

Feb. 13, 1968

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3,368,618

CONDUIT COUPLING WITH MULTIPLE FLUID LINES

Filed Oct. 3, 1963

2 Sheets-Sheet 1

FIG. 1.

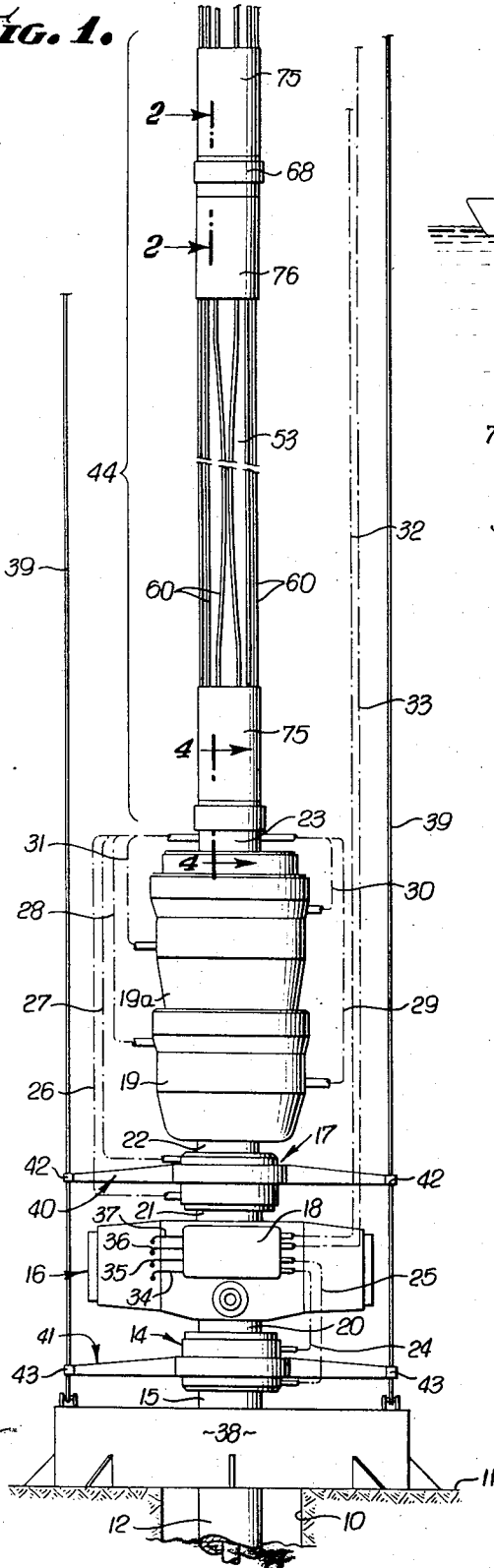


FIG. 1a.

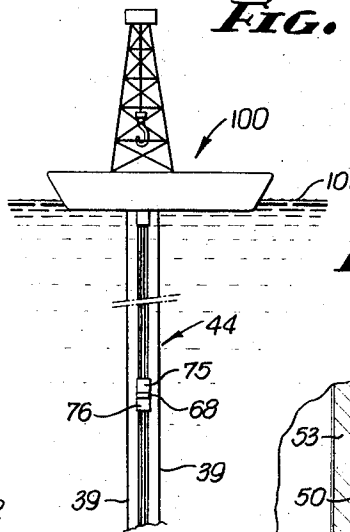
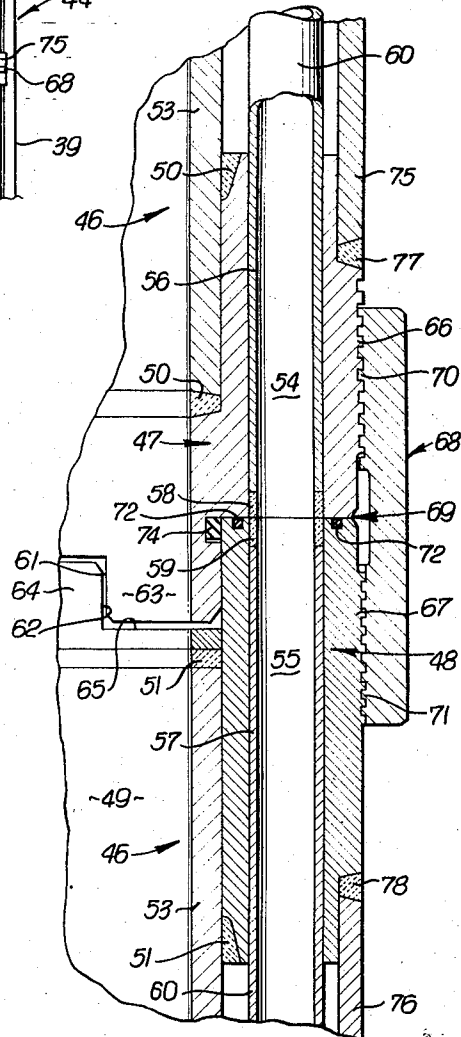


FIG. 2.



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FIG. 3.

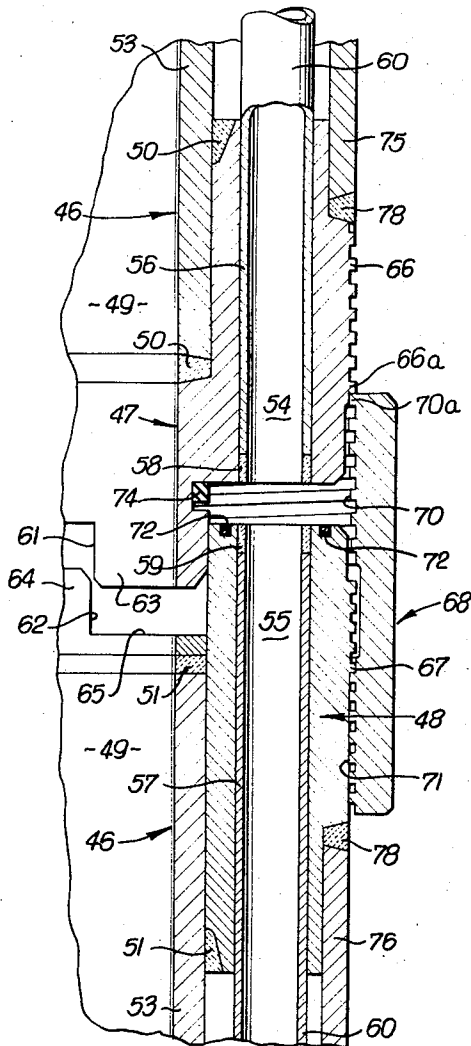


FIG. 4.

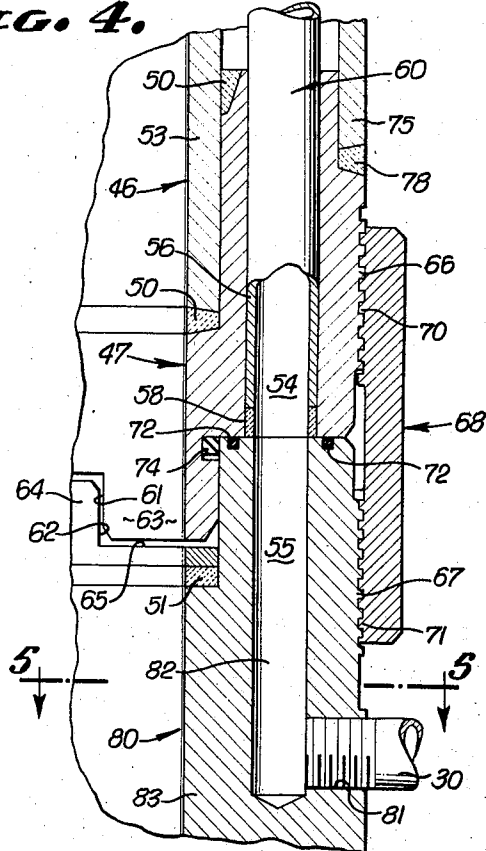


FIG. 6.

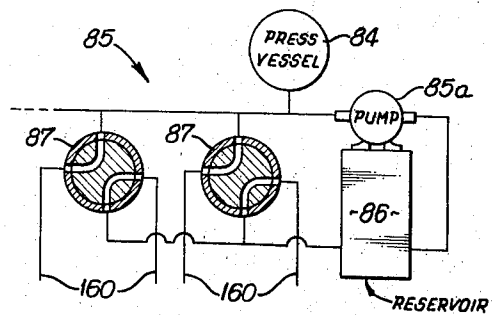


FIG. 5.

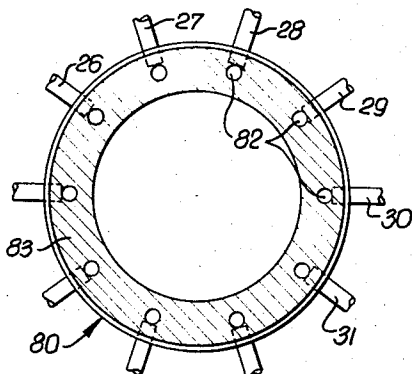
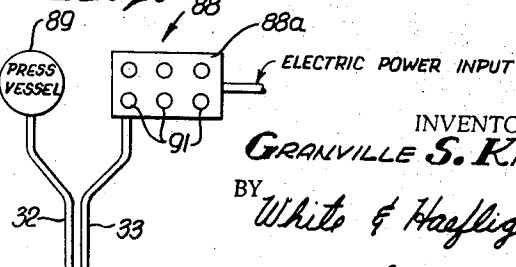


FIG. 7.



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CONDUIT COUPLING WITH MULTIPLE FLUID LINES

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16 Claims. (Cl. 166—5)

ABSTRACT OF THE DISCLOSURE

The disclosed invention concerns an underwater conduit string, the conduit having terminal flanges with ducts opening at the flanges, a differential thread connector being operable to draw the flange terminals together for bringing successive ducts into series communication. The conduit or well casing communicates with the well interior, and the ducts communicate pressure to underwater actuators. Also, the ducts may communicate with the actuators via radially outwardly opening delivery ports in a lower conduit and transfer pipes.

Background of the invention

This invention relates generally to underwater conduit strings, and more particularly concerns the provision of novel conduit members in an underwater string and having self-contained ducts transmitting fluid pressure from the surface to well head equipment at the ocean floor.

In certain underwater well drilling or producing operations it is desirable to service the well as by means of a tool or a string of tools connectible to a projecting well fitting, such as a submarine stub casing terminating above the ocean floor. As an example, where well casing has already been sunk in the submarine hole with the free end of the casing projecting above the ocean floor, it is desirable to provide for the controlled operation of well blowout prevention equipment, safety valves, safety joints or connectors, as well as other auxiliary apparatus, typically mounted on a frame and in a stack attached to the projecting well casing, in order to serve the well. Commercial equipment of this nature is generally fluid pressure operated, and it has heretofore been considered necessary to provide a bundle of separate pressure hoses extending underwater from a surface location to the tools so that independent operation thereof might be achieved as desired. However, the large number of hoses required to supply fluid pressure to multiple tools at the underwater well head creates problems such as the tendency of underwater currents to deflect pressure hoses, such deflection becoming greater as the size of the hose bundle increases, and such deflection creating further problems of entanglement with underwater equipment, the considerable weight of all the hoses particularly where the well head is several hundred feet below the ocean surface, and the tendency of the water pressure at greater depths to collapse, or seriously distort, the flexible hoses prior to filling with hydraulic fluid. Also, the greater the number of fluid pressure lines, the greater is the risk of rupture of one or more such lines, leading to costly stoppages in drilling or producing operations.

Summary of the invention

The present invention offers a solution to these and other problems through the elimination of, or at least in a substantial reduction of, the number of long pressure hoses independently serving different tools in a stack at the underwater well head. For this purpose, the invention concerns the provision of novel means to interconnect conduit members for use in an underwater string in com-

ination with underwater well head equipment including fluid pressure responsive actuators, the string of conduits being installable to extend downwardly to the well head zone for communication with the well interior. In this regard, each conduit member typically has end terminals, such as annular flanges, and multiple ducts opening at the terminals outside the conduit bore for transmitting pressure to operate the actuators. Also, the invention includes differential thread connector structure at the terminal portions or flanges for transmitting conduit coupling force by which successive of the conduits in the string are brought into made-up condition characterized in that corresponding ducts in successive conduits are brought into series communication.

More specifically, the conduits are formed so that minor lengths of the ducts at each conduit are contained by the terminal flanges, whereas major lengths of the ducts comprise typically stretchable pipes extending outside lengthwise extent of the conduit which is characterized as having reduced outer diameter in relation to the outer diameters of the terminal flanges. In this regard, the pipes are typically anchored at the end flanges, and are somewhat bowed between the flanges.

Additional features of the invention include the provision of a novel combination of such conduits connected in such operative relation with the underwater well head equipment as to very simply and effectively transmit and distribute the fluid pressure from the conduit ducts to certain of the well head equipment. Thus, the means for coupling together successive conduits to bring corresponding ducts therein into series communication preferably includes differential threads on adjacent terminal flanges and a collar spanning the joint between the flanges with collar threads engaging said flange threads for drawing the flanged terminals toward one another as the collar is rotated about the joints. Also, one of the conduits at a lower portion of the string has a series of generally radially outwardly opening pressure delivery ports respectively communicating with the ducts therein, the underwater equipment including transfer pipes for delivering from the ports fluid pressure which is intended to operate certain of the well head equipment or actuators. In this connection, a number of 4-way valves in a control manifold, located at the surface, serve to direct fluid pressure through the conduits and transfer pipes to operate certain of the blow-out preventers and other tools in the underwater well head stack.

Other features of the invention include provisions for a separate hydraulic control for operating a certain of the tools in the underwater stack. The separate control system may include a remotely controlled electrically responsive control manifold attached to a part of the underwater stack with a pressure supply line and electric cable extending from the underwater control manifold to suitable hydraulic and electric controls located at the surface. This provides a dual control system that is particularly advantageous because it then becomes possible to disconnect certain tools from the underwater stack so that they may be brought to the surface as needed for making adjustments and repairs while the remaining tools in the underwater stack are controllable through the electrically responsive control manifold to properly service the well.

These and other objects and advantages of the invention, as well as the details of an illustrative embodiment, will be more fully understood from the following detailed description of the drawings, in which:

FIG. 1 is an elevation showing a stack of well servicing tools at a submarine well head location, and a string of end-to-end connected conduit members above the stack;

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FIG. 1a shows means for running the conduit string at the surface;

FIG. 2 is an enlarged fragmentary section taken on line 2—2 of FIG. 1;

FIG. 3 is a view like FIG. 2, but showing the conduit members at an intermediate stage during their interconnection;

FIG. 4 is an enlarged fragmentary section taken on line 4—4 of FIG. 1;

FIG. 5 is a full cross-section taken on line 5—5 of FIG. 4 and through the string;

FIG. 6 shows means at the surface to control pressure transmission through the conduit member ducts; and

FIG. 7 illustrates another control means at the surface to operate a subsurface fluid pressure directing unit on the equipment string.

In FIG. 1 a drill hole 10 sunk beneath the ocean floor 11 contains a string of casing 12 cemented or otherwise fixed in position for further suitable drilling or producing operations. Drill pipe or tubing is shown at 13 extending downwardly through the casing string.

The submarine well head equipment includes a lower connector unit 14 releasably fastened onto the casing stub 15 projecting upwardly. In the sequence above unit 14 are a double master gate 16, another connector unit 17, a pressure distributing unit 18, and blowout preventers 19 and 19a, intermediate tubular stubs or extensions being indicated at 20, 21, 22 and 23. Stubs 20 and 21 are typically integral with the master gate 16, whereas, the connector 17 is releasably attached to stub 21. The connectors may be of the type disclosed in U.S. Patent No. 2,962,096 to Knox; the unit 18 may be of the type disclosed in Lewis application for U.S. Letters Patent, Ser. No. 165,742, filed Jan. 12, 1962, now Patent No. 3,219,118; and the blowout preventers may be of the type disclosed in U.S. Patent No. 2,609,836 to Knox. Thus, the connectors and preventers may be considered as fluid pressure responsive actuators, pressure transfer pipes to connector 14 from unit 18 being indicated at 24 and 25. Also pressure transfer pipes to connector 17 and to preventers 19 and 19a are respectively indicated by the pairs of numerals 26 and 27, 28 and 29, and 30 and 31. Pressure is typically supplied through unit 18 to connector 14 via auxiliary hose line 32, and electrical signals are transmitted to unit 18 via cable 33. A suitable pressure vessel seen at 39 in FIG. 7 supplies pressure through hose 32 to control unit 18, which directs fluid via transfer pipes 34, 35, 36 and 37 to the double master gate 16, and to the connector 14 via transfer pipes 24 and 25.

To complete the general description of FIG. 1, the numeral 38 designates the base of a frame for the well head equipment stack, the frame also including guide lines 39 attached to the base and transverse members 40 and 41 attached to the connectors and interconnecting the guide lines at vertically spaced locations. The guide lines extend to the surface and the members 40 and 41 have slidable connection therewith at 42 and 43 for guiding the connectors downwardly into position as shown. If the connector 14 is released from the stub 15, it and the equipment thereabove may be elevated to the surface as the conduit string generally indicated at 44 is run upwardly. Alternatively, if the connector 17 is released from stub 21, it and the equipment above unit 16 may be elevated as conduit string 44 is run upwardly. Conversely, the well head equipment is run downwardly by adding lengths of conduit to the string at the surface, as by suitable means seen at 100 above the ocean surface 101 in FIG. 1a. The conduit or casing as shown in FIG. 1 extends downwardly to the well head to communicate with the well interior.

Coming now to a description of the conduit string 44, the conduit members are generally shown at 46 in FIG. 2 connected in end-to-end series relation. Each conduit has an end terminal portion 47 at the lower end thereof,

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and an upper end terminal portion 48, such portions typically comprising flanges extending annularly about the conduit bore 49. Furthermore, flanged terminals are typically connected as at the welding locations 50 and 51 with the conduit reduced diameter extents 53 which form the bore 49. The latter extents 53 comprise the major lengths of the conduits as is more clearly seen in FIG. 1 and they are characterized as being somewhat flexible in an elongated string in order to deflect in response to underwater current or wave side loading.

It will be seen in FIG. 2 that the end terminals or flanges 47 and 48 have ducts 54 and 55 opening proximate the terminals outside the string bore, and that means is provided for coupling the successive conduits in made-up condition characterized in that the successive ducts 54 and 55 are brought into series communication at the terminals. Typically, multiple ducts are formed in the end flanges at spaced locations about the axis of the conduit string. More specifically, certain portions of the ducts are contained by the flanges and are formed by piping extensions 56 and 57 which are anchored into the flanges as by welding 58 and 59. Other portions of the ducts comprise the major lengths of the piping 60 exposed to the exterior along and outside the conduit major lengths, as better seen in FIG. 1. In this regard, the major lengths of the conduits 53 have reduced outer diameter in relation to the outer diameters of the annular flanges 47 and 48. Reference to FIG. 1 will show that the pipes 60 are bowed along their lengths to be capable of stretching to lesser bowed condition without rupture, and during flexing of the conduit members in response to underwater wave or current action.

Extending the description to FIG. 3, it will be seen that one form of means is illustrated for coupling the successive conduits in made-up condition and for bringing corresponding ducts in successive conduits into series communication by forcibly drawing the flanges toward one another. Such means includes guide shoulders 61 and 62 on tongue and grooved extents 63 and 64 of the upper and lower conduit members acting to resist relative rotation thereof as the flanges are brought together. For example, as the lower flange of the upper conduit member is stabbed downwardly toward the upper flange of the lower conduit member, the tongue 63 pilots into the groove 65 with the guide shoulders 61 and 62 proximate each other to resist relative rotation of the conduits such as would tend to misalign the ducts 54 and 55.

The said means for coupling the successive conduits also includes, as illustrated, differential pitch threads 66 and 67 on the flanges 47 and 48, as well as a collar 68 spanning the joint 69 between the flanges. The collar has threads 70 and 71 to interengage the flange threads 66 and 67 for drawing the flanged terminals toward one another as the collar is rotated about the joint. In this regard, the collar has a retracted position, better seen in FIG. 3, in which the upper flange 47 has its lowermost thread 66a seated on the uppermost thread 70a of the collar. In this position, the threads on the upper flange and collar are out of mesh, but the pilot tongue 63 has partially entered the groove 65 as shown. The advanced position of the collar is seen in FIG. 2, and is characterized in that the collar has been rotated about the joint to draw the upper and lower flanges 47 and 48 into forcible endwise interengagement by meshing of the threads on the upper flange and the collar. The differential pitch feature of the threads 66 and 67 enables the forcible drawing together of the flanges as the collar is rotated, and also enables rapid de-coupling of the conduit members when the conduit string is elevated and removed.

FIGS. 2 and 3 also show means such as O-rings 72 sealing off around the open ends of ducts 54 and 55 of successive conduits at the interface or joint 69 therebetween. An annular bore seal 74, carried by an annular extent of tongue 63, provides a positive seal between the flanges 47 and 48. FIGS. 2 and 3 also show cylindrical

members 75 and 76 weld connected at 77 and 78 to the flanges 47 and 48 respectively. The members 75 and 76 project axially for some distance along the conduit members in protective relation about the piping 60.

Extending the description to FIGS. 4 and 5, it will be seen that a terminal conduit 80, connectible at upper and lower ends of the string, has a series of generally radially outwardly opening delivery ports 81 respectively communicating with the ducts in the intermediate conduits as through passages 82 in the one conduit 80. The latter may typically comprise an annular extension on the uppermost member in the underwater equipment stack previously described, the portion of the stack or extension being indicated at 83 in FIG. 4. The ports 81 are placed into communication with the underwater equipment in the stack through transfer pipes 26-31, previously referred to, one of such transfer pipes being indicated at 30 in FIG. 4. Accordingly, the transfer pipes are then able to deliver fluid pressure from the ducts in the conduit string, so as ultimately to actuate the actuators in the stack under the control of the operator at the surface. FIG. 6 shows a control means 85 at the surface for selectively transmitting fluid pressure to the ducts 60 from a pressure vessel 84 which is charged by means of a pump 85a, the latter being in turn supplied with fluid from a reservoir 86. A number of 4-way valves 87 at the surface serve to direct fluid through lines 160 to delivery ports 81 in the upper terminal conduits and through the ducts 60 to and from pipes 26-31.

FIG. 7 shows a second control means 88 at the surface comprising an electric control panel 88a and a pressure vessel 89 connected to subsurface pressure distributing unit 18 by hose 32 and multiple conductor cable 33. The distributing unit 18 operates in response to electrical impulses directed by push buttons 91 to control operation of valves in unit 18 for selectively supplying pressure to actuators associated with the connector 14, and master gate 16, as referred to above.

From the foregoing it will be seen that most of the fluid pressure hoses formerly required for operating the underwater equipment at the well head are eliminated, along with the risk of rupture thereof, and that the present invention makes possible the controlled operation of the underwater equipment 17, 19 and 19a through the transmission of fluid pressure at the principal conduit therein. Accordingly, the tools 19 and 19a may be disconnected from the underwater stack, by release of upper connector 17, and then raised to the surface for adjustment and repair, all without disturbing the remaining tools such as master gate 16. The latter continues to be independently operable from the surface via the control seen in FIG. 7. Therefore, it is clear that a highly unusual and beneficial dual control system is provided, with only one fluid pressure hose being required.

I claim:

1. In combination with underwater well head equipment including fluid pressure responsive actuator means, an underwater conduit string extending downwardly to the well head to communicate with the well interior, successive conduits in the string having terminal flanges and ducts opening at the flanges outside the string bore for transmitting actuator pressure fluid, certain portions of the ducts being contained by said flanges and other portions of the ducts comprising piping extending outside reduced diameter lengthwise extents of the conduits, and means for coupling said successive conduits in made-up condition characterized in that successive ducts are brought into series communication at said terminals, said last named means also including differential threads on said flanges and a collar spanning the joint between said flanges and having threads to interengage the flange threads for drawing the flange terminals toward one another as the collar is rotated about said joint.

2. The combination of claim 1 including remotely

controllable valve means communicating with said ducts to control the delivery of fluid pressure to an upper actuator in a stack of said underwater equipment, and other means independently to control the delivery of fluid pressure to a lower actuator in said stack, said other means including a separate pressure line extending downwardly from the surface toward said underwater stack.

3. In combination with underwater well head equipment including fluid pressure responsive actuator means, an underwater conduit string extending downwardly to the well head to communicate with the well interior, vertically successive conduits in the string having annular terminal flanges and ducts opening at the flanges outside the string bore for transmitting actuator pressure fluid, and means for coupling said successive conduits in made-up condition and for bringing corresponding ducts in successive conduits with series communication by forcibly drawing said flanges toward one another, said last named means including guide shoulders carried by said conduit members to resist relative rotation thereof as the flanges are drawn together, said last named means also including differential threads on said flanges and a collar spanning the joint between said flanges and having threads to interengage the flange threads for drawing the flange terminals toward one another as the collar is rotated about said joint.

4. The combination of claim 3 including means sealing off between end flanges of successive conduits at the joint therebetween, and at annular locations inwardly and outwardly of said ducts.

5. The combination of claim 3 wherein the collar has a retracted position in which the upper flange has an unthreaded pilot portion stabbed downwardly into the collar with the threads on the upper flange and collar out of mesh, and an advanced position in which the upper and lower flange terminals are drawn into forcible endwise interengagement by meshing of said threads on the upper flange and collar.

6. The combination of claim 3 in which minor lengths of the ducts at each conduit are contained by the flanges, and major lengths of the ducts at each conduit comprise pipes extending outside lengthwise extents of the conduit characterized as having reduced outer diameter in relation to the outer diameters of said flanges.

7. The combination of claim 6 in which said pipes are bowed along their lengths to be capable of stretching to lesser bowed condition without rupture.

8. The combination of claim 6 in which said pipes are anchored at said flanges.

9. In combination with underwater well head equipment including fluid pressure responsive actuator means, an underwater conduit string extending downwardly to the well head to communicate with the well interior, vertically successive conduits in the string having annular terminal flanges and ducts opening at the flanges outside the string bore for transmitting actuator pressure fluid, and means for coupling said successive conduits in made-up condition and for bringing corresponding ducts in successive conduits into series communication by forcibly drawing said flanges toward one another, said last named means including guide shoulders carried by said conduit members to resist relative rotation thereof as the flanges are drawn together, one of said conduits at a lower portion of the string having a series of generally radially outwardly opening delivery ports respectively communicating with the ducts in said one conduit, said underwater equipment including transfer pipes for delivering fluid pressure communicated to said ports so as ultimately to actuate said actuator means.

10. The combination of claim 9 including remotely controllable valve means communicating with said transfer pipes to control the delivery of fluid pressure to selected actuators.

11. For combination with underwater well head equip-

ment including fluid pressure responsive actuator means, a conduit string adapted to extend underwater and downwardly to a well head to communicate with the well interior, successive conduits in the string having annular terminal flanges with end terminals and ducts opening proximate said terminals outside the string bore for transmitting actuator pressure fluid, and means for coupling said successive conduits in made-up condition characterized in that successive ducts are brought into series communication at said terminals, said last named means including differential pitch threads on said flanges and a collar spanning the joint between said flanges and having threads to interengage the flange threads for drawing the flange terminals toward one another as the collar is rotated about said joint.

12. For combination with underwater well head equipment including fluid pressure responsive actuator means, a conduit string adapted to extend underwater and downwardly to a well head to communicate with the well interior, successive conduits in the string having annular terminal flanges and ducts opening at the flanges outside the string bore for transmitting actuator pressure fluid, and means for coupling said successive conduits in made-up condition and for bringing corresponding ducts in successive conduits with series communication by forcibly drawing said flanges toward one another, said last named means including guide shoulders carried by said conduit members to resist relative rotation thereof as the flanges are drawn together, said last named means including differential pitch threads on said flanges and a collar spanning the joint between said flanges and having threads to interengage the flange threads for drawing the flange terminals toward one another as the collar is rotated about said joint.

13. The string as defined in claim 12 wherein the collar has a retracted position in which the upper flange has an unthreaded pilot portion stabbed downwardly into the collar with the threads on the upper flange and collar out of mesh, and an advanced position in which the upper and lower flange terminals are drawn into forcible endwise interengagement by meshing of said threads on the upper flange and collar.

14. The string as defined in claim 12 in which one

of said conduits at a lower portion of the string has a series of generally radially outwardly opening delivery ports respectively communicating with the ducts in said one conduit, said underwater equipment including transfer pipes for delivering fluid pressure communicated to said ports so as ultimately to actuate said actuator means.

15. A conduit member for use in an underwater string of like conduit members in combination with underwater well head equipment including fluid pressure responsive actuator means, the string being adapted to extend downwardly to the well head zone for communication with the well interior, said conduit member having endwise spaced annular terminal flanges and ducts opening at the flanges outside the conduit bore for transmitting operating pressure, and connector structure at said flanges for transmitting coupling force by which successive conduits are brought into made-up condition characterized in that corresponding ducts in successive conduits are brought into series communication, minor lengths of the ducts being contained by the flanges, and major lengths of the ducts comprising pipes extending outside lengthwise extent of the conduit member characterized as having reduced outer diameter in relation to the outer diameters of said flanges, said pipes being bowed along their lengths to be capable of stretching to lesser bowed condition without rupture.

16. The conduit of claim 15 in which said pipes are anchored at said flanges.

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