in plane alignment with the interrupted transversely extending truss 26. The shear webs 34 and 35 are joined to the upper and lower annular members 15 and 17 and are joined to the inner and outer walls of the upper buoyancy tank 14.

The interrupted ends of the longitudinally extending truss 22 are structurally connected to each upper buoyancy tank 14 by a connection between the lower chord 36 of the truss and the step 18 and by a connection between the upper chord 38 of the truss and the upper annular web 15 of the buoyancy tank 14 in the form of suitable tie plates 28. The interrupted truss 26 is similarly connected to the step 18 and to the web 15 by tie plates 29. A vertically extending member such as that shown at 30 joining the upper and lower chords of each truss at each interrupted end of the truss is connected to the outer wall 32 of the buoyancy tank 14 and thus to the shear webs 34 or 35 within the buoyancy tank. It will be evident that this structure provides ring girders in the form of the buoyancy tanks which serve to transfer load between the ends of each of each of the interrupted trusses.

The foundation columns 10 are elongated cylindrical members which extend through the annular buoyancy tanks 8 and each has affixed to its lower end a foundation tank 12 having a diameter considerably greater than that of the columns. Each of the columns 10 includes a cylindrical outer shell, eight longitudinally extending plates 43 positioned within the shell and lying on equally spaced radial planes therein and stiffener plates 45 affixed to the inner edges of the longitudinal plates 43. The columns are also provided with a plurality of spaced annular plates 47 positioned transversely of the columns and affixed to the outer walls thereof. Each of the annular plates 47 is provided with a stiffener plate 49 extending perpendicular thereto and attached to the inner edge thereof. Each foundation column is provided with a pump 44 and remotely controlled valve means, not shown, in order that the foundation tank and column may be flooded or pumped out in order to adjust the buoyancy thereof. By these means each column may be made to rise or settle in the water as may be desired.

A substantial annular space 46 is provided between each buoyancy tank and its associated foundation column to permit access to the inner wall of the annular buoyancy tank as well as to provide space for the jacking apparatus which will be described.

The truss structure is so designed that the seadrome may be supported in a position above the surface of the water by the foundation columns. Thus access is provided to the entire surface of each of the buoyancy tanks for maintenance or repair while the seadrome is in a self-docked condition at sea. Furthermore, the structure is so designed that any one foundation column may be raised upwardly within its associated buoyancy tank when the seadrome is in a self-docked condition and thus each foundation column and its foundation tank may be individually dry-docked and thus made accessible at this time.

Each foundation column is provided with four pairs of spaced flanges 50 extending outwardly and longitudinally of the column and spaced thereon at ninety degree intervals around the column. The pairs of flanges each have aligning recesses 51 adjacent to their outer edges and provide racks for engagement by a column jacking assembly.

Each column is provided with four jacking assemblies, one cooperating with each of the four racks mounted on the column. Each jacking assembly includes a double acting hydraulic cylinder 52 having a piston rod 54 extending downwardly therefrom pivoted at its lower end at 55 to a bracket 56 mounted to the top of the buoyancy tank. Each cylinder 52 is provided at its upper end with a transversely extending pin 58 adapted to fit the recesses 51 of one of the racks 50. A second double acting hydraulic cylinder 60 is positioned below the cylinder 52 and has a cylinder rod 62 extending downwardly therefrom and pivoted at its lower end at 63 to a suitable bracket 64 mounted on the interior wall of the buoyancy tank.

A roller 68 attached to the bracket 56 serves to guide the foundation column adjacent to the upper end of the buoyancy tank 8. A pair of rollers 70 mounted on a bracket 72 serves to guide the foundation column adjacent to the lower end of the buoyancy tank. Similar upper and lower rollers are provided for engagement with the foundation columns in the region of each of the four sets of racks on each of the columns. An additional set of similar upper and lower rollers is provided for engagement with the foundation columns in the regions between the sets of racks. The upper rollers of these sets are indicated at 69 in Figure 3 and are supported by brackets 71. Similar roller and bracket arrangements are positioned below the rollers 69. Each of the brackets supporting the rollers 69, 68 and 70 is provided with a pad 73 forming an extended surface which is adapted to engage the foundation column in the event of the failure of any of the rollers. The pads 73 are positioned relatively close to a foundation column in order to minimize any motion of the column which would occur in the event of failure of a roller.

An arm 74 is rigidly connected to the lower end of the piston rod 54. A hydraulic cylinder 76 is mounted in a frame 78 supported from the top of the buoyancy tank and has a piston rod 80 pivotally connected at its lower end to the arm 74. The cylinder 76 is so arranged that admission of fluid under pressure to within the cylinder acts against a piston therein and serves to drive the piston rod 80 downwardly and arm 74 in a clockwise direction around the pivot 55. A spring 82 connected between the arm 74 and the frame 78 urges the arm 74 upwardly.

When there is no fluid under pressure within the cylinder 76, the spring 82 will urge the arm 74 upwardly and, when the pin 58 at the upper end of the cylinder 52 engages a recess 51 in the rack 50, a contact 84 mounted on the free end of the arm 74 engages a fixed contact 86 supported by the frame 78. When fluid pressure is admitted to the cylinder 76 moving the arm 74 downwardly against the urging of spring 82, the pin 58 will be carried out of the recess in the rack 50 and the upper end of the cylinder will be moved in a position disengaged from the rack 50. At this time a contact 88 on the free end of the arm 74 will be in engagement with a contact 90 supported by the frame 78.

A vertically extending rod 92 has its lower end affixed to the arm 74 and its upper end passing through a bore in a member 94 affixed to the cylinder 52. An upper contact 96 which is mounted on the rod 92 is adapted to engage a contact 98 mounted on the member 94 when the piston rod 54 is extended from the cylinder 52. When the piston rod 54 is in a withdrawn position, a contact 100 on the rod 92 will be in engagement with a contact 102 mounted on the member 94.

A horizontally disposed pair of cylinders 106 have piston rods acting through a cross bar 108 on a rod 110 which is connected to the upper end of the cylinder 60 through a link 112.

A spring 107 acting between a collar 109 affixed to the shaft 110 by the cross pin 108 and a fixed guide member 111 urges the rod 110 and the cylinder 60 in the direction of the rack 50. The admission of fluid under pressure into the cylinders 106 serves to draw the upper end of the cylinder **60** out of engagement with the rack **50** and to compress the spring **107**.

A contact arm **116** is fixed to the link **112** and, when the cylinder **60** and its piston rod **62** are in extended relation, the upper end of the contact bar **116** engages a contact **118** mounted on a bar **120** affixed to the shaft **110**. When the cylinder **60** and its piston rod **62** are in contracted relation, the lower end of the contact bar **116** engages a contact **122** mounted on the lower end of the bar **120**.

When the cylinder **60** is withdrawn from engagement with rack **58** by the action of the cylinders **106**, the upper end of the bar **120** engages contact **124** supported by the frame **78**. When, in response to urging of the spring **107**, the pin **66** of the cylinders **60** is pisitioned in one of the recesses **51** in the rack **50**, the upper end of the bar **120** is in engagement with a contact **126** supported by the frame **78**. A mechanism such as that described for moving the upper ends of the cylinders **52** and **60** into and out of engagement with their associated rack bars **50** and the contacts associated therewith is provided with each of the pairs of cylinders associated with each of the four sets of rack bars provided on each of the foundation columns.

In the processes of jacking, i.e., raising or lowering the foundation columns with respect to the buoyancy tanks, the cylinders **52** are referred to as the lifting cylinders and actually serve to raise or lower the column. The cylinders **60** are referred to as holding cylinders and serve primarily to hold the column while the lifting cylinders are being extended or retracted in a position disengaged from the rack. The cylinders **76** and **106** are referred to as retraction cylinders and serve to retract the cylinders **52** and **60**, respectively, from engagement with the racks. The jacking control system, as will be described, is designed to provide for engagement of both sets of jacking cylinders with the rack when the system is at rest. The structure previously described provides for engagement of the jacking cylinders with the racks when the pressure in the disengaging cylinders **76** and **106** is relieved. Thus in the event of power failure, the cylinders will be held in engagement with the racks and the foundation columns can move only to the upward or downward limit of the stroke of the holding cylinders.

In Figure 7 there is shown in diagrammatic form the hydraulic and electrical control systems for operating the four pairs of cylinders associated with a foundation column. The hydraulic and electrical connections to each of the four jacking assemblies of each column are identical. The corresponding cylinders of each of the four jacking assemblies of a column are connected in parallel relation and the corresponding electrical contacts of each of the jacking assemblies are connected in series relation. Therefore, in the interest of space and simplicity, Figure 7 shows a first of the four jacking assemblies and a last of the four jacking assemblies with the two intermediate jacking assemblies omitted.

In the drawing, two of the four lifting cylinders are shown schematically at **52** and **52'**. The other two lifting cylinders are omitted. Two of the four retraction cylinders **76** for moving the lifting cylinders into and out of engagement with the racks are shown schematically at **76** and **76'** with their return springs **82** and **82'**. Two of the four holding cylinders are shown schematically at **60** and **60'**. Two of the four retraction cylinders for moving the holding cylinders into and out of engagement with the racks are shown schematically at **106** and **106'** with their return springs **107** and **107'**. It is noted that, while the structural arrangement of the retraction cylinders and their springs shown in Figure 7 is conveniently shown not precisely the same as that shown in the structural diagram of Figure 4, the functional relations of the elements in Figure 4 are maintained in the diagram of Figure 7. Thus when hydraulic fluid under pressure is admitted to the retraction cylinders, their associated lifting or holding cylinders are drawn out of engagement with the racks and, when hydraulic fluid is discharged from the retraction cylinders, their associated springs serve to urge their associated lifting or holding cylinders into engagement with the racks.

A pump **130** has its inlet end connected to a suitable hydraulic reservoir **132** and pressure is maintained in the output line **134** by means of a conventional pressure relief bypass valve **136**. Four solenoid operated hydraulic control valves **138**, **140**, **142**, and **144** are connected to the supply line **134**. Each of the control valves is also connected through a return line **154** to the reservoir **132**. The control valve **138** and **142** are four-way valves and each has connected in its return line a hydraulic throttling valve **146** and **150** respectively. The control valves **140** and **144** are three-way valves and each has connected in its supply line a hydraulic throttling valve **148** and **152** respectively.

Hydraulic lines **156** and **158** are connected to the hydraulic control valve **138**. The lifting jack cylinder **52** is connected to the lines **156** and **158** by lines **160** and **162** respectively. The other three lifting cylinders are similarly connected and the four lifting cylinders are thus in parallel relation in the hydraulic circuit. Hydraulic line **164** is connected to the control valve **140**. The retraction cylinder **76** is connected to the line **164** by line **166**. The other three retraction cylinders **76** are similarly connected to the line **164**. Thus all four of these retraction cylinders are in parallel relation in the hydraulic circuit. Hydraulic lines **168** and **170** are connected to the control valve **142**. The holding cylinder **60** is connected to the lines **168** and **170** by lines **172** and **174** respectively. The other three holding cylinders are similarly connected to the lines **168** and **170**. Thus all four of the lifting cylinders are in parallel relation in the hydraulic circuit. Hydraulic line **176** is connected to the hydraulic control valve **144**. The retraction cylinder **106** is connected to the hydraulic line **176** by means of line **178**. The other three pairs of retraction cylinders **106** are similarly connected to the line **176**. Thus all four of these retraction cylinders are in parallel relation in the hydraulic circuit.

The electrical system includes a pair of conductors **182** and **184** which are connected to a suitable source of power through a conventional disconnect switch **180**. Each of the four solenoid controlled hydraulic valves is provided with a pair of solenoid coils. These coils are shown at **188**, **190**, **192**, **194**, **196**, **198**, **200** and **202**. One side of each of the coils is connected to the conductor **184**. The other side of each of the coils **188** and **190** is connected to one of the terminals of the movable arms of a double pole reversing switch indicated at **204**. One of the fixed terminals of the reversing switch is connected to one side of a contact **206** and the other fixed terminal of the reversing switch is connected to one side of a contact **208**. The contact **206** is operated by a solenoid coil **210** and the contact **208** is operated by a solenoid coil **212**. The two contacts are provided with an interlock arrangement indicated at **214** in order to insure the closure of only one contact at a time. The other side of each of the contacts **206** and **208** and one side of each of the solenoid coils **210** and **212** are connected through a conductor **216** to the conductor **182**. It will be evident that energization of the solenoid coils **210** or **212** will control the actuation of the coils **188** or **190** and thus control the position of the valve mechanism within the valve **138**. The position of the valve **138** will, of course, determine whether hydraulic fluid under pressure delivered to the cylinders **52** will be in the direction to expand or contract the cylinders.

As previously noted, one side of the solenoid coil **210** is connected to the power line **182**. The opposite side of the solenoid coil **210** is connected through a conductor **219** and a series arrangement of contact **218** and identical contacts of each of the four jacking assemblies and through the conductor **186** to the conductor **184**. Similarly, the solenoid coil **212** has one side connected to the conductor **182** and the other side connected to the conductor **184** through a conductor **221** and a series arrangement of the contact **220** and identical contacts of each of the four jacking assemblies and the conductor **186**.

One side of each of the coils **192** and **194** of the valve **140** is connected to the conductor **184**. The other side of each of the coils is connected to one of the terminals of the movable arms of a double pole reversing switch indicated at **224**. One of the fixed terminals of the reversing switch is connected to one side of a contact **226** and the other fixed terminal of the reversing switch is connected to one side of a contact **228**. The contact **226** is controlled by a solenoid coil **230** and the contact **228** is controlled by a solenoid coil **232**. An interlock arrangement indicated at **234** is provided to prevent both of the contacts **226** and **228** from being closed at the same time. The other side of each of the contacts **226** and **228** and one side of each of the coils **230** and **232** are connected through a conductor **236** to the conductor **182**. It will be evident that energization of the coils **230** and **232** will control the position of the valve **140** and thus control the delivery of fluid under pressure to the cylinders **76**.

As previously noted, one side of the coil **230** is connected to the conductor **182**. The other side of the coil is connected through a conductor **241** and a series arrangement of contact **240** and identical contacts on each of the other three jacking assemblies through the conductor **186** to the conductor **184**. The coil **232** is similarly arranged with one side connected to the conductor **182** and the other side connected to the conductor **184** through a conductor **243** and a series arrangement of contact **242** and identical contacts on each of the other three jacking assemblies and the conductor **186**.

The primary side of a transformer **244** is connected through conductors **246**, **248** to conductors **184** and **182**, respectively. One side of the secondary or low voltage side of the transformer **244** is connected to a conductor **250**. The other side of the secondary is connected to ground at **252**. One side of a solenoid coil **254** is connected to the conductor **250** through a conductor **251**. The other side of the solenoid coil **254** is connected to the contact point **90**. The solenoid **254** controls the position of the contact **218**. When the retraction cylinder **76** is receiving fluid under pressure from the control valve **140** and the lifting cylinder is moved outwardly out of engagement with the rack **50**, the contact **90** will be engaged by the contact on the member **74** which is grounded through the cylinder mounting structure. Closure of this contact will serve to energize the solenoid coil **254** and close the contact **218**. One side of a solenoid coil **256** is connected to the conductor **251**. The other side of the solenoid coil **256** is connected to the contact **86**. When hydraulic fluid is exhausted from the cylinder **76** and the lifting cylinder **52** is moved into engagement with its associated rack **50**, the contact **86** will be engaged by the contact mounted on the member **74** and the solenoid coil **256** will be energized closing the contact **220**. Similar solenoids and contact connections are provided with each of the other three retraction cylinders **76**.

One side of a solenoid coil **260** is connected to the conductor **250**. The other side of the solenoid coil **260** is connected to the contact **96**. When the lifting cylinder **52** is in a fully extended condition, the contact **96** will be engaged by the grounded contact mounted on the member **94**. Under these conditions the solenoid **260** will be energized and the contact **240** closed. One side of a solenoid coil **262** is connected to the conductor **250**. The other side of the solenoid coil **262** is connected to the contact **100**. When the lifting cylinder **52** is completely contracted, the contact **100** will engage the grounded contact mounted on the member **94**. Under

this condition the solenoid **262** will be energized and the contact **242** will be closed. Similar solenoids and contact connections are provided with each of the other three lifting cylinders.

One side of each of the coils **196** and **198** of the control valve **142** is connected to the conductor **184**. The other side of each of the coils is connected to one of the terminals of the movable arms of a double pole reversing switch indicated at **264**. One of the fixed terminals of the reversing switch is connected to one side of a contact **266** and the other fixed terminal of the reversing switch is connected to one side of a contact **268**. The contact **266** is controlled by a solenoid **270** and the contact **268** is controlled by a solenoid **272**. An interlock arrangement indicated at **274** is provided to prevent both of the contacts **266** and **268** from being closed at the same time. The other side of each of the contacts **266** and **268** and one side of the coils **270** and **272** are connected through a conductor **276** to the conductor **182**. The opposite side of the coil **270** is connected through a conductor **277** and a series arrangement of contact **278** and identical contacts on each of the other three jacking assemblies through the conductor **186** to the conductor **184**. Similarly, the other side of the solenoid **272** is connected through a conductor **279** and a series arrangement of contact **280** and identical contacts on each of the other three jacking assemblies through the conductor **186** to the conductor **184**.

One side of each of the coils **200** and **202** of the control valve **144** is connected to the conductor **184**. The other side of each of the coils is connected to one of the terminals of the movable arms of a double pole reversing switch indicated at **282**. One of the fixed terminals of the reversing switch is connected to one side of a contact **284** and the other fixed terminal of the reversing switch is connected to one side of a contact **286**. A solenoid coil **288** controls the contact **284** and a solenoid coil **290** controls the contact **286**. The other side of each of the contacts **284** and **286** and one side of each of the coils **288** and **290** are connected through a conductor **294** to the conductor **182**. An interlock arrangement, as indicated at **292**, is provided to prevent both of the contacts **294** and **296** from being closed at the same time. The other side of the coil **288** is connected through a conductor **295** and a series arrangement of contact **296** and identical contacts on each of the other three jacking assemblies and the conductor **186** to the conductor **184**. The other side of the coil **290** is connected through a conductor **297** and a series arrangement of contact **298** and identical contacts in each of the other three jacking assemblies and the conductor **186** to the conductor **184**.

A solenoid coil **302** is connected through a conductor **300** to the conductor **251**. The other side of the solenoid coil **302** is connected to the contact **124**. When the cylinder **106** is receiving fluid under pressure from its control valve **144**, the holding cylinder **60** is out of engagement with its associated rack **50**, and the contact **124** will be in engagement with the member **120** closing the circuit through the coil **302** and closing the contact **278**. One side of the solenoid coil **304** is connected to the conductor **300**, and the other side of the coil **304** is connected to the contact **126**. When the cylinder **106** is not receiving fluid under pressure and the holding cylinder **60** is urged into engagement with a recess in the rack **50** by the spring **107**, the contact **126** is in engagement with the member **120** and the solenoid **304** will be energized closing the contact **280**. Similar solenoids and contact connections are provided with each of the other three retraction cylinders **106**.

One side of a solenoid coil **306** is connected to the conductor **251**, and the other side of the coil **306** is connected to the contact **122**. When the holding cylinder **60** is in a contracted position, the contact **122** will engage the member **116** energizing the coil **306** and closing the contact **296**. A solenoid coil **308** is connected to a conductor 251, and the other side of the coil is connected to the contact 118. When the holding cylinder 60 is in an expanded condition, the contact 118 will engage the member 116 closing the circuit through the coil 308 and closing the contact 298. Similar solenoids and contact connections are provided with each of the other three holding cylinders.

As will be noted from Figure 4, the length of the stroke of the lifting cylinders is slightly greater than the spaces between the recesses 51 in the racks 50. The length of the stroke of the holding cylinders is considerably less than the spaces between the recesses 51 in the racks 50.

The reversing switches 204 and 224 are operated by a common interlock control as indicated by the construction line 203. The reversing switches 264 and 282 are operated by a common interlock control as indicated by the construction line 205.

When the seadrome is afloat and is being moved to a drilling location, the foundation columns 10 and foundation tanks 12 will preferably be pumped dry by means of the pumps 44 and will thus be in their most buoyant condition with their foundation columns positioned with the foundation tanks 12 adjacent to the buoyancy tanks 8 and the greater portion of the foundation columns extending upwardly above the seadrome platform. When the seadrome is positioned in a drilling location, the procedure for docking preferably involves first reducing the buoyancy of the fundation columns until the foundation tanks settle to positions adjacent to the ocean bottom, for example, approximately ten feet from the ocean bottom. From this position the jacking system is put into operation to move the columns downwardly with respect to the seadrome platform and, as the columns come to rest on the ocean bottom, to raise the seadrome platform with respect to the columns. This jacking operation may be referred to as the raising cycle and is accomplished in the manner as will now be described.

The reversing switches 204 and 224 and the reversing switches 264 and 282 will both be closed to the right as viewed in Figure 7. With the reversing switches in these positions and with the hydraulic pump 130 in operation and the master control switch 180 closed, each of the lifting and holding cylinders will proceed through a cycle of operation in which the cylinders expand while disengaged from their associated racks and contract while engaged by their associated racks, thus serving to move the columns downwardly against their buoyancy until they engage the ocean bottom and thereafter to raise the seadrome platform on the columns.

The delivery of fluid to the lifting cylinders is controlled by the valve 138 which is, in turn, controlled by the solenoids 254 and 256 associated with each of the cylinders 76 and acting through the solenoids 210 and 212 and the reversing switch 204. When the reversing switch 204 is closed in the right-hand position, as viewed in Figure 7, and the cylinders 76 are receiving fluid under pressure and the lifting cylinders 52 are all disengaged from their associated racks, the solenoids 254 will be energized, closing the contacts 218, energizing the solenoid 210 which, in turn, energizes the coil 190 of the valve 138 and positions the valve as shown to supply fluid to the lifting cylinders 52 in such a direction as to cause the lifting cylinders to expand. When all of the lifting cylinders 52 are completely expanded and their associated contacts 94 and 96 are closed, the solenoids 260 will be energized, closing the contacts 240 which, in turn, actuate the solenoid 230 and energize the coil 194 of the valve 140 causing the valve 140 to connect the hydraulic line 164 with drain and permits the spring 82 to move the lifting cylinders 52 into engagement with their associated racks.

When the cross pin 58 of each of the lifting jacks 52 has entered a notch 51 in its associated rack 50, the contacts 86 are all grounded through the members 74 and position of the valve 138 is changed as a result of energization of the solenoids 256 and 212 and the valve coil 188 to that in which the lifting cylinders 52 are contracted. This contraction of the lifting cylinders will serve to depress the foundation columns with respect to the buoyancy tanks and the truss structure.

Upon the completion of the contracting stroke of the lifting cylinders 52, the contact 100 of each of the cylinders is closed with the member 92 associated therewith, the solenoids 262 are energized and the contacts 242 are closed. When each of the contacts 242 are closed, the coil 192 of the valve 140 is energized and the valve is actuated to supply fluid under pressure to the retraction cylinders 76 to move the lifting cylinders 52 out of engagement with their associated racks. From the foregoing it will be evident that each of the four lifting cylinders must have completed a step in its operation before any of the four cylinders may proceed with the next step in its operation. Similarly, each of the four retraction cylinders associated with the lifting cylinders can proceed to the next step of its operation only if each of the four lifting cylinders has completed the prior step of its operation. In this manner the four lifting cylinders and their associated retraction cylinders operate in unison to raise the buoyancy tank with respect to the foundation column.

It will be evident that the lifting cylinder cycle must be repeated sequentially in conjunction with the holding cylinder cycle which will now be described. From the foregoing description of the apparatus, it will be evident that the arrangement of the control system for the holding cylinders 60 and their retraction cylinders 106 is substantially the same as the arrangement of the control system for the lifting cylinders 52 and their retraction cylinders 76. The operation of this control system is such that, when the reversing switches 264 and 282 are in the right-hand position, as viewed in Figure 7, the holding cylinders 60, when out of engagement with the rack, will receive hydraulic fluid in such a direction as to expand the cylinders and, when in engagement with the rack, will receive hydraulic fluid in such a direction as to contact the cylinders. The operation of the retraction cylinders 106 will be such that, when the holding cylinders have become completely expanded, they will be moved into engagement with the rack and, when the holding cylinders are completely contracted, they will be disengaged from the rack.

It will be noted, however, that the recesses 51 in the racks 50 are undercut and thus, when the cylinders are acting on the recess in the racks, they cannot accidentally become disengaged therefrom. Furthermore, the retraction cylinders 76 and 106 cannot withdraw any of their associated cylinders 52 and 60, respectively, out of engagement with its associated rack until the racks have been moved beyond the limit of the stroke of their associated cylinders. This feature controls the sequential operation of the two sets of lifting and holding cylinders. In other words, when the lifting cylinders have become completely contracted, they cannot be disengaged from the racks until the holding cylinders have been reengaged with the racks and have commenced contracting and have moved the racks a sufficient distance to free the pins 58 of the lifting cylinders from the recess 51 in which they are engaged. When the holding cylinders have become completely contracted, they cannot be disengaged from the racks until the lifting cylinders have been reenegaged with the racks and have commenced contracting and have moved the racks a sufficient distance to free the pins from the holding cylinders in the recesses in which they are engaged.

When the seadrome has been jacked to a docked condition with the buoyancy tanks and the truss structure supported by the foundation columns, which are at that time solidly founded on the ocean bottom, operation of the jacking sequence may be arrested and the buoyancy tanks and truss structure held in a stationary position with respect to the foundation colums. Operation of the jacking structure is preferably, but not necessarily, arrested when all of the lifting and holding cylinders are in engagement with recesses in their associated racks. Under these conditions it will be evident that, in the event of any failure in the hydraulic system, relative motion can occur only until one or the other of the sets of cylinders has moved to the end of its stroke.

It will be evident that the jacking system associated with each of the eight columns will be identical with that described in conjunction with Figure 7. During the jacking operation, while the seadrome is in a partially buoyed condition, the seadrome structure may be maintained substantially level by adjusting the hydraulic operating pressures at **134** as indicated by a gauge **320** on each of the jacking systems of the eight foundation columns. Alternatively, the seadrome may be leveled at any time during a jacking operation by selectively arresting operation of the jacking systems of those columns at which the seadrome has been jacked to an elevation above that of any of the other columns.

It will also be evident that any one of numerous well known inclinometers may be employed in conjunction with a control system in order to provide automatic levelling of the seadrome when it is in a docked condition as well as during raising or lowering of the seadrome platform.

After the seadrome has been jacketed to a final docked condition and is leveled therein with the buoyancy tanks and the truss structure supported by the foundation columns, which are at that time solidly founded on the ocean bottom, operation of the jacking systems will be arrested with preferably all of the cylinders in engagement with their associated racks as previously described. If at this time in each of the jacking systems a valve **322** in the line **156** is closed, there will exist in the lifting cylinders a closed off body of oil the pressure in which is responsive to the loading between the buoyancy tank and the foundation column. This loading at each column will be indicated by the pressure reading on a gauge **324** positioned between the valve **322** and the lifting cylinders. It will be evident that the holding cylinders must be positioned intermediate the ends of their strokes in order that all of the loading will be transmitted through the closed off body of oil in the lifting cylinders. Any pressure existing in the oil contained within the holding cylinders will either bleed away of its own accord through the valve **142** or may be reduced to zero by special drain connections not shown in the drawings.

An alternative arrangement may equally well be employed in which a valve and gauge similar to the valve **322** and gauge **324** in the line **156** are positioned in the line **168** of the holding jack system, and the loading transmitted between any buoyancy tank and associated lifting column will then be indicated by the pressure existing in both of these lines.

It will be evident that either of these arrangements will provide a monitoring system whereby the relative loading of the seadrome structure on the supporting columns may be determined at any time. Inasmuch as a truss structure such as that described supported by foundation columns such as those described is an indeterminate structure with regard to the load distribution therein, it is highly desirable that a load monitoring provision be incorporated in the jacking system. It will further be evident that the gauges **324** in each of the eight jacking systems will serve as load monitoring indicators during a jacking operation as well as when the seadrome is in a stationary docked condition and the jacking operation has been completed.

Inasmuch as the jacking system permits jacking of any one column independently of the remaining columns if the foundation tank of any one column should settle into the ocean bottom to a degree greater than the settlement of any of the other foundation tanks, the settling will be detected by the monitoring system and the column associated with the settling tank can be jacked downwardly or, more accurately, the portion of the structure surrounding the column can be jacked upwardly in order to level the structure and equalize the loading upon each of the columns.

The lifting cycle previously described is that which is involved when the columns are being lowered with respect to the seadrome platform and the columns are buoyant with respect to the seadrome platform or are supporting the seadrome platform. In other words, the cycle described is involved when the natural tendency of the columns is to move upwardly with regard to the platform.

A reverse condition exists when the columns are being raised with regard to the platform and are in a non-buoyant condition. This cycle of operation is accomplished by positioning all of the reversing switches **204**, **224**, **264** and **282** in left-hand positions as viewed in Figure 7. When the reversing switches are in these positions, each of the cylinders will undergo a cycle of operation in which the cylinder expands while in engagement with the column rack and contracts while out of engagement with the column rack. Inasmuch as the column is normally resisting motion in the direction in which it is being jacked, it is necessary, for example, for the holding jack to engage the rack and raise the column a slight distance in order to free the lifting jack to permit the lifting jack to be extracted and returned to a contracted condition. It is similarly necessary for the lifting jack to reengage the rack and commence expanding in order to release the holding jack from the rack to permit the holding jack to be extracted from the rack prior to its contraction stroke.

By proper adjustment of the flow rate control valves **164—152**, undesirably rapid rates of operation of the lifting and holding cylinders are prevented when these cylinders are in disengaged conditions. On the other hand, the flow rate control valves are adjusted to permit sufficiently rapid operation of the disengaged cylinders so as to minimize the period of time during which the cylinders are in a retracted position and thus, during the larger portion of the operating cycle, the pins **58** and **66** of the lifting and holding cylinders, respectively, will be eithter bearing upon the outer surface of the rack or engaged in a recess in the rack.

The system heretofore described for automatically raising and lowering the foundation columns will not operate under conditions where the column is being raised while it is in a buoyant condition or when the column is being lowered when it is in a non-buoyant condition. By adjustment of the amount of water contained within the column it is possible to avoid the condition of having a buoyant column while it is being raised.

When, however, the column has been raised above the surface of the water in order to dry dock the column and thereafter it becomes necessary to lower the column, the column will, of course, be lowered while it is in a non-buoyant condition. During this relatively brief interval, it is necessary that the column be lowered by manual operation of the jacking system. This can easily be done by operating the hydraulic pump **130** and deenergizing the electrical control system. The valves **138**, **140**, **142** and **144** are provided with levers **338**, **340**, **342**, and **344**, respectively, by means of which the valves may be manually operated. It will be evident that this manual operation of the jacking system may be employed at any time when manual operation may be desired.

The alternative control system shown by the diagram of Figure 8 is somewhat less complex than that shown in Figure 7 and employs the well known and entirely conventional expedient of substituting, for the exposed contacts shown in Figure 4 such as, for example, the grounded contact **86**, an enclosed switch which is adapted to be engaged by the moving member **84**. In Figure 8 this switch is indicated at **400**. Similarly, the contacts **96** and **100** are replaced by limit switches **402** and **404**. The contact **126** associated with the holding cylinder **60** is replaced by a switch **406**. An additional limit switch **408** is associated with one of the lifting cylinders **52** and is adapted to be actuated by a cam **410** affixed to the surface of the cylinder, as shown in Figure 8, in a position displaced from the block **102** in order that the cam **410** and its cooperating switch **408** may operate independently of the switch **404** and the block **102** which is affixed to the cylinder **52**.

In this system the cylinders **60** are filled with a hydraulic fluid and are connected together. They are not caused to expand and contract during any of the cycles of operation. Thus, for convenience in the following description, the cylinders **60** will be referred to as holding dogs and the cylinders **52** will be referred to as lifting jacks.

A hydraulic pump **412** pumps hydraulic fluid from a reservoir **414** into a supply line **416** at a pressure determined by an adjustable relief valve **418** and indicated on a conventional pressure gauge **420**. Three solenoid operated hydraulic control valves **422**, **424** and **426** are connected to the supply line **416** and are connected to a return line **428** through throttling valves **430**, **432** and **434**, respectively. The valve **422** is connected through line **436** and **438** to the jacking cylinders **52**. The line **436** is connected to the cylinders **52** so as to supply liquid for contracting the jacks, and the line **438** is connected to the cylinders **52** so as to provide liquid for expanding the jacks.

A hydraulic line **440** connected to the valve **424** provides hydraulic fluid to the retraction cylinders **76** to cause the retraction cylinders to pull their associated jacks away from the racks **50**. A hydraulic line **442** is connected to the retraction cylinders **106** of the dogs **60** to supply liquid to the retraction cylinders to withdraw the dogs from their racks **50**.

The upper portions of the dog cylinders **60** are connected together through a hydraulic line **441**. The lower portions of the dog cylinders **60** are connected together through a hydraulic line **443**. These cylinders are not supplied with hydraulic fluid except for make-up purposes. The result is that the dogs do not expand or contract but do provide an automatically balanced length adjustment so that, whenever the dogs are in engagement with their associated racks, the loading on the dogs is uniform.

The hydraulic control valve **422** is actuated by a pair of solenoid coils **444** and **446**. The hydraulic control valve **424** is actuated by a solenoid coil **448** acting against a return spring **450**. The hydraulic control valve **426** is actuated by a solenoid coil **452** acting against a return spring **456**.

A pair of conductors **460** and **462** is connected to a suitable source of power through a conventional disconnect switch **458**. One side of each of the coils of the hydraulic control valves **422**, **424** and **426** is connected to the conductor **460**. One side of a coil **464** of a relay **465** is connected to the conductor **460**. The other side of the coil **444** of the control valve **422** is connected to one side of a normally open contact **468** of the relay **465**. The other side of the coil **446** is connected to one side of a normally closed contact **470** of the relay **465**. The other side of the coil **464** is connected to one side of a normally open contact **466** of the relay **465** and is also connected through a conductor **472** and a series arrangement of contacts **402** to the conductor **462**. The other side of the contact **466** is connected through a conductor **474** and a parallel arrangement of the contacts **404** to the conductor **462**. The other side of each of the contacts **468** and **470** is connected through a conductor **476** to the conductor **462**.

As previously noted, one side of the coil **448** is connected to the conductor **460**. The other side of the coil **448** is connected through a conductor **478** and a series arrangement of the contacts **406** to a center contact **482** of a reversing switch **480**.

As previously noted, one side of the coil **452** is connected to the conductor **460**. The other side of the coil **452** is connected through a conductor **484** and a series arrangement of the contacts **400** to the other center contact **486** of the reversing switch **480**.

One side of a coil **488** of a relay **490** is connected through a conductor **492** to the conductor **460**. The other side of the coil **488** is connected through a conductor **495** and the contact **408** of one of the lifting jack cylinders **52** to the conductor **462**. The relay **490** is provided with a normally open contact **494** and a normally closed contact **496**. One side of each of these contacts is connected through a conductor **498** to the conductor **462**. The other side of the contact **494** is connected to a contact **500** of the reversing switch **480** and the other side of the contact **496** is connected to a contact **502** of the reversing switch **480**.

The cycle of operation may now be described. Assuming that it is desired to move the column downwardly with respect to the seadrome platform, the reversing switch **480** will be positioned in a "down" position connecting the contacts **482** and **500** and connecting the contacts **486** and **502**, and the master control switch **458** closed. With the remainder of the parts as shown in the drawing, the coil **446** of the hydraulic control valve **442** will be energized, positioning the valve as shown and feeding the blank end of the jack cylinders **52** with oil under pressure and thus moving the cylinders upwardly or expanding the jacks. The contacts **408** are open, the relay coil **488** is deenergized, the contact **494** is open, and hence the coil **448** of the control valve **424** is deenergized. Since the coil **448** is deenergized, the spring **450** will hold the valve **424** in the position shown in which the springs **82** of the jack retraction cylinders **76** will urge the jack cylinder pins **58** against their associated racks **50**. The pins **58** will slide along the racks until they reach a slot in the rack at which time they will move in the slot as the result of the urging of the springs **82**. When all of the pins are in engagement with a slot in their associated racks, the switches **400** will all be closed, closing the circuit through the coil **452** of the hydraulic control valve **426** and pressure will be applied to the dog cylinders **406** so as to retract the dogs from their associated rack. At this time, however, the pins **66** of the dogs are engaged within the rack recesses and thus the dogs cannot be withdrawn from the racks.

After the jacks have engaged the recesses in their associated racks **50** and have continued to expand a slight distance therein, the contacts **402** are closed. When all of the contacts **402** are closed, the relay coil **464** is energized and the relay is sealed in through contact **466** and the contacts **404**. When the relay coil **464** is energized, the contact **468** closes and the contact **470** opens, resulting in a reversal of the position of the hydraulic control valve **422**, causing the jacks **52** to start moving downwardly. Downward movement of the jacks **52** moves the racks **50** downwardly, freeing the pins **66** of the dogs **60** whereupon they are withdrawn from their associated racks by the hydraulic pressure within the retraction cylinders **106**. Upon downward movement of the jacks **52**, the contacts **402** are opened. This, however, has no effect on the relay **465** because the relay coil is now sealed in through the contacts **466** and **404**.

The jacks **52** continue their downward movement and, at approximately the midpoint in this stroke, the switch **408** engages the cam surface **410** and is closed, energizing the coil **488** of the relay **490**. Energization of the coil **490** serves to close the contact **494** and open the contact **496**. Opening the contact **496** deenergizes the coil **452** of the control valve **426**, and permits the spring **456** to position the control valve **426** so as to remove the oil pressure from the retraction cylinders **106**, permitting the springs **107** to urge the dog pins **66** into engagement with their associated racks.

As the jack cylinders **52** approach the bottom of their strokes, the dog pins **66** fall into rack notches in response to the urging of the springs **107**. This movement closes the contacts **406** and completes the circuit through the contact **494** of the relay **490** and the coil **448** of the hydraulic control valve **424**, actuating the valve **424** to apply hydraulic pressure to the jack retraction cylinders **76** which then act to pull the jack pins **58** out of the recesses in their associated racks. The pins, however, are engaged in the recesses and at this time cannot be removed therefrom. The jack cylinders **52** continue to move downwardly for a short distance further and then the block **102** of each of the jack cylinders engages the contact **404**, opening the contact and causing the relay coil **464** to be de-energized and causing the position of the control valve **422** to be reversed. The reversal of the control valve **422** causes the jack cylinders to receive hydraulic pressure in such a direction as to expand the jacks whereupon the contacts **404** are then closed. However, the relay coil **464** is not reenergized due to the fact that the contact **466** thereof is open and the contact **402** is open.

After a short upward movement of the jacks **52** and their associated racks, the lower portion of the notches in the racks engaged by the pins **66** of the dogs come into contact with the pins and take the load of the column and stop its movement. The jacks **52** continue their upward motion until their pins **58** clear the lips of their associated notches in the racks and, at this point, the pins **58** are pulled out of the notches by the pressure of the fluid in the cylinder **76**.

The jack cylinders **52** continue their upward movement and, at about the middle of their strokes, the cam **410** moves clear of the contact **408** and the contact **408** opens, deenergizing the coil **488**, opening the contact **494** and closing the contact **496**. The opening of contact **494** deenergizes the coil **448** whereupon, in response to the urging of the spring **50**, the valve **424** is positioned so as to remove the hydraulic pressure from the cylinders **76** allowing the springs **82** to urge the jack pins **58** into engagement with their associated racks **50**. Continued upward movement of the jack cylinders carry the jack cylinders **52** to the position shown in the Figure 8. The jacking system has now completed a cycle and the column has been moved one rack pitch.

It will be evident that, regardless of whether the column is being moved downwardly under a positive load or whether the column is heavy and is attempting to sink of its own accord and being restrained in its downward movement by the operation of the jacking system, the system described in connection with Figure 8 will operate equally well. This is true because of the fact that the system operates to attempt to withdraw the pins **58** of the jacking cylinders from their associated notches before the completion of one stroke of the jacking cylinders and returns the pins into engagement with the faces of the rack prior to the completion of the opposite stroke of the jacking cylinders, and the non-expanding dog cylinders **60** are operated in a similar manner.

When it is desired to raise the columns with respect to the platform, the reversing switch **480** will be positioned in an "up" position, closing contacts **500** and **486** and closing contacts **502** and **482**, and serving to reverse the control of the relay **490** over the hydraulic control valves **424** and **426**. Thus the periods during which the jack retraction cylinders **76** and the dog retraction cylinders **106** are operative will be substantially reversed. Under this condition also it is immaterial whether the columns are buoyant or heavy.

The control system described in conjunction with Figure 8 has several advantages over that described in connection with Figure 7. In the system shown in Figure 8, the dogs do not extend or contract during raising or lowering operations. They are merely connected together hydraulically so as to equalize the forces all around one column during the holding operation. The result of this is a greatly simplified control system. A further advantage lies in the fact that the lifting jacks never reach the ends of their mechanical strokes and, therefore, the forces on them are balanced at all times around any one column. It is noted that the contacts **400** and **406** form an interlock system which prevents either of the sets of pins **58** and **66** from being withdrawn from their associated rack recesses unless the other set is in engagement with their associated rack recesses.

In the system shown in Figure 8, a pair of gauges **504** and **506** may be positioned to indicate the pressure existing in the hydraulic lines **441** and **443**, respectively, interconnecting the dog cylinders **60**. These valves will show, when the system is inoperative and also during the jacking cycle, the load carried by each of the columns. Thus the gauges provide a monitoring means whereby the load balance of the entire seadrome may be determined. It will be evident that, if desired, a gauge **508** and a shut off valve **510** may be positioned in the hydraulic line **436** to provide for load monitoring of the hydraulic system of the jack cylinders **52**, when the system is inoperative, by closing off the valve **510** and noting the pressure indication on the gauge **508** in conjunction with pressure indications appearing on the gauge **506**.

By way of example, it may be set forth that the seadrome structure described herein may be a structure of approximately 220 feet in length, 134 feet in width, and adapted to have a deck level normally approximately 28 feet above the surface of the water. Such a structure would carry the necessary supplies for drilling a 10,000 to 16,000 foot well and provide accommodations for a crew of forty men. The upper and lower portions of the buoyancy tanks and the foundation columns and tanks may be used as storage tanks when the seadrome is in a docked condition.

As previously noted, there is adequate space provided between each of the foundation columns and its associated buoyancy tank to provide access to the inner wall of each annular buoyancy tank for any repairs as may be necessary while the seadrome is at sea. Additionally, any one foundation column may be jacked upwardly while the seadrome is docked and thus individually each of the foundation columns may be dry docked for such repair or service as may be required while the seadrome is at sea.

Each of the foundation tanks **12** are provided with a plurality of jets which are fed through lines **41** and discharge under the conical base **42** of the foundation tank. These jets may be employed to clear and level the ocean bottom before each of the foundation tanks is positioned thereon. Additionally, the jets will serve to break the suction from under a foundation tank when it is desired to raise a foundation column. A still further use for the jets is, by selectively employing jets under each of the foundation tanks when the seadrome is in a floating condition, the seadrome may be propelled at a speed of three to four knots which is sufficient to move the seadrome from the vicinity of drilling operations in the event of an accident or an emergency such as, for example, fire.

It is particularly noted that the open truss structure employed provides a minimum of resistance to the passage of waves through the structure and the construction providing for the framing of the buoyancy tanks into the truss structure wherein the buoyancy tanks provide ring girders for transferring load between the ends of the interrupted trusses and for transferring load between the jacks and the trusses provide a floating structure of limited vertical dimension and a structure which may be raised completely above the water when it is in a docked condition.

The seadrome may also be employed as a fixed storage reservoir supporting means adjacent to a producing well. In this application the seadrome need not provide accommodations for a drilling crew or provision for drilling equipment. A seadrome employed as a storage station would employ the buoyancy tanks, the foundation columns and tanks and additional storage vessels mounted on the seadrome deck to provide storage for oil being produced from a producing well. Tankers would then, at such intervals as would be necessary, pump the oil from the seadrome and carry it away. This structure would eliminate the necessity of laying pipe lines from a producing well to the shore. It will be evident that such a structure must be capable of withstanding severe weather at sea and thus the open truss structure with the framed in buoyancy tanks and the jacking system described is ideally suited to this type of operation.

What is claimed is:

1. A seadrome including a truss structure comprising crossing transversely and longitudinally extending trusses, means providing a plurality of buoyancy tanks having vertically extending openings passing therethrough and positioned within said truss structure, the tanks interrupting transversely and longitudinally extending trusses and forming ring girders for transferring load between the ends of interrupted trusses, means providing foundation columns extending downwardly through the openings in the tanks, and means for raising and lowering the columns through the tanks mounted on the tanks adjacent to the ends of each interrupted truss, each of the tanks including a vertically extending shear web extending between the inner and outer walls thereof adjacent to the end of each interrupted truss for transferring load between the raising and lowering means and the end of each interrupted truss.

2. A seadrome including a truss structure comprising crossing transversely and longitudinally extending trusses, means providing a plurality of buoyancy tanks having vertically extending openings passing therethrough and positioned within said truss structure, the tanks interrupting transversely and longitudinally extending trusses and forming ring girders for transferring load between the ends of interrupted trusses, means providing foundation columns extending downwardly through the openings in the tanks, means for raising and lowering the columns through the tanks, each of the tanks including a vertically extending shear web extending between the inner and outer walls thereof adjacent to the end of each interrupted truss for transferring load between the ring girder formed by the tank and the ends of each interrupted truss, and guide means mounted on the tanks within the openings therein for guiding the columns extending therethrough, each of said guide means being mounted over a shear web.

3. In a seadrome comprising a structure providing a generally horizontal platform, columns extending downwardly from said platform and adapted to engage the ocean bottom, and means associated with each of said columns for raising or lowering said structure on said columns when said columns are engaging the ocean bottom, raising and lowering means each including a plurality of vertically acting fluid operated jacks, means mounting one end of each jack on the platform and providing for movement of the other end of the jack toward and away from its associated column, receiving means extending longitudinally of said columns adapted to receive said other ends of said jacks, power operated means associated with each jack for selectively moving the jack on its mounting into and out of engagement with its receiving means on the column, and control means for supplying fluid under pressure to said jacks to actuate said jacks and for actuating said jack moving means to selectively either contract said jacks when they are engaged with said receiving means and expand said jacks when they are disengaged from said receiving means, or expand said jacks when they are engaged with said receiving means and contract said jacks when they are disengaged from said receiving means.

4. In a seadrome comprising a structure providing a generally horizontal platform, columns extending downwardly from said platform and adapted to engage the ocean bottom, and means associated with each of said columns for raising and lowering said structure on said columns when said columns are engaging the ocean bottom, raising and lowering means each including a plurality of pairs of vertically acting fluid operated jacks, means mounting one end of each jack of each pair on the platform and providing for movement of the other end of the jack toward and away from its associated column, receiving means extending longitudinally of said columns adapted to receive said other ends of said jacks, power operated means associated with each jack for selectively moving the jack on its mounting into and out of engagement with its receiving means on the column, and control means for supplying fluid under pressure to said jacks to actuate said jacks and for actuating said jack moving means to contract a first jack of each of said pairs of jacks when it is engaged with said receiving means and expand said first jack of each of said pairs of jacks when it is disengaged from said receiving means, and to contract the second jack of each of said pairs of jacks when it is engaged with said receiving means and expand said second jack of each of said pairs of jacks when it is disengaged from said receiving means.

5. In a seadrome comprising a structure providing a generally horizontal platform, columns extending downwardly from said platform and adapted to engage the ocean bottom, and means associated with each of said columns for raising and lowering said structure on said columns when said columns are engaging the ocean bottom, raising and lowering means each including a plurality of pairs of vertically acting fluid operated jacks, means mounting one end of each jack of each pair on the platform and providing for movement of the other end of the jack toward and away from its associated column, receiving means longitudinally of said columns adapted to receive said other ends of said jacks, power operated means associated with each jack for selectively moving the jack on its mounting into and out of engagement with the receiving means on the column, and control means for supplying fluid under pressure to said jacks to actuate said jacks and for actuating said jack moving means to expand a first jack of each of said pairs of jacks when it is engaged with said receiving means and contract said first jack of each of said pairs of jacks when it is disengaged from said receiving means and to expand the second jack of each of said pairs of jacks when it is engaged with said receiving means and contract said second jack of each of said pairs of jacks when it is disengaged from said receiving means.

6. In a seadrome comprising a structure providing a generally horizontal platform, columns extending downwardly from said platform and adapted to engage the ocean bottom, and means associated with each of said columns for lifting said structure on said columns when said columns are engaging the ocean bottom, lifting means each including a plurality of pairs of vertically acting fluid operated jacks, means mounting one end of each jack of each pair on the platform and providing for movement of the other end of the jack toward and away from its associated column, receiving means extending longitudinally of said columns adapted to receive said other ends of said jacks, power operated means associated with each jack for selectively moving the jack on its mounting into and out of engagement with its receiving means on the column, and control means for supplying fluid under pressure to said jacks to actuate said jacks and for actuating said jack moving means to selectively either contract a first jack of each of said pairs of jacks when it is engaged with said receiving means and expand said first jack of each of said pairs of jacks when it is disengaged from said receiving means or expand a first jack of each of said pairs of jacks when it is engaged with said receiving means and contract said first jack

of each of said pairs of jacks when it is disengaged from said receiving means, and to selectively contract the second jack of each of said pairs of jacks when it is engaged with said receiving means and expanded said second jack of each of said pairs of jacks when it is disengaged from said receiving means or expand the second jack of each of said pairs of jacks when it is engaged with said receiving means and contract said second jack of each of said pairs of jacks when it is disengaged from said receiving means.

7. In a seadrome comprising a structure providing a generally horizontal platform, columns extending downwardly from said platform and adapted to engage the ocean bottom, and means associated with each of said columns for lifting said structure on said columns when said columns are engaging the ocean bottom, lifting means each including a plurality of fluid operated jacks, means pivotally mounting each of said jacks on said platform, means for selectively positioning the jacks on their pivots into and out of engagement with their associated column, and means for holding the column in position with respect to the platform when its associated jacks are out of engagement with it.

8. A seadrome including a truss structure comprising crossing transversely and longitudinally extending trusses, a plurality of buoyancy tanks having vertically extending cylindrical openings passing therethrough and positioned within said truss structure, said tanks interrupting transversely and longitudinally extending trusses and forming ring girders for transferring load between the ends of interrupted trusses, each of the tanks including a vertically extending sheer web extending between the inner and outer walls thereof for transferring load between the end of each interrupted truss and the ring girder formed by

the tank, a foundation column extending downwardly through the opening in each of said tanks, each of said columns including a cylindrical outer shell, longitudinally extending spaced plates affixed to the inner wall of the shell and lying radially of the shell, at least some of said column plates extending in alignment with the interrupted trusses and vertically extending tank sheer webs, and means positioned adjacent to aligning interrupted trusses, tank sheer webs and column plates for lifting said structure on said columns when said columns are engaging the ocean bottom.

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