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Campbell et al.

[11] **3,719,238**

[45] **March 6, 1973**

[54] **COMPACT ROTARY WELL DRILLING RIG WITH HYDRAULIC SWIVEL PULL DOWN MECHANISM**

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[73] Assignees: **Charles M. Dykema, Trustee,** Chicago, Ill.; **Small Business Administration, an agency of the United States Government**

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[21] Appl. No.: **173,009**

[52] **U.S. Cl.** **173/147,** 173/28, 175/122, 175/203

[51] **Int. Cl.** **E21c 5/06,** F01b 29/08

[58] **Field of Search** 173/147, 289; 175/122, 162, 175/203, 207

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Primary Examiner—David H. Brown
Attorney—Wayland D. Keith

[57] **ABSTRACT**

A compact, mobile, portable rotary drilling rig which enables the use of drill pipe of a length slightly less than the height of the mast. The drilling rig has a power driven swivel or drilling head connectable to a drill pipe, which swivel may be pulled down by a hydraulic cylinder-plunger arrangement, which cylinder is about one-half the length of the distance which the swivel is to be pulled down, and which cylinder is so constructed that no hoses are connected directly to the movable hydraulic cylinder. The hydraulic cylinder exerts tension on cables to perform the pull down action. Provision is made to mount the present compact, mobile, rotary drilling rig, including the mast, on a vehicle which may be enclosed in a van-like structure, if desired, which van-like structure may be so insulated that men can work within an insulated enclosure when the outside temperature is well over 100° or they can work therein when the outside temperature is subzero without injury to the machinery and without discomfort to themselves.

6 Claims, 15 Drawing Figures

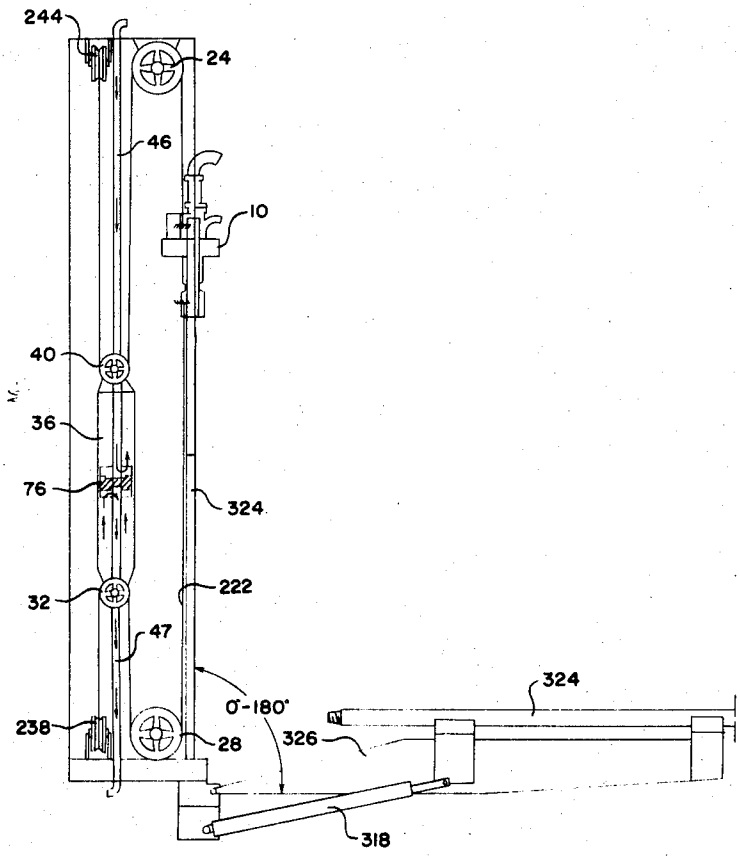

FIG. 1

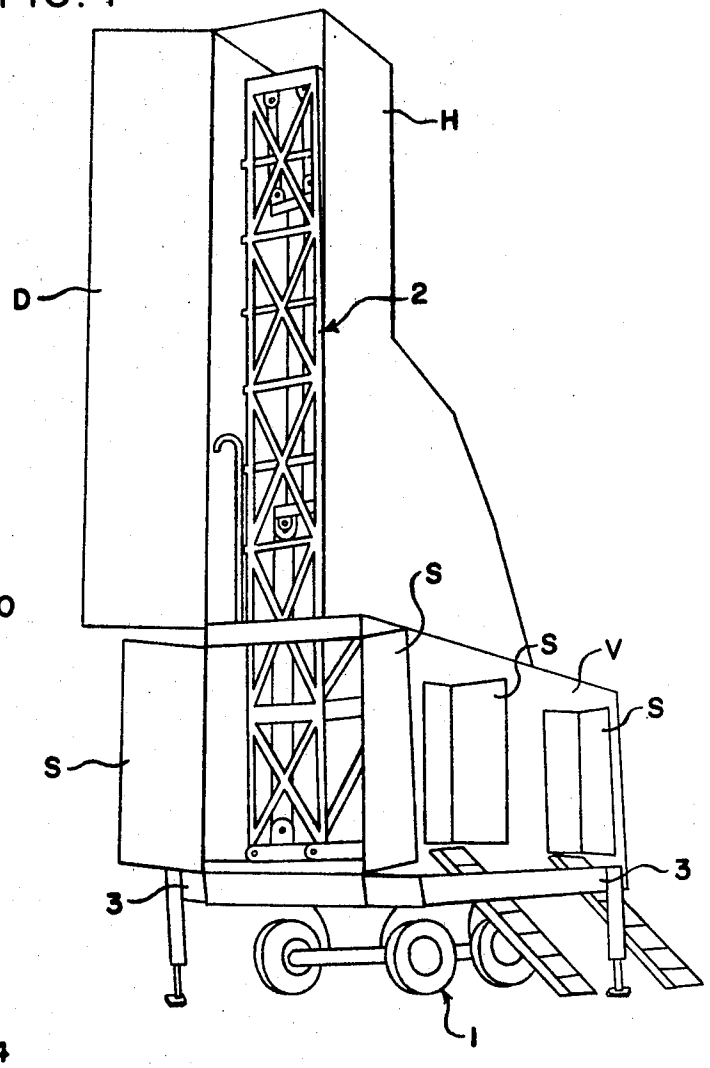
H
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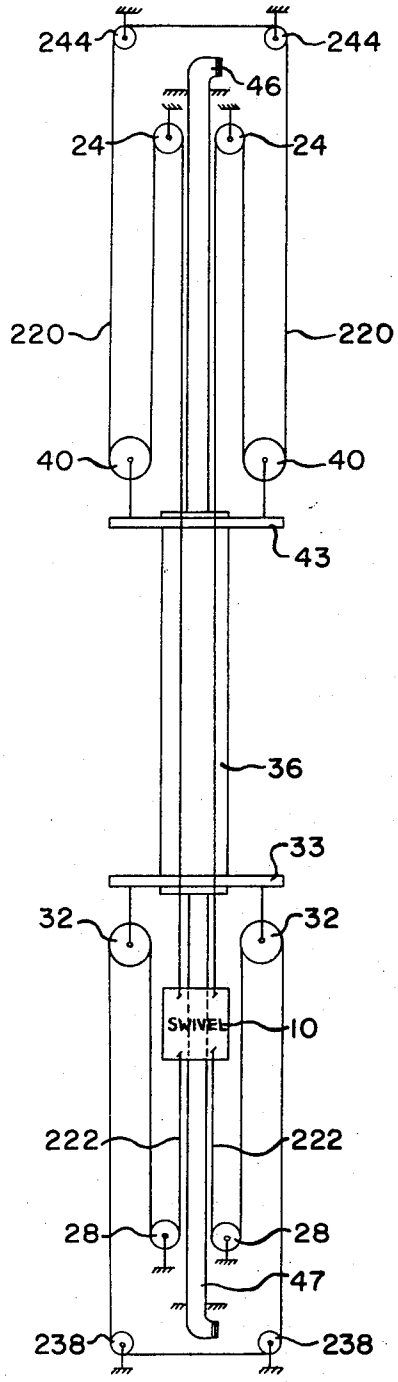
FIG. 4

244
24
46
10
40
36
76
324
32
222
47
0-180°
238
28
326
324
318

FIG. 2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46
24
24
220
220
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43
36
33
32
32
SWIVEL
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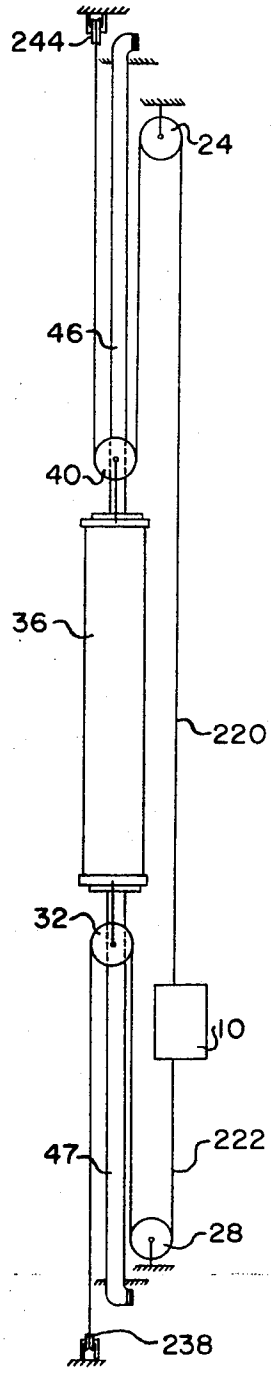
222
222
28
28
47
238
238

FIG. 3


244
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220
32
10
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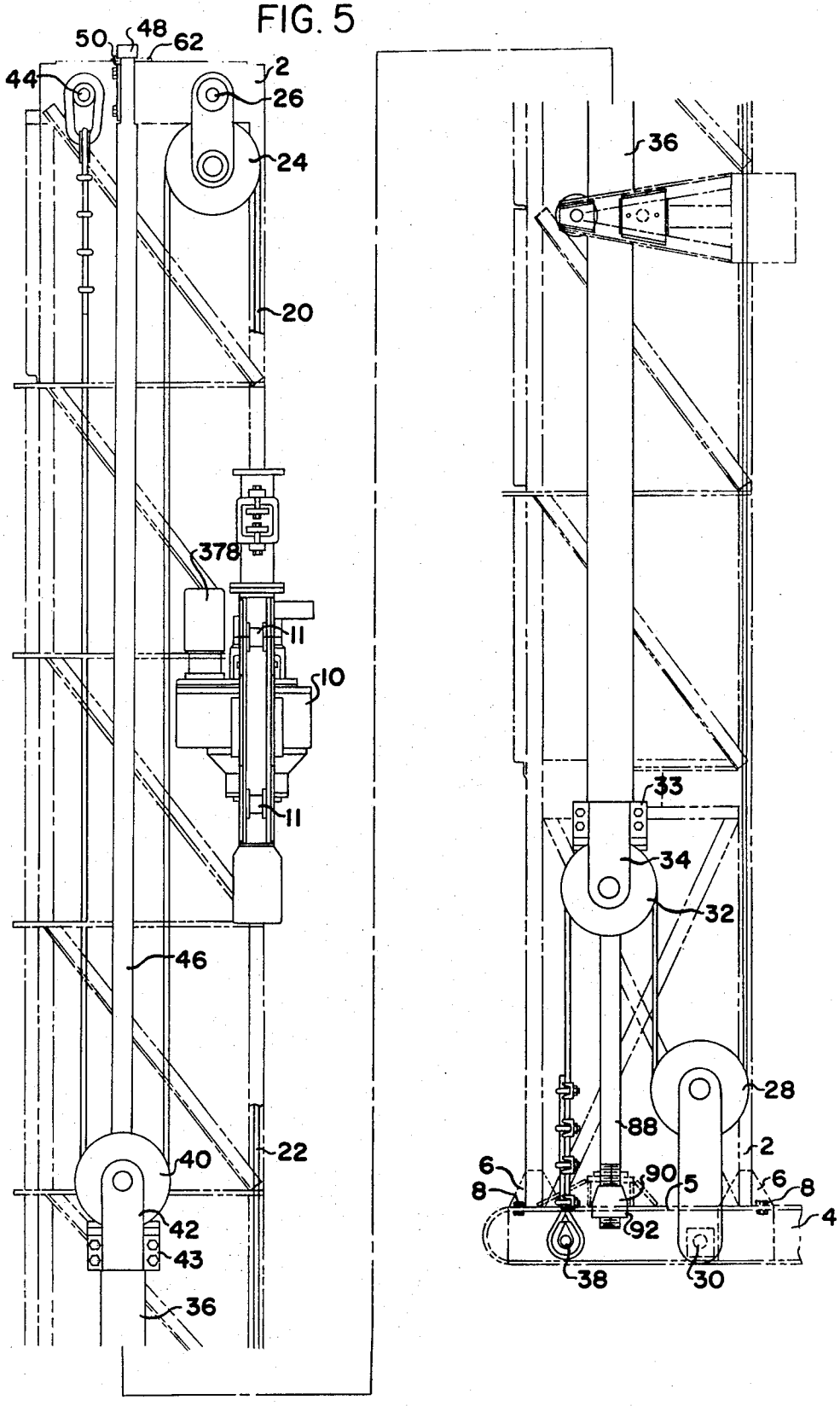
222
28
238

FIG. 5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48
62
2
44
26
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378
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10
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40
22
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32
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88
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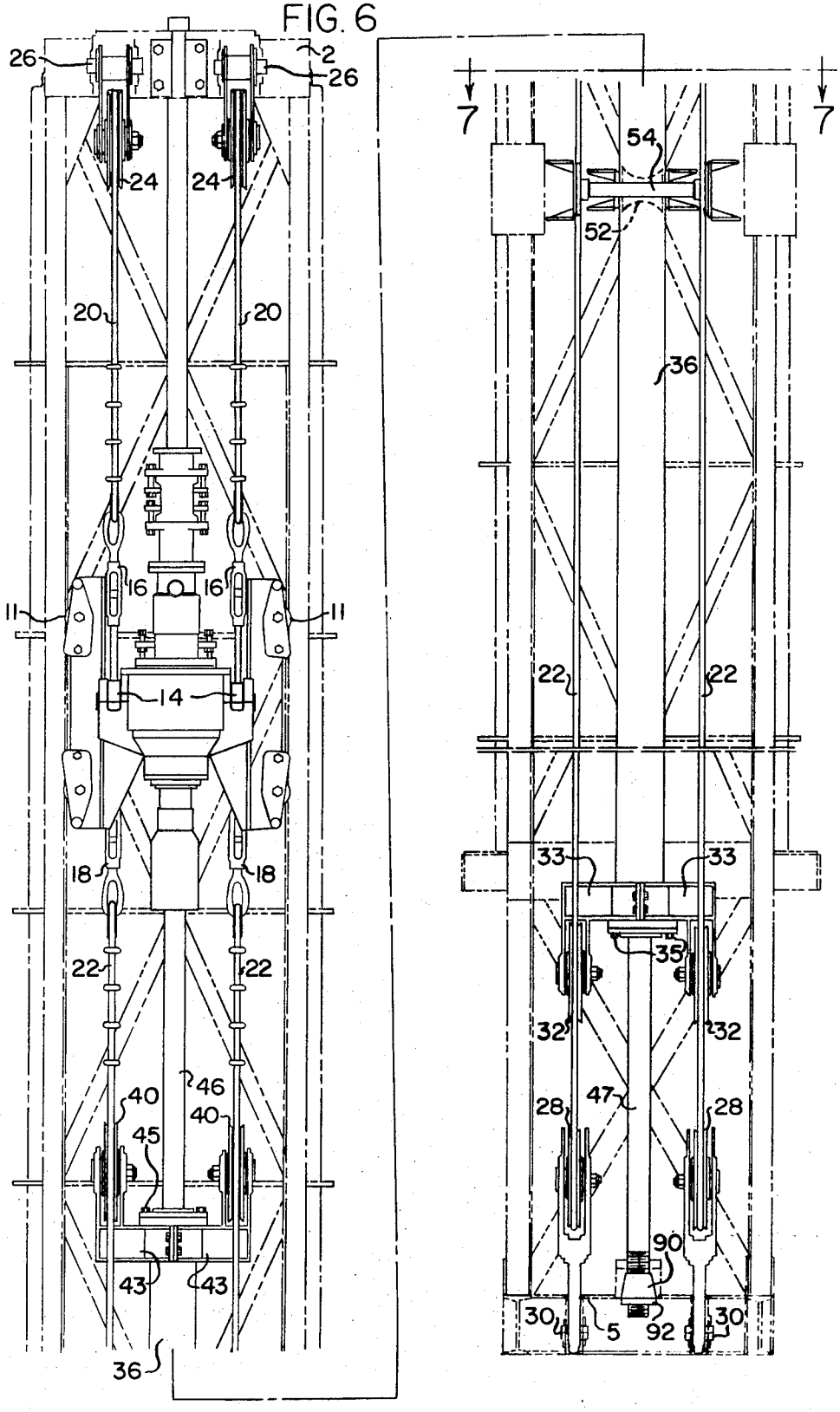
6
8
90
5
6
8
4
92
38
30

FIG. 6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14
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43
36
7
7
54
52
36
22
22
33
33
35
32
32
47
28
28
90
30
5
92
30

FIG. 7

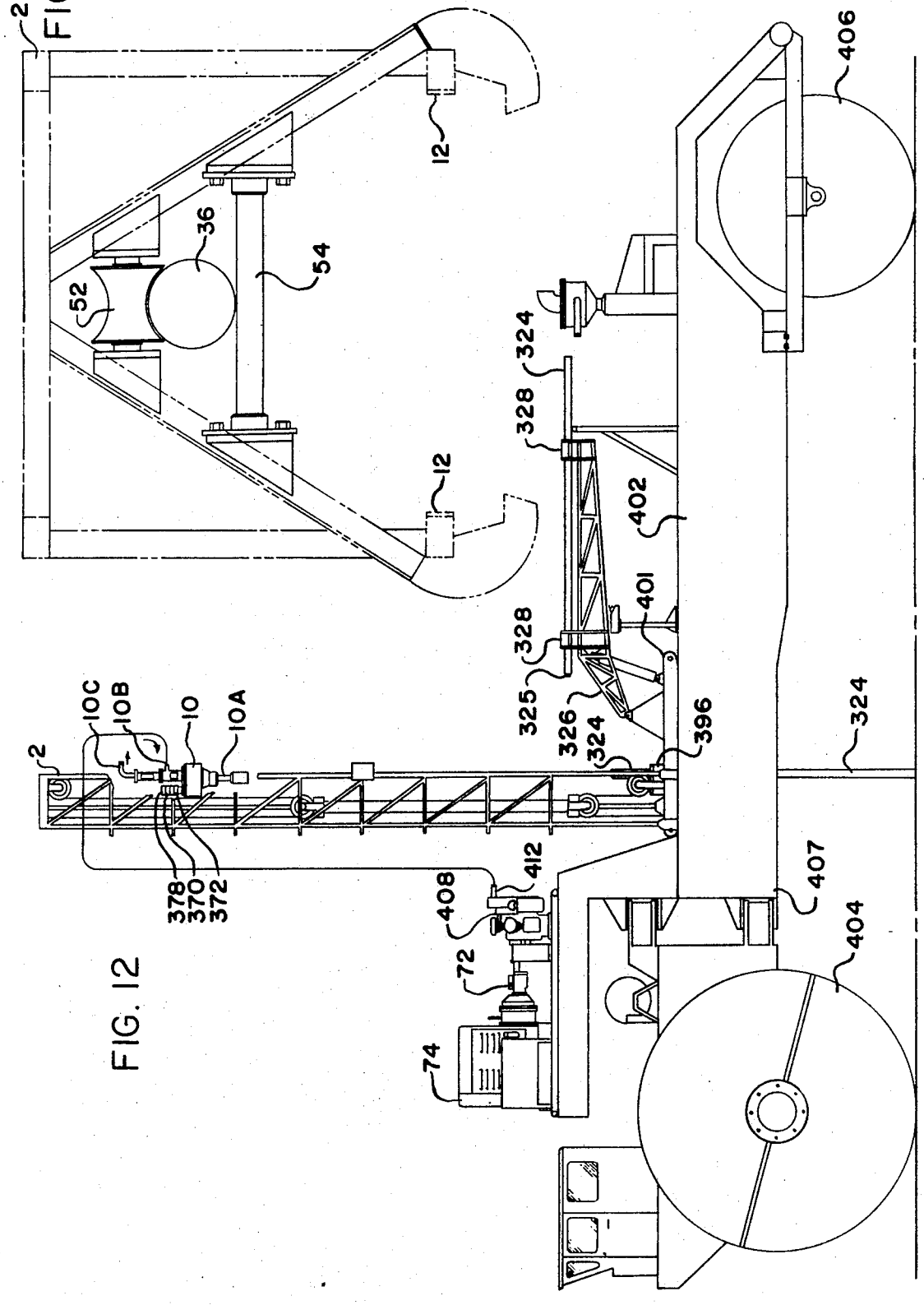
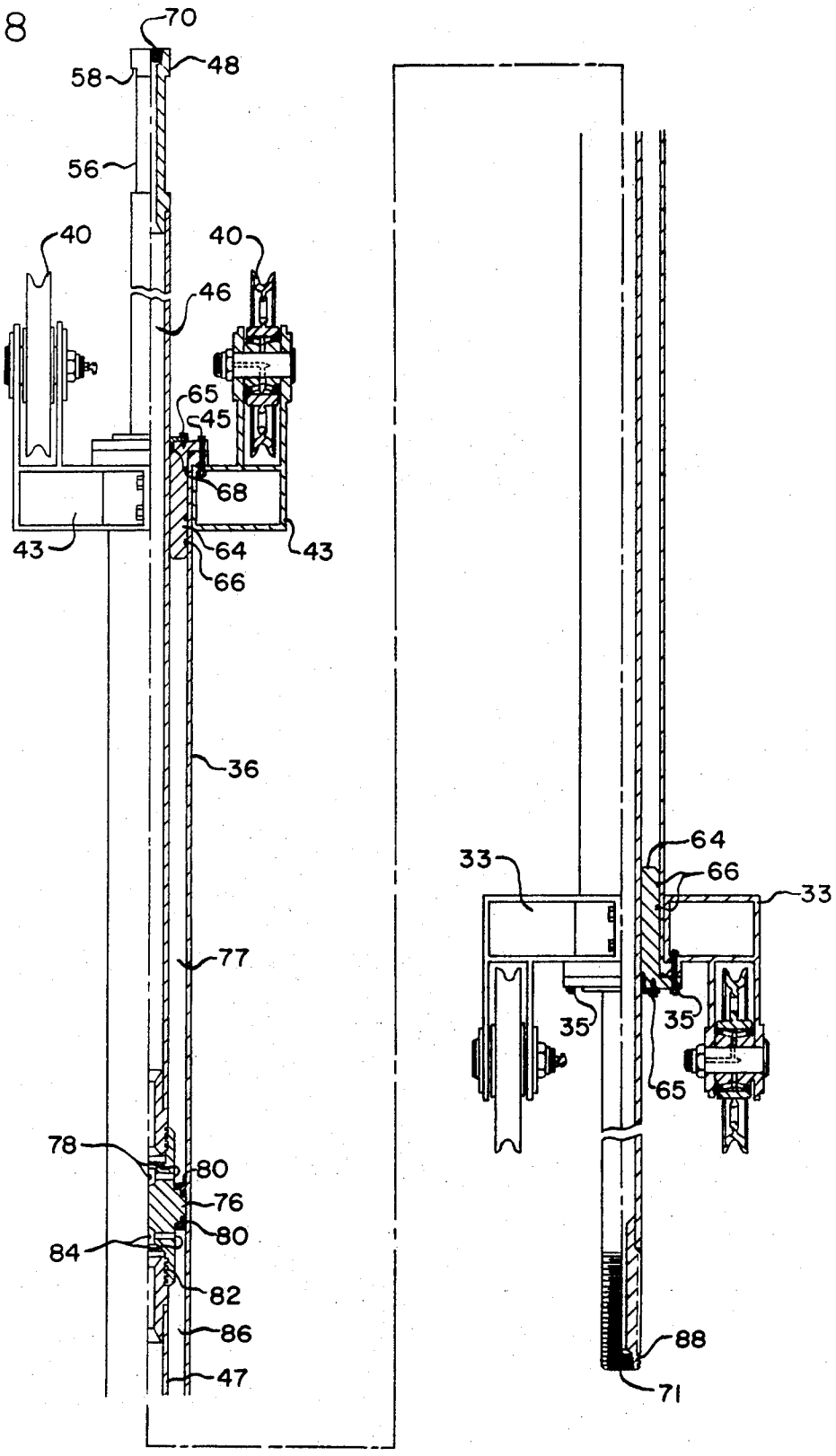

2
12
36
54
52
12
406
324
328
402
328
401
325
326
324
396
324
10C
10B
10
10A
2
378
370
372
412
408
407
72
404
74

FIG. 12

FIG. 8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64
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47
33
64
66
33
35
35
65
88
71

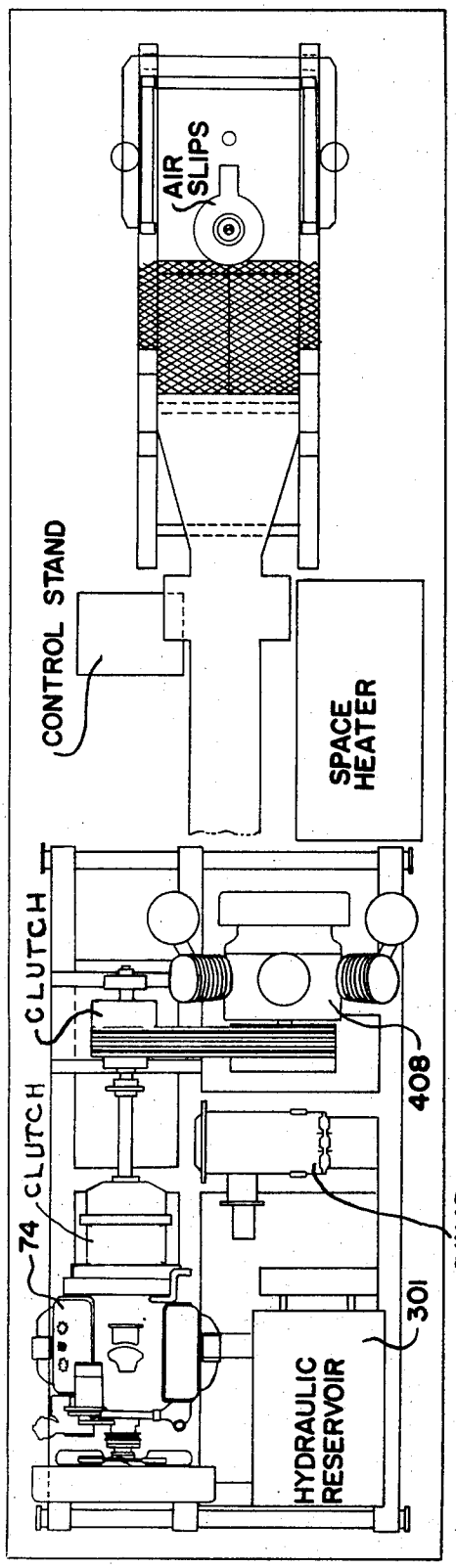

AIR SLIPS
CONTROL STAND
SPACE HEATER
CLUTCH
CLUTCH
74
408
PUMP
301
HYDRAULIC RESERVOIR

FIG. 9

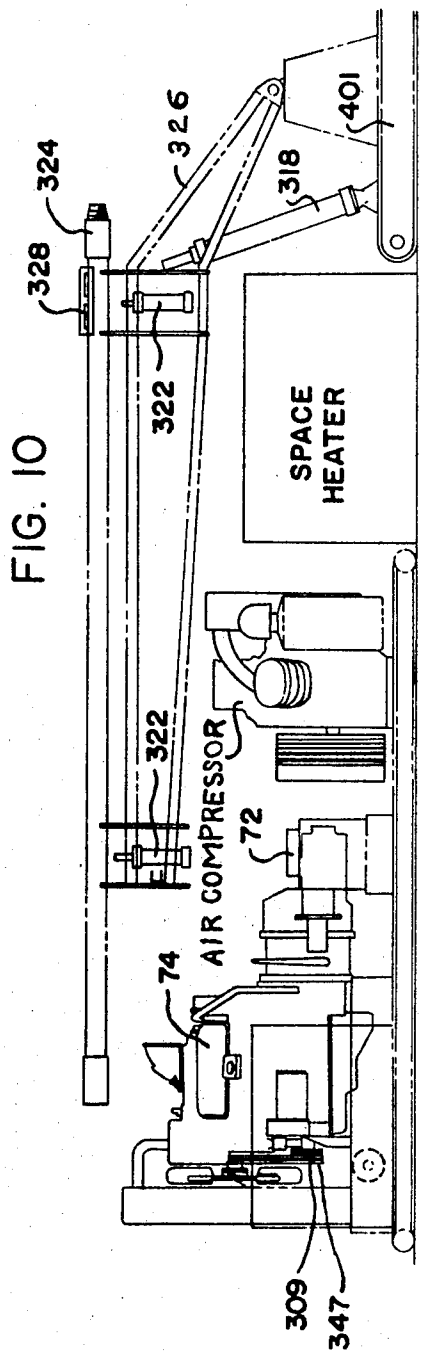

324
326
401
318
328
322
SPACE HEATER
322
AIR COMPRESSOR
72
74
309
347

FIG. 10

FIG. 11

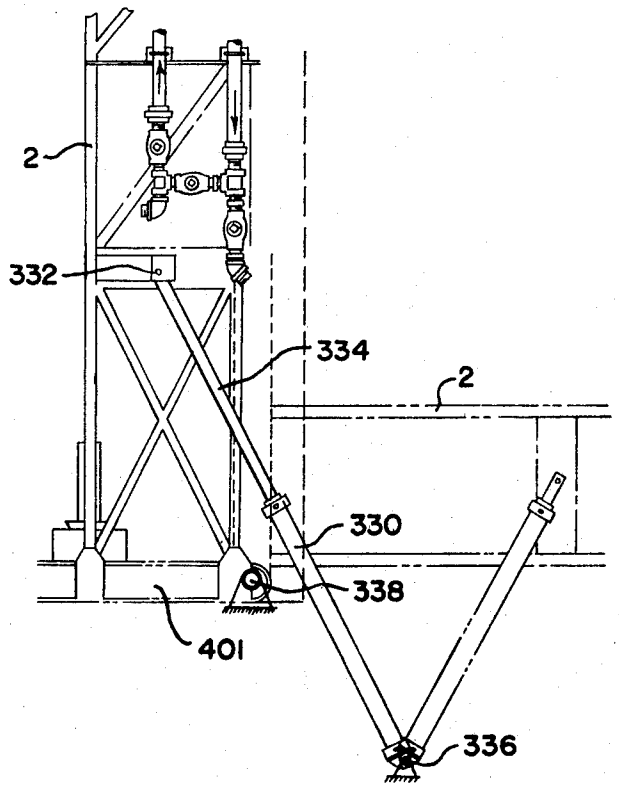


FIG. 15

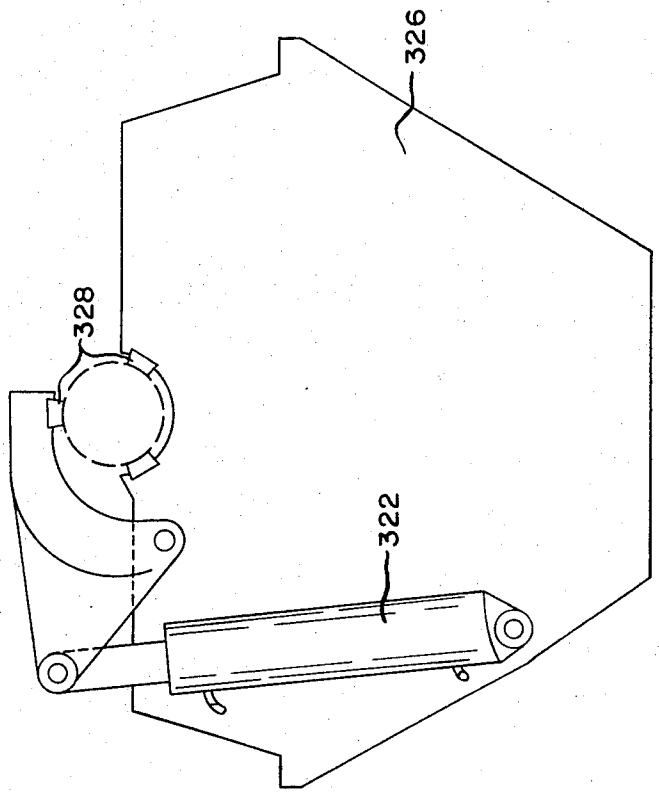


FIG. 13

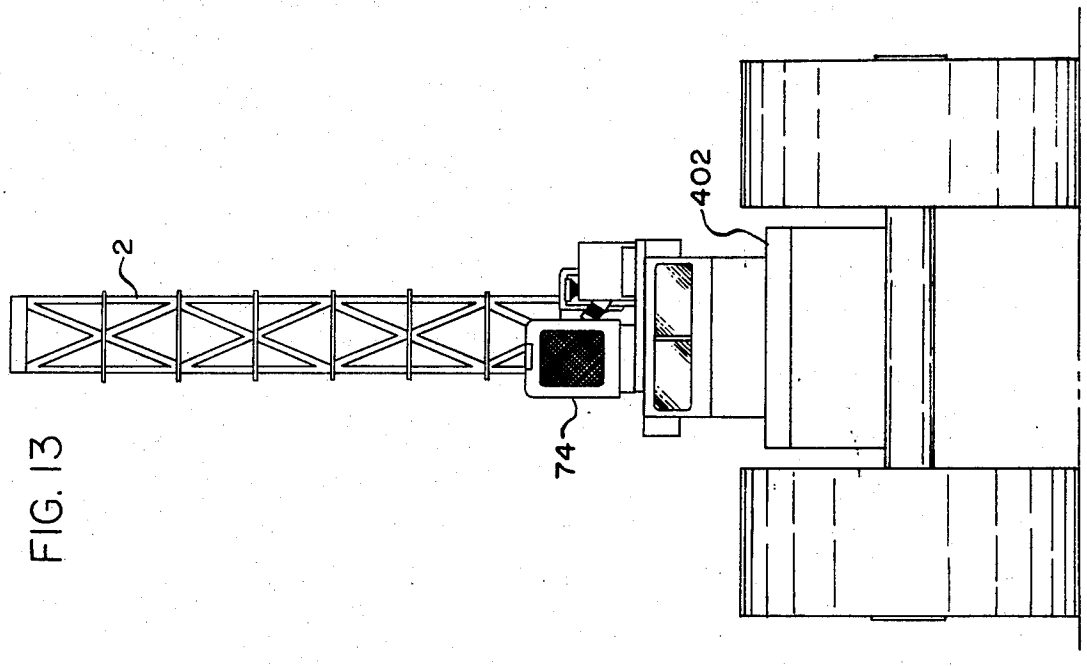
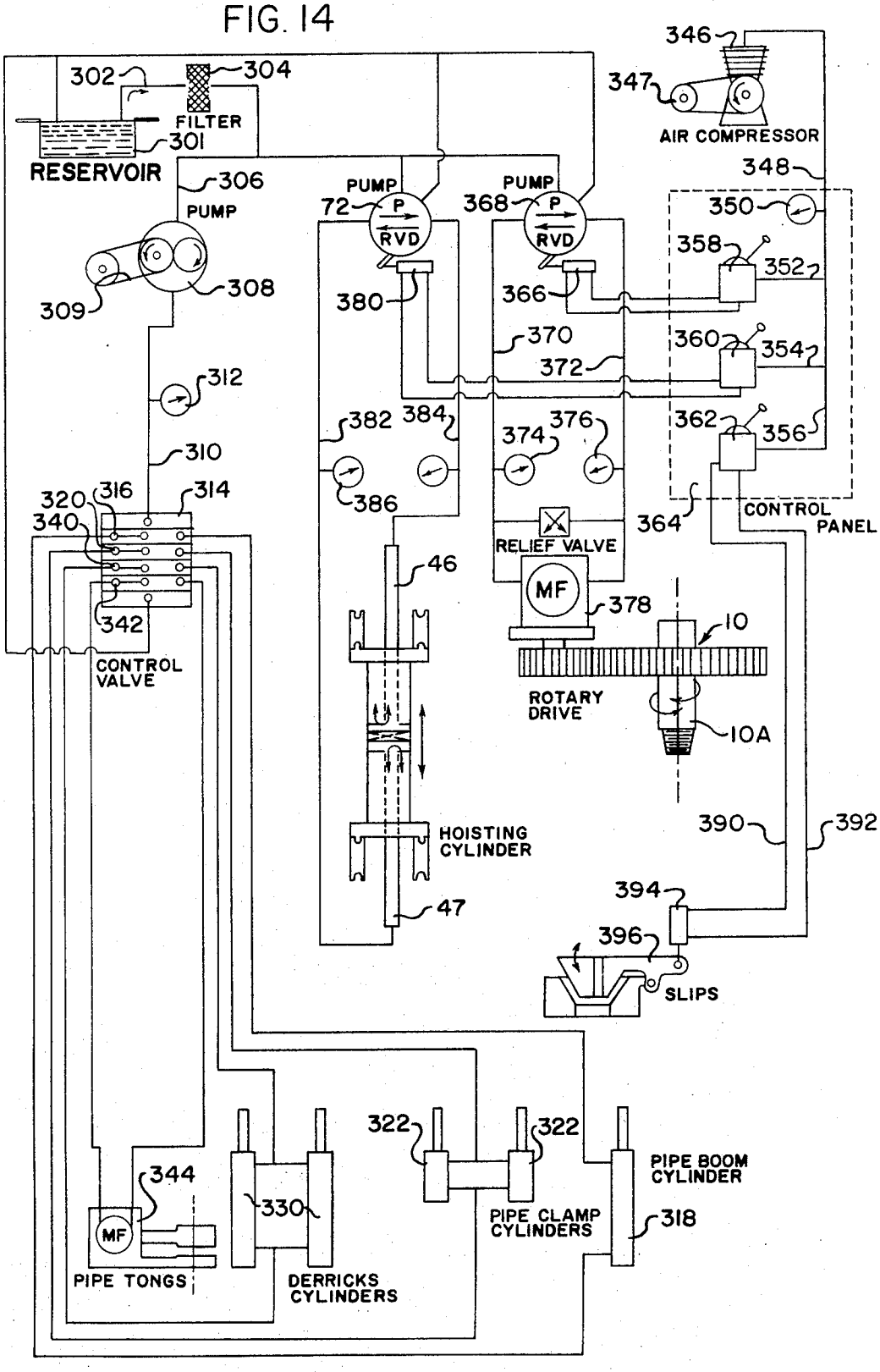


FIG. 14


302
304
FILTER
301
RESERVOIR
306
PUMP
309
308
312
310
316
314
320
340
342
CONTROL VALVE
PUMP
72
P
RVD
380
382
384
386
46
HOISTING CYLINDER
47
PUMP
368
P
RVD
366
370
372
374
376
RELIEF VALVE
MF
378
346
347
AIR COMPRESSOR
348
350
358
352
360
354
362
356
364
CONTROL PANEL
10
ROTARY DRIVE
10A
390
392
394
396
SLIPS
322
322
PIPE CLAMP CYLINDERS
PIPE BOOM CYLINDER
318
344
MF
PIPE TONGS
330
DERRICKS CYLINDERS

COMPACT ROTARY WELL DRILLING RIG WITH HYDRAULIC SWIVEL PULL DOWN MECHANISM

BACKGROUND OF THE INVENTION

This invention relates to a rotary drilling rig which is adapted to be erected and put into operative condition within a space of restricted height, such as for use in a van type vehicle, wherein it may be completely enclosed, or it may be used within a basement or subterranean cavern where limited head room restricts the use of conventional drilling rigs.

The drilling rig embraces other features, as will be evident as the description proceeds, which are useful in making the rig more efficient over other rigs, regardless of size. The present rotary drilling rig furnishes the necessary mechanisms for efficient and speedy drilling which are not usually found in rigs of this size. The manner of feeding and operating the drilling rig enables a maximum footage of bore hole to be drilled in a minimum of time and with a minimum of physical effort and discomfort on the part of the operators.

The rotary drilling rig is so constructed that it has its own prime mover mounted thereon, which usually consists of an internal combustion engine or an electric motor. Furthermore, a hydraulic pumping unit, and an air compressor units are also provided, many of which apparatuses may be hydraulically actuated, and air may be used for a drilling fluid, and to clean the well of cuttings and the like. The present rig is so constructed that it may be enclosed and insulated so men may work therein in subzero weather or in excessive heat in perfect comfort.

The present hydraulic system and controls therefor are such that controlled weight may be exerted on the drill stem and on the bit on the lower end thereof to insure maximum efficiency in drilling and the minimum wear on the drill bit.

By combining the hydraulic rotary swivel, the pipe handling arm, and the hydraulic raising and lowering cylinder, the operator can have a complete single package which can pull up or pull down on the drill pipe, and can rotate the drill pipe forward or backward. It can move drill pipe from storage racks to a position in the derrick where it can be made up in or broken out of the drill string hydraulically. This can be done by two men acting remotely and safely.

The derrick section may be set at any angle from a vertical position to a horizontal position.

Hydraulic Power Swivel

The main spindle which extends through the swivel is gear driven and hydraulically powered. It may be driven forward or backward. The hydraulic pump that drives the motor is preferably a variable volume pump so the speed of rotation may be variable, usually from 0 -135 RPM, either in forward or reverse rotation.

The swivel serves two basic functions: one, it supplies rotational means for drilling the well, and secondly, it is used to make up and break out joints in the drill string.

Pipe Handling Boom

The pipe boom receives the drill pipe from a pipe storage rack and positions it in the derrick with the female threads upward in order to allow making up the male thread on the lower end of the swivel spindle. The pipe boom hydraulically clamps the drill pipe and supports itself against rotation by mating support guides located on the end of the boom and the derrick. This

provides a safe and convenient method of handling the heavy stands of pipe.

Hydraulic Raising and Lowering Cylinder

The movable hydraulic pull down and pull up cylinder raises and lowers the power swivel by hydraulic pressure.

The raising operation is accomplished by pumping hydraulic oil into the hollow rod on the lower side of the piston member. The oil passes through the lower section of the piston and into the chamber between the cylinder and rod. Lowering operations are performed in the reverse manner.

Since oil under pressure is being delivered to the cylinder on one end and the external force is on the opposite, the strain is always in tension. Likewise, the hollow shaft that forms the piston rods are always in tension. This is a great advantage because there is no chance for the rod or cylinder to fail due to buckling of long slender columns since no compressive forces can be exerted on the tubular members.

It is a necessary design requirement that at least one end of the rod be free to move vertically in order to compensate for variations of length due to stress and temperature variations induced in the metal members.

During a situation where the weight of the drill string is exerting tension on the top of the cylinder, the oil in the lower section of the cylinder is caused to be under pressure. Likewise, when the string of drill pipe is being lowered into the well, pressure must be bled off of the lower chamber of the cylinder; consequently, in order to affect a braking action to the load, the pressurized oil must be metered off. This is accomplished by use of a variable displacement hydraulic pump which will receive the oil at pressure and discharge to the low side of the pressure loop in a closed circuit, or hydrostatic transmission, hydraulic system. Heat generated in the oil system by the release of the oil pressure during braking operations is dissipated by a heat exchanger unit which is connected to the prime mover radiator.

OBJECTS OF THE INVENTION

An object of this invention is to provide an arrangement whereby a controlled weight on the drill stem and drill bit may be had at all times.

Another object of the invention is to provide a rotary drilling rig that has a relatively short mast which will use a maximum length drill stem within a space having a minimum amount of head room.

A further object of the invention is to provide an enclosed insulated drilling rig which may be operated at temperatures well above or below that which is normal for men to work in unprotected.

Still a further object of the invention is to provide a drilling rig which may be operated and controlled from a remote position by the use of pneumatic and hydraulic controls.

Yet a further object of the invention is to provide a prime mover and power components located at remote positions while having the hoisting and control sections as individual separate stations.

Still another object of the invention is to provide a drilling rig having light weight components which are capable of being transported by helicopter and assembled into an operative unit on the location.

A still further object of the invention is to provide a draw works and rotary tables and drive lines that require less space than the conventional units of a rotary drilling rig.

Yet another object of the invention is to provide a drilling rig, the equipment of which may be installed within a limited space and in separate packages.

Another object of the invention is to provide a rotary drilling rig which is compact in construction, easy to operate, simple in construction and relatively low in the cost of manufacture.

BRIEF DESCRIPTION OF THE DRAWINGS

With these objects in mind and others which will become manifest as the description proceeds, reference is to be had to the accompanying drawings in which like reference characters designate like parts in the several views thereof, in which:

FIG. 1 is a perspective view of a rotary well drilling rig installed within a van type vehicle, showing the mast enclosed, and showing out-riggers on the vehicle to stabilize the vehicle against tipping;

FIG. 2 is a schematic, elevational view of one form of the cable arrangement and part of the hydraulic system of the rotary well drilling rig, but with all cables and pulleys of the cable system lying in the same plane for the sake of clarity;

FIG. 3 is a side elevational view of the schematic arrangement of the hydraulic pull down cylinder and cable arrangement, showing the swivel connected to the cables, such as shown in FIG. 2;

FIG. 4 is a schematic, side elevational view of the cylinder and cable arrangement, partly in section, as shown in FIG. 2, but showing a hydraulic cylinder associated therewith for raising and lowering a reversible power swivel or hydraulic powered drilling head, with the swivel mounted within guide tracks, and further showing the path of hydraulic fluid entering into the pull down and pull up cylinder and exhausting fluid therefrom through hollow connecting rods extending thereinto and to the piston within the cylinder, showing the mast on which the mechanism is mounted in diagrammatic outline;

FIG. 5 is an enlarged, side elevational view of one form of the hydraulic actuated swivel pull down and pull up mechanism, with parts broken away and parts not shown, to bring out the details of construction, with portions thereof being shown in dot-dash outline;

FIG. 6 is a front elevational view of the mechanism embodied in FIG. 5 and showing the mast thereon in dot-dash outline;

FIG. 7 is a sectional view taken on line 7—7 of FIG. 6, looking in the direction indicated by the arrows;

FIG. 8 is a longitudinal view of the hydraulic pull down and pull up cylinder and associated mechanism, with parts shown in elevation and parts shown in section to bring out the details of construction;

FIG. 9 is a top plan view of the rotary drilling rig, showing the placement of the various elements on a base or on the floor of a vehicle, such as shown in FIG. 1;

FIG. 10 is a side elevational view of the drilling rig as shown in FIG. 5, a portion thereof being broken away;

FIG. 11 is a portion of the side elevational view of the rotary drilling apparatus and pipe handling mechanism as shown in FIG. 10;

FIG. 12 is a side elevational view of a modified form of the drilling rig mounted on a vehicle, showing the component mechanisms with which to operate the device, with the specific hydraulic pull down mechanism and pipe handling mechanism being the same as disclosed in the aforementioned FIGS., and showing the mast in upright position;

FIG. 13 is a front elevational view of the vehicle and rotary drilling rig with the mast in upright position;

FIG. 14 is a diagrammatic view of hydraulic and air systems and associated mechanisms,

FIG. 15 is a cross sectional view through the pipe clamping mechanism and pipe, showing the hydraulic cylinder associated therewith.

DESCRIPTION OF ONE EMBODIMENT OF THE INVENTION

One embodiment of the invention is disclosed in FIGS. 1 and 5 through 12. The form of the invention as shown in these specified FIGS. enables a vehicle 1 to mount a mast 2 therein, which mast may seat on a frame 4. The mast 2 has feet 6 on the lower end thereof, which feet are secured in place in a conventional manner as by bolts 8 or by hinges.

The mast 2 has an open side, which will permit a swivel 10, which includes a reversible power driven drilling head, having guide rollers 11 thereon, to move along a track 12 mounted on each side of the mast 2. The swivel 10 has anchor means 14 thereon to receive ends of turn buckles 16 and 18 thereon, which turnbuckles anchor the ends of the respective cables 20 and 22 thereto.

The cables 22 are anchored to swivel 10 and pass downward and beneath the respective sheaves 28, which sheaves are anchored to the frame 4 by pivot pins 30 so that the cables 22 will pass thereunder and over sheaves 32, which sheaves are mounted in journaled relation on apertured brackets 34, on clamp on brackets 33, on the lower end of hydraulic pull down and pull up cylinder 36, with the cables 22 extending downward and anchored to an anchor pin 38 on frame 4, as will best be seen in FIG. 5.

The cables 20 are anchored to the swivel 10 and extend upward over sheaves 24 which are anchored by pins 26 to the upper end of the mast 2. The cables then pass downward under sheaves 40 mounted on brackets 43 on the upper end of the hydraulic pull down and pull up cylinder 36. The cables 20 and 22 are maintained in taut condition by adjustment of turnbuckles 16 and 18 so that the movement of hydraulic cylinder 36, on hollow piston rods 46 and 47 will enable free movement of the cylinder within the length of the mast 2. The piston rods 46 are suspended at the upper end of the mast on a shouldered end 48 thereof, which piston rod is maintained against rotary movement by a flattened side thereof which is held in position by a bracket 50 bolted to the upper end of mast 2, as will best be seen in FIGS. 5 and 6.

The brackets 33, on which sheaves 32 are mounted, each have bolts 35 passing therethrough and through the flanges on the lower end of hydraulic cylinder 36, so as to secure the brackets 33 and sheaves 32 against longitudinal movement with respect to the movable hydraulic cylinder 36. Bolts 45 pass through holes in the flanges on the upper end of movable hydraulic cylinder 36 and through holes in brackets 43 to hold

the brackets 43 against longitudinal movement with respect to the movable hydraulic cylinder 36.

The hydraulic cylinder 36 moves in guided relation between a concave roller 52 and a cylindrical roller 54, as will best be seen in FIG. 7. In this manner the hydraulic fluid passing into and out of hollow piston rods 46 and 47 moves the cylinder 36 with respect to piston rods 46 and 47. The hollow piston rod 46 is of reduced diameter at its upper end, as indicated at 56, with a flattened shoulder 58 on an enlarged end 60 to engage the upper portion of the mast to restrain the rod against longitudinal movement or against rotary movement with respect to the mounting bracket 50 and the lug 62 which form clamps to engage the flattened shoulder 58.

The hydraulic cylinder 36 has guide members 64 within each end thereof, which guide members have sealing elements 66, such as O-rings, packing or the like, therein to form a seal between the cylinder 36 and the respective guide members 64. The guide members 64 each have a sealing element 68 therein, which sealing elements are held in sealing relation between hollow piston rod 46 and the inner diameter of guide members 64 by a gland 65.

The piston rod 46 is threaded at the upper and lower ends thereof, as indicated at 70 and 72, to threadably connect a conduit thereto, which conduit is connected to a suitable source of hydraulic pressure, such as hydraulic pump 72. The pump 72 is driven by a prime mover 74, such as an engine or motor. The hollow piston rod is formed of upper and lower sections 46 and 47 respectively, which piston rods are threadably connected to the respective ends of piston 76, which forms a fluid barrier between the two hollow piston rod sections to prevent the passage of fluid therethrough. The piston rod 46 has passages 78 formed therein which interconnect with the hollow portion of the piston rod and the annular space between the piston rod and the inner diameter of hydraulic cylinder 36, as will best be seen in FIG. 8. The piston 76 has fluid sealing rings 80 thereon to form a seal between the piston 76 and the inner diameter of the hydraulic cylinder 36.

The piston rod section 47 is screw threaded to the piston 76, as indicated at 82, which hollow piston rod has passages 84 connecting with the inner diameter of piston rod section 47 with the annular space 86 between the piston rod 47 and the inner diameter of cylinder 36. The hollow piston rod section 47 is exteriorly threaded on the lower end thereof, as indicated at 88 in FIG. 5, to enable a screw threaded element 90 to threadably engage the threads on the lower end of piston rod 47, so the screw threaded element 90 will seat on flange 5 of frame 4. A lock nut 92 threadably engages the screw threads 88 to bindingly engage the lower end of the piston rod 47 in taut relation with respect to mast 2 to enable the hydraulic cylinder 36 to traverse a longitudinal path in guided relation between rollers 52 and 54, to move the swivel 10 from a point adjacent sheaves 24 to a point adjacent sheaves 28 and vice versa. Since the cables 20 and 22 also pass over sheaves 40 and 32, a block and tackle action is had with respect to the movement of the cylinder 36 in moving the swivel 10, however, with this arrangement, the swivel 10 is moved twice the distance of travel of the cylinder 36 with respect to the piston 76, and, although this gives only one-half the pull down or pull up tension on swivel 10, with the swivel being moved twice as fast as the movement of the cylinder 36, due to the multiplication arrangement of the cables.

MODIFIED CABLE ARRANGEMENT FOR MOVING THE POWER DRIVEN SWIVEL WITH RESPECT TO THE MAST

A modified form of cable arrangement is shown in FIGS. 2, 3 and 4, wherein a single upper cable 220 and a single lower cable 222 are connected to the top and bottom respectively of the swivel 10 by the respective turnbuckles 16 and 18, to move the swivel 10 up and down within mast 2. The hydraulic cylinder 36 has a bracket 33 on the lower end thereof, which bracket mounts sheaves 32 in journaled relation, in the same manner as set out for the aforementioned form of the invention.

The cable 222 is anchored on swivel 10 and passes downward beneath sheaves 28 mounted on the mast 2 near the lower end, and upward over sheaves 32, mounted on brackets 33, thence downward beneath sheaves 238 mounted on the mast 2 near the lower end to form a single cable loop to equalize the tension on the cable 222 when pull is exerted thereon.

The cable 220 is secured to swivel 10 and extends upward therefrom and over sheaves 24 mounted on the upper end of the mast 2 in journaled relation by anchor pin 26 and downward beneath sheaves 40, which sheaves are mounted on bracket 43, in the same manner as set out for the aforementioned form of the invention. Thence, the cable extends upward over sheaves 244 to complete a single loop, so as to equalize the tension on the cable at all times.

FIG. 4 illustrates diagrammatically the flow of the hydraulic fluid downward through hollow piston rod 46 and outward through the passages in the upper portion of piston 76, thence into the annular space 77 between the piston rod 46 and the cylinder 36, whereupon the fluid will urge the cylinder 36 upward, which will move bracket 33 upward, which, through the sheaves 28, will pull cable 222 downward and since the cable 222 is attached to the lower end of power swivel 10, this will exert a pull down action on swivel 10 to urge a drill stem, which is connected thereto, downward, which drill stem is rotated by the hydraulically power driven reversible drilling head and swivel in a manner well understood in the art of drilling.

While the hydraulic fluid is being forced into the upper end of the cylinder 36, it is being exhausted out through passages in the lower end of piston 76 in the same manner as hereinbefore set out for the aforementioned form of the invention. The hydraulic fluid will be exhausted back into a reservoir to be recirculated, under hydraulic pressure, to move the hydraulically powered swivel or drilling head. The flow of fluid is reversed and fluid is directed into the lower end of hollow piston rod section 47 and the reverse action is had to move the hydraulically powered swivel or drilling head upward.

HYDRAULIC AND AIR CONTROL SYSTEMS

The air and hydraulic control systems are shown diagrammatically in FIG. 14, wherein a reservoir 301 is provided for the hydraulic fluid, which is usually oil or

other hydraulic fluid which preferably will not freeze. A common pump inlet conduit **302** leads from the reservoir **301** through a filter **304**. A branch inlet pipe **306** leads from pump inlet pipe **302** to a hydraulic pump **308** that discharges the hydraulic fluid, under pressure, into conduit **310**, which conduit has a gauge **312** therein to register the pressure. The discharge conduit **310** connects with a multiple control valve unit **314**, which valve unit has a multiplicity of controls thereon to furnish hydraulic fluid to the various elements from zero pressure to the maximum pressure on the conduit.

A control valve **316** controls the pressure to hydraulic boom cylinder **318**, as shown in FIGS. **10** and **14**. The variable pressure control valve **320** controls the pressure to pipe clamp cylinders **322**, as shown in FIGS. **10** and **14**, which clamp cylinders hold a length of drill pipe **324** near each end thereof, in fixed relation to the pipe handling boom **326**, until the boom **326** moves from a horizontal position to a vertical position, or vice versa. The cylinders **322** actuate the pipe clamping members, indicated at **328**, with pressure control valve **320** to cause the hydraulic cylinder plungers to move the clamp members **328** into engagement with the pipe when in one position and move clamp members **328** out of engagement with the pipe when the valve is moved to another position.

A pair of mast cylinders **330** is positioned on each side of the mast **2**, each of which cylinders is connected thereto by a pivot pin **332** at the upper end of the plunger **334**, with the pairs of cylinders **330** being pivotally connected by pins **336**, which enable the derrick to pivot on the lower end of the legs and be moved from horizontal to upright position, either with feet **6** thereon as shown in FIG. **5**, or with a hinge joint as shown at **338** in FIG. **11**. A variable hydraulic pressure control valve **340** permits hydraulic fluid to be directed into cylinders **330** at any pressure from zero to maximum pressure and be released in reverse manner.

A variable pressure hydraulic control valve **342** directs hydraulic fluid from conduit **310** to variable speed, hydraulically actuated pipe tongs **334** so as to enable pipe to be made up or broke out, depending on the direction in which the motor of the pipe tongs is driven, and depending upon the position of the dies therein. These pipe tong elements are well known in the art and are utilized with the present rig arrangement to enable the rig to be controlled by various controls so that many automated features are present. In this manner, two men can do work that normally requires the work of four or five men, and do it with greater ease.

An air compressor **346** is connected in driving relation with the engine or prime mover **74** to supply air for actuating various elements. The air is directed into a discharge pipe **348** which has an air gauge **350** connected thereto. Branch outlet pipes **352**, **354** and **356** lead from air line **348** to variable pressure control valves **358**, **360** and **362** on valve console panel **364**. The valve **358** actuates a cylinder **366**, which in turn actuates a reversible, variable delivery pump **368** that is driven by prime mover **74**. The pump **368** withdraws hydraulic fluid through conduit **302**, and filter **304** and directs the fluid either into conduit **370** or into conduit **372**, which conduits have gauges **374** and **376** therein, to a reversible hydraulic motor **378** of power driven drilling head or swivel **10**, so as to rotate the tubular spindle **10A** within the swivel **10** so as to rotate the drill pipe **324** connected to the swivel in a manner well understood in the art of well drilling.

The variable delivery air valve **360** directs air from air supply line **348** to a cylinder **380**, which actuates the controls of reversible variable delivery pump **72**. The pump **72** has two conduits **382** and **384** leading therefrom, which have pressure gauges **386** and **388** therein with conduit **382** connecting with the lower end of stationary hollow piston rod **47** and conduit **384** connecting with the upper end of stationary hollow piston rod **46**, so by manipulation of valve **360**, the hydraulic fluid can be either directed into conduit **382** or into conduit **384** to move the plunger of the air control cylinder **380**, so the pump **72** will deliver hydraulic fluid into either of the piston rods **46** or **47**, and at the same time, the hydraulic fluid is exhausted from the opposite end as has been brought out hereinbefore.

The variable pressure air control valve **362** will direct air from air lines **348** and **356** either into air line **390** or air line **392** at any desired pressure within the maximum pressure of the air line, and will direct air into an air cylinder **394** to actuate a conventional pipe slip **396** to grip the drill pipe **324** when the pipe is being run into or removed from the well in a manner well understood in the art of drilling.

With the aforementioned controls which may be operated remotely from the well being drilled, which controls can be operated by one man in a semi-automated and expeditious manner.

FURTHER MODIFIED FORM OF THE INVENTION

A further modified form of the invention is shown in FIGS. **12** and **13**, wherein the drilling rig, designated generally by the numeral **401**, is mounted on an amphibious vehicle **402**, which vehicle has pontoon type wheels **404** and **406** on the front and rear thereof to support the drilling rig **401**. The drilling rig uses the same components, that is, a mast **2**, the hydraulically driven drilling head and the swivel **10** which drives a spindle **10A** to which drill pipe **324** is attached. The tubular spindle **10A** directs fluid, either air or liquid, through connection **10B** to the bottom of the hole being drilled in a manner well known in the art of drilling. The reversible power driven drilling head **10** is supported on cables **20** and **22** or **220** and **222** in the manner set forth in the aforementioned forms of the invention, which drilling head moves upward and downward in the drilling mast **2** in the manner set forth for the aforementioned form of the invention, and as shown in detail in FIGS. **5** and **6**.

The prime mover **74** drives the air compressor **408** as well as hydraulic pumps **72**, **308** and **368** and an air compressor **346** is driven from the V-belt pulley within prime mover **74**. The pump **308** is also driven from a V-belt pulley **309** on the forward end of prime mover **74**. The air compressor **346** is driven by a pulley, indicated at **347** in FIG. **10**. The drilling rig, as shown in FIGS. **12** and **13**, is not enclosed, however, the height and diameter of wheels **404** and **406** together with the hollow body **407** makes it possible for the vehicle to navigate over snow, ice, sand and through water, to carry the rig to the location which is to be drilled by the drilling rig **401**.

The pipe handling boom **326** receives drill pipe **324** thereonto and is clamped in place by clamps **328**, as shown in FIG. **15**, by hydraulic pressure exerted by hydraulic cylinders **322** acting upon these clamps, and with the drill pipe **324** located in the correct longitudinal position with respect to the boom **326**, the boom may be moved from horizontal position to an upright position and the tubular spindle **10A** engaged with the upper end of the pipe **324** and the pipe lowered so that the threaded pin **325** will seat in the threaded box of the upstanding length of drill pipe **324**, as will best be seen in FIG. **12**, in a manner well known in the art of drilling. The slips **396** grip the pipe in such manner as to hold the pipe against rotation and against downward movement until released by actuator valve **362**. The slips **396** are well known components in the drilling art.

When air is used for circulation to remove the cuttings from the well and to cool the drill bit as it drills the bore hole, the compressor **408** is utilized to direct the air outward through conduit **412** to the swivel connection **10B** and thence downward through the swivel **10** and through the drill pipe **324** to be exhausted out through the bit (not shown) at the bottom of the well, while the drill bit is being rotated by motor **378** on power driven swivel or drilling head **10**. It is to be pointed out that all component parts of this rig are substantially the same as the component parts shown in the aforementioned form of the rig, except for modifications that have been specifically set out.

What is claimed is:

1. A portable drilling rig having a drill string comprising;

a. a base,

b. a prime mover mounted on said base,

c. an upstanding mast mounted on said base,

1. a fluid powered swivel mounted on said mast for movement longitudinally thereof in guided relation,

d. a fluid pump connected in driven relation with said prime mover,

e. a piston rod having two hollow portions, mounted longitudinally of and within said mast and having a fluid blockage therein between said hollow portions,

f. a movable fluid cylinder mounted on said hollow piston rod and being longitudinally movable with respect thereto,

1. packing means sealing the ends of said cylinder with respect to said hollow piston rod,

g. a piston mounted on said piston rod within the length of said fluid cylinder,

h. cable sheaves mounted on each end of said fluid cylinder,

i. further cable sheaves mounted near each end of said mast,

j. at least two cables connected to said fluid powered swivel and extending in opposite directions over said sheaves at each end of said mast and over said sheaves at each end of said cylinder, with a portion of said cable being restrained against substantial movement at each end of said mast,

k. pressure control means for directing fluid under pressure into said cylinder through on said portion of said hollow piston rod at one end thereof on one side of said piston and directing fluid under pressure out of said fluid cylinder on the other end of said piston and on the other side if said blockage in said hollow piston rod into the other said portion of said hollow piston rod to move said cylinder relative to said piston by fluid pressure so as to move said swivel longitudinally of said mast by means of said cables connected thereto.

2. A portable drilling rig, as defined in claim **1**; wherein

a. said piston rod and said cylinder are each in tension when fluid pressure is directed thereinto to lift a load.

3. A portable drilling rig as defined in claim **1**; wherein

a. said cable arrangement, connected to said swivel and to said movable fluid cylinder, is adapted to move said swivel a greater distance of travel than the distance traveled by said movable cylinder.

4. A portable drilling rig as defined in claim **1**; wherein

a. said cable arrangement, connected to said swivel and to said movable cylinder, is adapted to move said swivel at a greater speed than the speed of said movable cylinder.

5. A portable drilling rig as defined in claim **1**; wherein

a. said fluid under pressure is metered out of said movable cylinder to perform a braking action when going into the bore hole of a well.

6. A portable drilling rig as defined in claim **1**; wherein

a. said fluid under pressure is metered out of said cylinder by fluid control valves to obtain a controlled weight on the drill string.

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