

Apparatus for remote hydraulic control of a subsea well device

Background of the invention

This invention relates to apparatus for hydraulic control of a subsea well device, and more particularly to hydraulic apparatus for the individual control of a relatively large number of subsea operators of a well device using only a few hydraulic pressure source lines from a surface vessel to the seafloor.

Description of the prior art

The production of oil and gas from offshore wells has developed into a major endeavour of the petroleum industry. Wells are commonly drilled several hundred or even several thousand feet below the surface of the ocean, substantially beyond the depth at which divers can work efficiently. As a result, the drilling of a well, completing pipeline connections, operating of a subsea well and performing other subsea tasks must be controlled from a surface vessel or from an offshore platform. The testing, production and shutting down of the subsea well is regulated by a subsea Christmas tree which is positioned on top of the subsea wellhead. The Christmas tree includes a plurality of valves having operators which are biased to a non-active position by spring returns, and it has been found convenient to actuate these operators by hydraulic fluid which is directly controlled from the surface vessel. For this purpose, a plurality of hydraulic lines are commonly run from the surface vessel to the wellhead to open and close these valves, and to actuate other devices in the well and the wellhead during installation, testing, and operating the subsea well equipment, and also during work over procedures being performed on the well.

A plurality of relatively short flowline loops are connected to the Christmas tree before the tree is lowered into place atop the wellhead, with the free ends of the flowline loops gathered together and supported above the seafloor to facilitate connecting them to one or more flowlines that extend to a remote collecting or storage facility. Once the Christmas tree has been installed on the wellhead, the flowline or flowline bundle is pulled across the seafloor into alignment with the flowline loops so that it and the flowline loops can be connected together in a fluid-tight manner. Hydraulic lines from the surface vessel provide power to actuate hydraulic operators which move the flowline bundle into a fluid-tight connection with the flowline loop.

In some of the prior art systems a separate hydraulic line is run from the surface vessel to each of the hydraulically powered devices at the seafloor. Some of these hydraulic lines may be run through a riser, but for many of the subsea operations the riser is too small to contain all of the lines required. A common solution is to

employ additional hydraulic lines that are stored on a reel located on the surface vessel, the line being made up into a hose bundle that is connected to the outside of the drill pipe or riser and lowered therewith to the seafloor. However, such a hose bundle is expensive, and is heavy and cumbersome to handle simultaneously with the drill pipe or riser, particularly in deep water. Also a relatively large number of hydraulic lines requires a relatively large hose reel which uses a considerable amount of storage space on a work boat having a limited amount of space. By reducing the number of hydraulic lines required to control the hydraulic devices the size of the hose reel is reduced which provides a savings in weight and in the space required on the surface vessel.

It is known from U.S. Patent No. 3,894,560 to provide apparatus for the remote individual control of a plurality of hydraulically-actuated subsea operators using a number of hydraulic lines between a surface control center and a subsea well device containing said operators, said number of hydraulic lines being less than the number of operators.

In this patent, a single hydraulic control signal line is connected to a multiple pressure responsive valve to deliver a variable fluid input signal to the multiple pressure responsive valve from which output signals are supplied for actuating the operators.

Again, from U.S. Patent No. 3,993,100 it is known to utilise a single hydraulic control signal line which controls a reference hydraulic manifold providing a reference pressure and a signal hydraulic manifold providing various control pressures, the manifolds being connected to the operators of the subsea well device to actuate the operators in dependence on the pressure differences applied thereto by applying a predetermined sequence of predetermined pressure levels to the single control signal line. This document represents the prior art part of independent claims 1 and 13.

The present invention seeks to achieve a high degree of flexibility of control of a greater number of subsea operators, by utilising more than one hydraulic control signal line, although substantially less than the number of operators, in a simple and effective manner.

According to the invention there is provided a first and a second hydraulic signal line and a hydraulic power line, a plurality of hydraulic AND-gates each having first and second signal inputs and a power line input and an output, said gates being arranged in a matrix of rows and columns, control means for coupling predetermined values of fluid pressure from a fluid source to said first and said second signal lines, valve means for applying signals from said first signal line to the first input of each of the gates in a predetermined column when the

pressure in said first signal line is within a corresponding predetermined range, and valve means for applying signals from said second signal line to the second input of each of the gates in a predetermined row intersecting with the predetermined column when the pressure in said second line is within a corresponding predetermined range, the output of each of said gates being connected to a corresponding one of said operators.

The use of gates in the control art is well known and by way of example U.S. Patent No. 3,503,423 describes a system for selecting at least one of three or more fluid input signals of different pressure by the use of fluidic logic means including gates.

More specifically and in accordance with one embodiment of the invention a plurality of hydraulic AND-gates and other control apparatus is mounted adjacent the hydraulically-actuated subsea operators at the sea floor. Only two hydraulic signal lines and a hydraulic power line are connected between a surface control center and a subsea well device which contains the operators. When low pressure subsea operators are used the hydraulic power line can be omitted and the operators powered by one of the signal lines.

The hydraulic AND-gates each having an output and a pair of inputs, are arranged in rows and columns. The signal lines are each coupled to a source of pressurized hydraulic fluid by a corresponding pressure control means which provides the required signal pressure to the signal lines. A plurality of pressure sensitive valves connected between a first one of the signal lines and a first one of the inputs of each of the AND-gates provide an "enable" signal to each of the gates in a predetermined column when a predetermined value of pressure is applied to the first signal line. Another plurality of pressure sensitive valves connected between a second one of the signal pressure lines and a second one of the inputs of each of the AND-gates provide another signal to each of the gates in a predetermined row when a predetermined value of pressure is applied to the second signal line. By applying the proper pressures to the two signal lines a predetermined AND-gate at the intersection of a predetermined row and a predetermined column is enabled and the subsea operator which is connected to the output of the enabled AND-gate is actuated.

According to another aspect the present invention provides apparatus for the remote individual control of a plurality of hydraulically actuated subsea operators using a number of hydraulic lines between a surface control center and a subsea well device containing said operators, said number of hydraulic lines being less than the number of operators, said apparatus being characterised by said hydraulic lines comprising a first and a second signal line and a power line providing a hydraulic source, and further characterised by a multiple-position

switching valve having an inlet port and a plurality of outlet ports, control means for selectively coupling said inlet port of said multiple-position switch to said hydraulic source, a multiple-section multiple-mode switching valve having a plurality of inlet ports and a plurality of outlet ports, each of said inlet ports of said multiple-section valve being coupled to a corresponding one of said outlet ports of said multiple-position valve, each of said outlet ports of said multiple-section valve being connected to one of said operators, a switch in one said pressure line for selectively switching said multiple-position valve into a selected position, and a switch in the other said pressure line for selectively switching said multiple-section valve into a selected mode to couple a selected operator to said inlet line of said multiple-position valve.

Brief description of the drawings

Figure 1 is a diagrammatic view, partly in elevation and partly in perspective, with portions broken away, of a subsea wellhead system in which the apparatus of the present invention is used.

Figure 2 is a schematic of the gate and valve circuitry of the present invention.

Figure 3 is a diagrammatic view of a matrix showing the operators which can be controlled by using two signal pressure lines each operating at five discrete levels or positions.

Figure 4 is a diagrammatic view of an operational matrix having rows and columns separated by inactive zones.

Figure 5 comprises a schematic of the AND-gates used in Figure 2.

Figure 6 comprises a schematic of a portion of the circuitry of Figure 2 showing operation of the AND-gates and showing their connections to an actuator.

Figure 7 comprises a schematic of a circuit for sending operator status from the sea floor to a surface control unit.

Figure 8 comprises a schematic of another embodiment of valve circuitry of the present invention.

Figure 9 is a diagrammatic view of a matrix showing the operators which can be controlled by the circuit of Figure 8.

Description of the preferred embodiment

Figures 1 and 2 diagrammatically illustrate hydraulic apparatus according to the present invention for controlling many valves or other subsea well operators while using only a few hydraulic pressure source lines. As illustrated in Figure 1, the invention can be employed with a completion/workover riser or other type of riser 11 having its upper end connected to a control center 12 on a surface vessel 13, and its lower end connected to a valve container 16 that is mounted on a subsea guidebase diagrammatically illustrated at 17. The guidebase 17 includes a main guidebase 17a with a plurality

of guideposts 18, and an ancillary guidebase 17b that is welded or otherwise connected to the guidebase 17a.

A subsea Christmas tree assembly 19 includes a plurality of sleeves 21 which are each guided into working position on the guideposts 18 as the assembly 19 is lowered to the seafloor. A first end of a flowline 22 is connected to a Christmas tree 23, and a second end of the flowline is connected to a flowline connector 26 that is positioned at the end of an alignment funnel 27. The alignment funnel can be connected to the ancillary base 17b by welding or other suitable means. A flowline bundle hub 26b, connected on the end of a flowline 28, is guided into axial alignment with the connector 26 by the alignment funnel 27, and the hub 26b is secured to the connector 26 to connect the flowlines 22 and 28 together in a fluidtight manner. A pair of hydraulic rams 31a, 31b, mounted on the funnel 27, provide means for locking the flowline bundle hub 26b in position for connection to the flowline connector 26, and power to operate the hydraulic rams is controlled by the valves in the valve container 16. These valves in container 16 also control a plurality of valves 32a-32c mounted on the Christmas tree 23 as well as other Christmas tree valves not shown.

Extending along the riser 11 between the valve container 16 (Fig. 1) and the vessel 13 are a pair of hydraulic signal lines A, B and a hydraulic power line P. The upper ends of each of the signal lines A, B are connected to a corresponding one of a pair of flow control units 35, 36, and each of the flow control units is connected to a pump 37 or other source of pressurized fluid by one of a pair of hydraulic switches 40, 41. A pair of pressure gages 45, 46 monitor the fluid pressure in the signal lines A, B, respectively. The upper end of the power line P is connected directly to the pump 37 by a hydraulic switch 42. The lower ends of the hydraulic lines A, B, P are connected to a plurality of AND-gates G1-G25 (Fig. 2) and to a plurality of valve-pairs V1-V10 mounted in the valve container 16 (Fig. 1). A plurality of outlets O1-O25 (Fig. 2) of the AND-gates G1-G25 are each connected to operators (not shown) which are used to open and close valves, connect and disconnect tree caps, control pods, etc. and provide installation, testing and operation of the well.

The schematic diagram of Figure 2 discloses hydraulic circuitry for controlling a total of twenty-five subsea operators using only two hydraulic signal lines and one hydraulic power line between the hydraulic pump 37 (on the surface vessel) and the valve-pairs V1-V10 (located on the seafloor). If desired, a third hydraulic signal line can be added to this circuit, thereby facilitating the operation of many more AND-gates and the resulting control of many more operators.

The number of operators which can be con-

trolled by two signal lines is diagrammatically illustrated in the matrix of Figure 3 where a first signal controls the level or position in the columns of the matrix and a second signal controls the level or position in the rows of the matrix. The total number of functions which can be obtained and the number of operators which can be controlled is determined by the formula $N_f = N_l(N_s)$, where N_f = the number of functions, N_l = the number of levels of signals, and N_s = the number of signal lines. While the matrix of functions shown in Figure 3 serves to illustrate the fundamental use of two signals at a plurality of levels to control a plurality of operators, the practical use of such a matrix encounters some problems. For example, in order to reach the function 34 shown in the matrix of Figure 3 it is necessary to pass through at least two other functions and to actuate operators which perform at these levels. This may not be desirable or practical.

A more practical solution is to provide a function-selection matrix of the type shown in Figure 4 where each of the function rows and columns of the matrix is separated from the nearest function row or column by a non-functional row or column. There is no actuation of any subsea operators in columns M, O, Q, S and U or in rows C, E, G, I and K. The only "function areas" where subsea operators are actuated are the shaded areas shown in Figure 4. This permits movement through the non-functional rows and columns to any one of the shaded function areas without passing through any of the other function areas. For example, signal A (Fig. 4) can be increased to a value of approximately 1850 psi and held at this level while signal B is increased to a value of approximately 1100 psi to move the operation to the non-functional area FS, as shown by the dotted line 49. Increasing the signal A to 2100 psi then moves the operation to the shaded area FT and actuates the operator at the function FT without actuating any other operators during the level changing process.

Hydraulic circuitry to implement the function selection diagram of Figure 4 comprises a plurality of hydraulic AND-gates G1-G25 (Fig. 2) each having a pair of input leads AL1-AL5, BL1-BL5, a pressure input lead R1-R25 and an output lead O1-O25, and a plurality of hydraulic valve-pairs V1-V10 each having an input lead A1-A5, B1-B5, an output lead AL1-AL5, BL1-BL5 and a pilot lead P1-P10. Each of the valve pairs (Fig. 2) includes a pressure relief valve PR1-PR10 and a pressure sensitive pilot valve PS1-PS10 connected in series to provide a hydraulic switch that is open between a predetermined lower pressure limit and a predetermined upper pressure limit. For example, the valve pair V1 includes the relief valve PR1 which is open when the pressure at the input A1 is above 500 psi, and the pilot valve PS1 which is open when the pressure on the pilot lead P1 is below 700 psi so



that fluid is coupled from the input A1 to the output AL1 when the fluid pressure on signal line A is between 500 psi and 700 psi. At all pressures below 500 psi and above 700 psi the valve-pair V1 is closed. The other valve-pairs V2—V10 are each open between the corresponding upper and lower pressure limits shown on the circuit of Figure 2. A check valve 50 connected in parallel with each of the pressure relief valve aids in relieving pressure across the relief valve when the pilot valve opens. The outputs of the valve-pairs V1—V10 are connected to inputs of the hydraulic AND-gates G1—G25 with the outputs of the valve-pairs V1—V5 connected to one input of each of the gates which are arranged in vertical columns and the outputs of the valve-pairs V6—V10 connected to an input of each of the gates as arranged in horizontal rows.

All of the valves in Figures 2 and 5—7 are shown in the deenergized or relaxed position. Each of the pressure sensitive pilot valves is held in the deenergized position by a spring S until the pressure on the pilot line rises above the switching pressure. When the pilot line pressure exceeds the switching pressure the valve moves against the spring and into the energized position. For example, the pressure sensitive valve PS2 (Fig. 2) is held in the open position shown, by the spring S, until the pressure on the pilot line exceeds 1200 psi (82.74 kPa). Above 1200 psi (82.74 kPa) the valve moves upward against the spring S causing the valve PS2 to close.

Each of the AND-gates G1—G25 (Fig. 2) comprises a pair of pressure sensitive pilot valves, such as valves 53a, 53b shown in gate G1 of Figure 5 with valves 53a, 53b connected in series between the pressure input lead R1 and the output lead O1, with the pressure input lead R1 (Fig. 5) being connected to the hydraulic power lead P (Fig. 1) and the output lead O1 being connected to a subsea operator. The AND-gate of Figure 5 is shown with both of the pilot valves in the deenergized position. When signal pressure is applied to both of the pilots PL1, PL2 (Fig. 5) the valves each move upward against the springs SP1, SP2 to the energized position and connect the input lead R1 through the lower portion of valves 53a, 53b to the output lead O1.

Returning to the above example where the operator is associated with the shaded area of Figure 4, the operating procedure is to increase the pressure on signal line A (Figs. 1 and 2) by closing the switch 40 (Fig. 1) until the pressure on line A is approximately 1850 psi (127.55 kPa) as read on the meter 45. This places operation of the system in column S (Fig. 4) along line 49. Closing the switch 41 (Fig. 1) and monitoring the gage 46 until the gage 46 reads approximately 1100 psi (75.84 kPa) moves the operator into the intersection of column S and row F (Fig. 4). An increase of pressure on line A to 2100 psi (144.79 kPa) by closing the switch

40 (Fig. 1) moves the operation into the shaded area FT at the intersection of column T, row F (Fig. 4). At a pressure above 2000 psi (137.90 kPa) on line A the pressure relief valve PR4 (Fig. 2) is open, and at a pressure below 2200 psi (151.68 kPa) the pressure sensitive pilot valve PS4 is open, so that at a pressure of 2100 psi (144.79 kPa) pressurized fluid is coupled from line A through the valve-pair V4 to the AL4 input of AND-gates G16—G20. The pressure of 1100 psi (75.84 kPa) on signal line B causes the pressure relief valve PR7 to be open, and since the pressure sensitive pilot valve PS7 is open below 1200 psi (82.74 kPa) pressurized fluid is coupled from line B through the valve-pair V7 to the BL2 input of the AND-gates G2, G7, G12, G17 and G22. The signals on inputs AL4 and BL2 enable the AND-gate G17 and connects the pressure input lead R17 through gate G17 to the output O17 where an operator (not shown) connected to the output O17 is actuated.

Details of the connection of the AND-gates and of the means for using the AND-gates to open and close subsea operators are shown in Figure 6 where portions of the circuitry of Figures 2 and 5 are also shown. The circuit (Fig. 6) includes a two-position four-way pilot valve 54 which remains in one of the two positions until moved by pressure applied to the opposite pilot. When a signal pressure is applied to a pilot 55a the valve moves into the open position which interconnects the actuator 58 and the hydraulic power line P as shown in Figure 6. The valve remains in the open position until a signal pressure is applied to a pilot 55b to close the valve by moving the valve to the left. A regulator 59 connected between the power line P and an accumulator 60 reduces the fluid pressure which is applied to the pilots of the valve 54, and the accumulator 60 prevents the pressure from dropping when a device is connected to the pressure line P through the regulator 59.

To operate the actuator 58 (Fig. 6) a fluid pressure of approximately 600 psi (41.37 kPa) is applied on the signal pressure line A and a pressure of 1100 psi (75.84 kPa) is applied on the signal pressure line B. The 600 psi (41.37 kPa) signal from line A is coupled through the valve-pair V1 to the pilots of valves 53a of AND-gate G1 and 53d of AND-gate G2, thereby shifting the valves 53a, 53d from the closed position shown in Figure 6 to the open position. The 1100 psi (75.84 kPa) signal from line B is coupled through the valve-pair V7 to the pilot of valve 53c of the AND-gate G2, thereby opening the valve 53c and coupling fluid pressure from the accumulator 60 through the valves 53c, 53d of the AND-gate G2 to the pilot 55a to shift the two-position valve 54 to the open position shown. Fluid pressure from the power line P, coupled through the open valve 54, moves the actuator 58 into the energized position where it remains until a pressure signal is applied to the pilot 55b of the valve 54.



To deenergize the actuator 58 (Fig. 6) a signal of approximately 600 psi (4137 kPa) must be applied to signal line A and another signal of approximately 600 psi (4137 kPa) to signal line B. The 600 psi (4137 kPa) signal from line A opens the pilot valve 53a and the 600 psi (4137 kPa) from line B, coupled through the valve-pair V6, opens the pilot valve 53b to couple fluid pressure from the accumulator 60 through valves 53a, 53b to the pilot 55b of the valve 54. The valve 54 shifts to the left to connect the actuator 58 to a vent 63 and allow a spring 64a to return the actuator to the deenergized position.

In many applications it is desirable to be able to check the operation of hydraulic subsea valves to see if they have actually moved in response to signals which were supposed to have caused them to move. Apparatus for checking the position of remote valve is disclosed in Figure 7 where signal feedback circuitry has been added to a portion of the circuit of Figure 2. In the example shown (Fig. 7) a master valve 65 mounted in a subsea location is mechanically coupled to a pair of two-way valves 68, 69 by adjustable means 72a, 72b. The valves 68, 69 provide status position signals which are determined by the position of the master valve 65 and transmit these signals to the surface control center 12 (Fig. 1) through the signal pressure line A. Thus, status signals are transmitted from the subsea location to the control center without the use of any additional hydraulic or electrical lines to carry the return signals.

The power line P (Fig. 7) is also connected to the two-way valve 69 by a regulator 73 which provides hydraulic fluid at a pressure of 1500 psi (10342 kPa) to the valve 69, and the two-way valve 68 is connected to a vent 74 through a 1200 psi (8274 kPa) pressure relief valve 77. The regulator 73 and pressure relief valve 77 cause a junction point 78 to have a pressure of 1500 psi (10342 kPa) when the valves 68, 69 and master valve 65 are in the position shown (the master valve open position). When the master valve is moved to the left to the closed position, the junction point 78 is connected to the vent 74 by the two-way valve 68 and the pressure relief valve 77 producing a pressure of 1200 psi (8274 kPa) at the junction point 78. A pressure signal on the pilot 79a of a two-way valve 79 (Fig. 7) shifts the valve 79 to the right to the open position and connects the junction point 78 to the gage 45 (Figs. 1 and 7) where the pressure can be observed and the open or closed status of the master valve 65 can be determined.

The interrogation concerning the status of a subsea valve or operator can be done at any of the non-shaded areas on the function selection diagram of Figure 4, such as area HQ where the signal on line B is approximately 1600 psi (11032 kPa) and the signal on line A is approximately 1350 psi (9308 kPa). The interro-

gation circuit of Figure 7 has been assigned to this area HQ.

The procedure for interrogation of the subsea circuitry to determine the status of the master valve 65 includes opening the switch 40 (Fig. 1) until the gage 45 reads approximately 1350 psi (9308 kPa) from signal line A, and adjusting the pressure on the signal line B until the gage 46 reads approximately 1600 psi (11032 kPa), then closing switch 40 to isolate line A from the pump 37. The 1600 psi (11032 kPa) pressure in signal line B is coupled through the valve-pair V8 (Fig. 7) to the pilot 82a of a pilot valve 82 causing the valve 82 to move to the left and to connect a hydraulic line 83 to another hydraulic line 84. The 1350 psi (9308 kPa) pressure in signal line A does not change the open status of a pilot valve 87, which requires 1700 psi (11727 kPa) to change, so that the 1350 psi (9308 kPa) from line A is coupled through a check valve 88 and pilot valves 87, 82 to the pilot 79a of the valve 79 causing the valve 79 to open and connect the junction point 78 to the gage 45. With the master valve 65 in the closed position shown (Fig. 7) the 1500 psi (10342 kPa) from the valve 69 is coupled to the gage 45 (Figs. 1 and 7) to show that the master valve is closed.

When the master valve 65 is open, the two-way valve 69 is closed and the valve 68 is open, thereby connecting the junction point 78 and the gage 45 to the pressure relief valve 77. The pressure on the signal line A decreases to 1200 psi (8274 kPa) as determined by the pressure relief valve 77. When the master valve is between the open and the closed positions, the junction point 78 is not connected to the regulator 73 and is not connected to the pressure relief valve 77 so the pressure on the signal line A remains at the approximately 1350 psi (9308 kPa) when the subsea circuitry is interrogated. The open position, the closed position and the in-between position of the master valve can all be determined by observing the pressure at the gage 45 (Figs. 1 and 7) by using the same two signal pressure lines A, B that control operation of the various subsea operators to couple status signals from the seafloor to a control center at the surface.

Another embodiment of the present invention diagrammatically illustrated in Figure 8 employs a pair of multiple-position switching valves 92, 93 to replace the pressure sensitive valve-pairs V1—V10 and the AND-gates G1—G25 of Figure 2. The operating condition of each of the valves 92, 93 is determined by the number of signal pulses applied to a pilot section rather than being determined by the value of hydraulic pressure applied, as in the apparatus of Figure 2. The details of construction of such a multiple-position switching valve are disclosed in our copending U.S. patent application Serial Number 873,323 filed January 30, 1978.

The inlet line of the valve 92 (Fig. 8) is



connected to a hydraulic power switch S1 and the switch S1 is connected through a power line 90 to a hydraulic pump 37a which provides hydraulic fluid to the valve 92 when the switch S1 is closed. A pair of hydraulic switches S2, S3 each connect a pilot section 104a, 104b of one of the valves 92, 93 through a signal pressure line 91a, 91b to the hydraulic pump 37. Each time one of the switches S2, S3 is closed hydraulic pressure is applied to a corresponding one of pilot sections 104a, 104b causing the associated valve to move from one operating mode or position to the next. For example, when the switch S2 is closed the valve 92 moves from mode C, as shown in Figure 8, to mode D. When the switch S2 is opened and then closed again the valve 92 moves from mode D to mode E, then from mode E to mode F, and then from mode F back to mode C. The power switch S1 is open whenever switch S2 or switch S3 is closed.

A plurality of outlet lines 92c—92f (Fig. 8) are each connected between one of the outlet ports on the valve 92 and a corresponding one of a plurality of inlet ports on the valve 93. A plurality of outlet lines 96c—96f, 97c—97f, 98c—98f and 99c—99f, extending from the valve sections 96—99 of the valve 93, are each connected between one of the outlet ports on the valve 93 and a corresponding one of a plurality of subsea operators 107a—107s. The 4-position single-section valve 92 and the 4-position 4-section valve 93 provide individual control for a total of sixteen subsea operators (Figs. 8 and 9) using only three hydraulic lines between the hydraulic pump 37a (on the surface vessel) and the valves 92, 93 (located on the seafloor). Only one subsea operator can be controlled at a time. When the valve 92 operates in mode C and valve 93 operates in mode C (Figs. 8 and 9) the switch S1 controls the operator 107a; when the valve 92 operates in mode C and valve 93 operates in mode D the switch S1 controls operator 107b; etc. The operators which are not connected to the hydraulic power line 90 are each coupled to a vent V by the valves 92, 93.

Claims

1. Apparatus for the remote individual control of a plurality of hydraulically-actuated subsea operators (such as 31a, b, c) using a number of hydraulic lines between a surface control centre and a subsea well device containing said operators, said number of hydraulic lines being less than the number of operators, said apparatus being characterised by said hydraulic lines comprising a first and a second signal line (A, B) and a power line (P), a plurality of hydraulic AND-gates (G1—G25) each having first and second signal inputs (AL1, BL1—AL5, BL5) and a power line input (R1—R25) and an output (O1—O25) said gates being arranged in a matrix of rows and columns,

control means for coupling predetermined values of fluid pressure from a fluid source (37) to said first and said second signal lines, valve means (V1—V5) for applying signals from said first pressure line to the first input of each of the gates in a predetermined column when the pressure in said first signal line is within a corresponding predetermined range, and valve means (V6—V10) for applying signals from said second signal line to the second input of each of the gates in a predetermined row intersecting with the predetermined column when the pressure in said second line is within a corresponding predetermined range, the output of each of said gates being connected to a corresponding one of said operators.

2. Apparatus according to claim 1 characterised in that said control means includes a first means (35) for regulating the value of pressure in said first signal line and a second means (36) for regulating the value of pressure in said second signal line.

3. Apparatus according to claim 1 or claim 2 characterised in that each of said means for regulating includes a fluid-flow control unit (35, 36) and means (40, 41) for connecting said control unit between said fluid pressure source and a corresponding one of said first and said second signal lines (A, B).

4. Apparatus according to claim 3 characterised in that said means for connecting includes a hydraulic switch (40, 41) connected between said fluid pressure source (37) and said fluid-flow control unit (35, 36).

5. Apparatus according to any preceding claim characterised in that said valve means for applying signals from said first and second signal lines comprise a plurality of series-connected valve-pairs (V1—V10) for conducting fluid from an input to an output when the pressure applied to a predetermined valve-pair is between a predetermined lower limit and a predetermined upper limit, said valve-pairs being segregated into a first group (V1—V5) and a second group (V6—V10), said first signal line being connected to the input of each of said valve-pairs in said first group, and said second signal line being connected to the input of each of said valve-pairs in said second group, the output of each of said first group of valve-pairs being coupled to a first input of each of said gates in a corresponding row and the output of each of said second group of valve-pairs being coupled to a second input of each of said gates in a corresponding column.

6. Apparatus according to claim 5 characterised in that each of said valve pairs includes first and second pressure-sensitive valves, the output of said first pressure-sensitive valve being connected to the input of the second pressure sensitive valve, the first valve being arranged to open when the pressure at the input of said first valve is above a first predetermined value, and said second valve being arranged to open when the pressure applied to

connected to a hydraulic power switch S1 and the switch S1 is connected through a power line 90 to a hydraulic pump 37a which provides hydraulic fluid to the valve 92 when the switch S1 is closed. A pair of hydraulic switches S2, S3 each connect a pilot section 104a, 104b of one of the valves 92, 93 through a signal pressure line 91a, 91b to the hydraulic pump 37. Each time one of the switches S2, S3 is closed hydraulic pressure is applied to a corresponding one of pilot sections 104a, 104b causing the associated valve to move from one operating mode or position to the next. For example, when the switch S2 is closed the valve 92 moves from mode C, as shown in Figure 8, to mode D. When the switch S2 is opened and then closed again the valve 92 moves from mode D to mode E, then from mode E to mode F, and then from mode F back to mode C. The power switch S1 is open whenever switch S2 or switch S3 is closed.

A plurality of outlet lines 92c—92f (Fig. 8) are each connected between one of the outlet ports on the valve 92 and a corresponding one of a plurality of inlet ports on the valve 93. A plurality of outlet lines 96c—96f, 97c—97f, 98c—98f and 99c—99f, extending from the valve sections 96—99 of the valve 93, are each connected between one of the outlet ports on the valve 93 and a corresponding one of a plurality of subsea operators 107a—107s. The 4-position single-section valve 92 and the 4-position 4-section valve 93 provide individual control for a total of sixteen subsea operators (Figs. 8 and 9) using only three hydraulic lines between the hydraulic pump 37a (on the surface vessel) and the valves 92, 93 (located on the seafloor). Only one subsea operator can be controlled at a time. When the valve 92 operates in mode C and valve 93 operates in mode C (Figs. 8 and 9) the switch S1 controls the operator 107a; when the valve 92 operates in mode C and valve 93 operates in mode D the switch S1 controls operator 107b; etc. The operators which are not connected to the hydraulic power line 90 are each coupled to a vent V by the valves 92, 93.

Claims

1. Apparatus for the remote individual control of a plurality of hydraulically-actuated subsea operators (such as 31a, b, c) using a number of hydraulic lines between a surface control centre and a subsea well device containing said operators, said number of hydraulic lines being less than the number of operators, said apparatus being characterised by said hydraulic lines comprising a first and a second signal line (A, B) and a power line (P), a plurality of hydraulic AND-gates (G1—G25) each having first and second signal inputs (AL1, BL1—AL5, BL5) and a power line input (R1—R25) and an output (O1—O25) said gates being arranged in a matrix of rows and columns,

control means for coupling predetermined values of fluid pressure from a fluid source (37) to said first and said second signal lines, valve means (V1—V5) for applying signals from said first pressure line to the first input of each of the gates in a predetermined column when the pressure in said first signal line is within a corresponding predetermined range, and valve means (V6—V10) for applying signals from said second signal line to the second input of each of the gates in a predetermined row intersecting with the predetermined column when the pressure in said second line is within a corresponding predetermined range, the output of each of said gates being connected to a corresponding one of said operators.

2. Apparatus according to claim 1 characterised in that said control means includes a first means (35) for regulating the value of pressure in said first signal line and a second means (36) for regulating the value of pressure in said second signal line.

3. Apparatus according to claim 1 or claim 2 characterised in that each of said means for regulating includes a fluid-flow control unit (35, 36) and means (40, 41) for connecting said control unit between said fluid pressure source and a corresponding one of said first and said second signal lines (A, B).

4. Apparatus according to claim 3 characterised in that said means for connecting includes a hydraulic switch (40, 41) connected between said fluid pressure source (37) and said fluid-flow control unit (35, 36).

5. Apparatus according to any preceding claim characterised in that said valve means for applying signals from said first and second signal lines comprise a plurality of series-connected valve-pairs (V1—V10) for conducting fluid from an input to an output when the pressure applied to a predetermined valve-pair is between a predetermined lower limit and a predetermined upper limit, said valve-pairs being segregated into a first group (V1—V5) and a second group (V6—V10), said first signal line being connected to the input of each of said valve-pairs in said first group, and said second signal line being connected to the input of each of said valve-pairs in said second group, the output of each of said first group of valve-pairs being coupled to a second input of each of said gates in a corresponding row and the output of each of said second group of valve-pairs being coupled to a second input of each of said gates in a corresponding column.

6. Apparatus according to claim 5 characterised in that each of said valve pairs includes first and second pressure-sensitive valves, the output of said first pressure-sensitive valve being connected to the input of the second pressure sensitive valve, the first valve being arranged to open when the pressure at the input of said first valve is above a first predetermined value, and said second valve being arranged to open when the pressure applied to



said second valve is above a second predetermined value.

7. Apparatus according to any preceding claim characterised in that said apparatus further includes a means (59) for connecting said hydraulic power line between said fluid source and said power input of each of said AND-gates, and that the output of one selected AND-gate communicates with said connecting means upon first and second pressure signals each of selected values being simultaneously applied to the first and said second inputs of said one selected AND-gate.

8. Apparatus according to claim 1 characterised by means (68, 69) for coupling a status signal from said subsea operator to said first signal line, said status signal indicating the open or closed position of said operator.

9. Apparatus according to claim 8 characterised in that said means for coupling status signals includes a feedback valve (65) connected to said operator, said first and second hydraulic signal lines or other pair of sources of hydraulic pressure, said feedback valve connecting a first hydraulic pressure source to said first signal line (A) when said subsea operator is in a first position and said feedback valve connecting a second hydraulic pressure source to said first signal line when said subsea operator is in a second position.

10. Apparatus according to claim 9 characterised in that said first signal line is isolated from said source of hydraulic fluid when said status signals are coupled to said first signal line.

11. Apparatus according to claim 1 characterised by the first and second signal applying means comprising a plurality of series-connected valve-pairs (V1—V10) for conducting fluid from an input to an output when the pressure applied to a predetermined valve-pair is between a predetermined lower limit and a predetermined upper limit, said valve-pairs being segregated into first and second groups (V1—V5, V6—V10), said first signal line being connected from the hydraulic pressure source (37) to the input of each of said valve-pairs in said first group, said second signal line being connected from said source to the input of each of said valve-pairs in said second group, the output of each of said first group of valve-pairs being connected to a first input of each of said gates in a corresponding column the output of each of said second group of valve-pairs being connected to a second input of each of said gates in a corresponding row intersecting with said column, and the output of each of said gates being connected to a corresponding one of said subsea operators.

12. Apparatus for the remote individual control of a plurality of hydraulically-actuated subsea operators (such as 32a, b, c) via first and second hydraulic lines (A, B) between a surface control center and a subsea well device containing said operators, said first and second

hydraulic lines (A, B) powering a substantially greater number of operators characterised by a plurality of hydraulic AND-gates (G1—G25) each having an output and a pair of inputs, said gates being arranged in rows and columns, a plurality of series-connected valve-pairs (V1—V10) for conducting fluid from an input to an output when the pressure applied to a predetermined valve-pair is between a predetermined lower limit and a predetermined upper limit, said valve-pairs being segregated into first and second groups (V1—V5, V6—V10), said first hydraulic line being connected from a hydraulic pressure source (37) to the input of each of said valve-pairs in said first group, said second hydraulic line being connected from said source to the input of each of said valve-pairs in said second group, the output of each of said first group of valve-pairs being connected to a first input of each of said gates in a corresponding column the output of each of said second group of valve-pairs being connected to a second input of each of said gates in a corresponding row intersecting with said column, and the output of each of said gates being connected to a corresponding one of said subsea operators.

13. Apparatus for the remote individual control of a plurality of hydraulically actuated subsea operators (such as 32a, b, c) using a number of hydraulic lines between a surface control center and a subsea well device containing said operators, said number of hydraulic lines being less than the number of operators, said apparatus being characterised by said hydraulic lines comprising a first and a second signal line (91a, 91b) and a power line (90) providing a hydraulic source, and further characterised by a multiple-position switching valve (92) having an inlet port and a plurality of outlet ports, control means (S1) for selectively coupling said inlet port of said multiple-position switch to said hydraulic source, a multiple-section multiple-mode switching valve (93) having a plurality of inlet ports and a plurality of outlet ports, each of said inlet ports of said multiple-section valve (93) being coupled to a corresponding one of said outlet ports of said multiple-position valve (92), each of said outlet ports of said multiple-section valve (93) being connected to one of said operators, a switch (S2) in one said pressure line (91a) for selectively switching said multiple-position valve into a selected position, and a switch (S3) in the other said pressure line (91b) for selectively switching said multiple-section valve into a selected mode to couple a selected operator to said inlet line of said multiple-position valve.

14. Apparatus according to claim 13 characterised by first and second pilot section (104a, 104b), said first pilot section (104a) being connected to said multiple-position valve (92), so that energization of said first pilot section causes said multiple-position valve to change from one position to another, said second pilot



section (104b) being connected to said multiple-section valve (93) so that energization of said second pilot section (104b) causes said multiple-section valve to change from one mode to another.

Revendications

1. Appareil pour la commande individuelle à distance de plusieurs dispositifs d'actionnement sous-marins commandés hydrauliquement (comme 31a, b, c) en utilisant un nombre de conduites hydrauliques entre un centre de commande en surface et un dispositif de forage sous-marin contenant lesdits dispositifs d'actionnement, ledit nombre de conduites hydrauliques étant inférieur au nombre des dispositifs d'actionnement, ledit appareil étant caractérisé par lesdites conduites hydrauliques comprenant une première conduite et une seconde conduite de signaux (A, B) et une conduite d'alimentation (B), plusieurs portes ET hydrauliques (G1—G25) ayant chacune une première et une seconde entrées de signaux (AL1, BL1—AL5, BL5) et une entrée de conduite d'alimentation (R1—R25) et une sortie (O1—O25) lesdites portes étant disposées en une matrice de rangées et de colonnes, un dispositif de commande pour appliquer des valeurs prédéterminées de pression de fluide provenant d'une source de fluide (37), ladite première et ladite seconde conduites de signaux, un dispositif à distributeurs (V1—V5) pour appliquer des signaux de ladite première conduite de pression à la première entrée de chacune des portes dans une colonne prédéterminée quand la pression dans ladite première ligne de signaux se situe à l'intérieur d'une plage prédéterminée correspondante, et un dispositif à distributeurs, V6—V10 pour appliquer des signaux de ladite seconde ligne de signaux à la seconde entrée de chacune des portes dans une rangée prédéterminée coupant la colonne prédéterminée quand la pression dans la seconde conduite se situe dans une plage prédéterminée correspondante, la sortie de chacune desdites portes étant reliée à l'un des correspondants desdits dispositifs d'actionnement.

2. Appareil selon la revendication 1, caractérisé en ce que ledit dispositif de commande comporte un premier dispositif (35) pour réguler la valeur de la pression dans ladite première conduite de signaux et un second dispositif (36) pour réguler la valeur de la pression dans ladite seconde conduite de signaux.

3. Appareil selon la revendication 1 ou la revendication 2, caractérisé en ce que chacun desdits dispositifs pour réguler comporte une unité de commande de débit de fluide (35, 36) et un dispositif (40, 41) pour relier ladite unité de commande entre ladite source de pression de fluide et l'une correspondante de ladite première et ladite seconde conduite de signaux (A, B).

4. Appareil selon la revendication 3, caractérisé en ce que ledit dispositif pour relier comporte un commutateur hydraulique (40, 41) branché entre ladite source de pression de fluide (37) et ladite unité de commande de débit de fluide (35, 36).

5. Appareil selon l'une quelconque des revendications précédentes, caractérisé en ce que ledit dispositif à distributeurs, destiné à appliquer des signaux de ladite première et de ladite seconde conduites de signaux comporte plusieurs paires de distributeurs (V1—V10) branchés en série pour conduire du fluide depuis une entrée jusqu'à une sortie quand la pression appliquée à une paire prédéterminée de distributeurs se trouve entre une limite inférieure prédéterminée et une limite supérieure prédéterminée, lesdites paires de distributeurs étant séparées en un premier groupe (V1—V5) et un second groupe (V6—V10), ladite première conduite de signaux étant reliée à l'entrée de chacune desdites paires de distributeurs dans ledit premier groupe et ladite seconde de signaux étant liée à l'entrée de chacune des paires de distributeurs dans ledit second groupe, la sortie de chacune desdites paires de distributeurs du premier groupe étant reliée à une première entrée de chacune desdites portes dans une rangée correspondante, et la sortie de chacune desdites paires de distributeurs du second groupe étant reliée à une seconde entrée de chacune desdites portes dans une colonne correspondante.

6. Appareil selon la revendication 5, caractérisé en ce que chacune desdites paires de distributeurs comprend un premier et un second distributeurs sensibles à la pression la sortie dudit premier distributeur sensible à la pression étant reliée à l'entrée du second distributeur sensible à la pression, le premier distributeur étant agencé pour s'ouvrir quand la pression à l'entrée dudit premier distributeur est supérieure à une première valeur prédéterminée, et le second distributeur étant agencé pour s'ouvrir quand la pression appliquée audit second distributeur est supérieure à une seconde valeur prédéterminée.

7. Appareil selon l'une quelconque des revendications précédentes, caractérisé en ce que ledit appareil comporte en outre un dispositif 59 pour relier ladite conduite d'alimentation hydraulique entre ladite source de fluide et ladite entrée d'alimentation de chacune desdites portes ET, et que la sortie de l'une sélectionnée des portes ET communique avec ledit dispositif de liaison quand un premier et un second signal de pression, ayant chacun une valeur sélectionnée, sont appliqués simultanément à la première et à la seconde entrées de ladite porte sélectionnée.

8. Appareil selon la revendication 1, caractérisé par un dispositif 68, 69 pour coupler un signal d'état provenant dudit dispositif d'actionnement sous-marin avec ladite première conduite de signaux, ledit signal d'état



indiquant la position ouverte ou fermée dudit dispositif d'actionnement.

9. Appareil selon la revendication 8, caractérisé en ce que ledit dispositif pour coupler des signaux d'état comporte un distributeur de réactions (65) relié audit dispositif d'actionnement, ladite première et ladite seconde conduites de signaux hydrauliques ou une autre paire de sources de pressions hydrauliques, ledit distributeur de réactions reliant une première source de pressions hydrauliques à ladite première conduite de signaux (A) quand ledit dispositif d'actionnement sous-marin se trouve dans une première disposition et ledit distributeur de réactions reliant une seconde source de pressions hydrauliques à ladite première conduite de signaux quand ledit dispositif d'actionnement sous-marin se trouve dans une seconde position.

10. Appareil selon la revendication 9, caractérisé en ce que ladite première conduite de signaux est isolée de ladite source de fluide hydraulique quand lesdits signaux d'état sont coupés avec ladite première conduite de signaux.

11. Appareil selon la revendication 1, caractérisé en ce que le premier et le second dispositifs d'application de signaux comprennent plusieurs paires de distributeurs reliés en série (V1—V10) pour conduire du fluide d'une entrée à une sortie quand la pression appliquée à une paire prédéterminée de distributeurs se situe entre une limite inférieure prédéterminée et une limite supérieure prédéterminée, lesdites paires de distributeurs étant séparées en un premier et un second groupe (V1—V5, V6—V10), ladite première conduite de signaux étant reliée depuis la source de pression hydraulique (37) à l'entrée de chacune desdites paires de distributeurs dudit premier groupe, ladite seconde conduite de signaux étant reliée entre ladite source et l'entrée de chacune des deux paires de distributeurs dans ledit second groupe, la sortie de chacune des paires de distributeurs du premier groupe étant reliée à une première entrée de chacune desdites portes dans une colonne correspondante, la sortie de chacune des paires de distributeurs du second groupe étant reliée à une seconde entrée de chacune desdites portes dans une rangée correspondante coupant ladite colonne et la sortie de chacune desdites portes étant liée à l'un correspondant desdits dispositifs d'actionnement sous-marins.

12. Appareil pour la commande individuelle à distance de plusieurs dispositifs d'actionnement sous-marins, actionnés hydrauliquement (comme 32a, b, c) par une première et une seconde conduites hydrauliques (A, B) entre un centre de commande en surface et un dispositif de forage sous-marin contenant lesdits dispositifs d'actionnement, ladite première et ladite seconde conduites hydrauliques (A, B) alimentant un nombre nettement plus élevé de dispositifs d'actionnement, caractérisé par

plusieurs portes ET hydrauliques (G1—G25) comprenant chacune une sortie et deux entrées, lesdites portes étant disposées en rangées et en colonnes, plusieurs paires de distributeurs (V1—V10) branchées en série pour conduire le fluide d'une entrée à une sortie quand la pression appliquée à une paire prédéterminée de distributeurs se situe entre une limite inférieure prédéterminée et une limite supérieure prédéterminée, lesdites paires de distributeurs étant séparées en un premier et un second groupe (V1—V5, V6—V10) ladite première conduite hydraulique étant reliée entre une source de pression hydraulique (37) et l'entrée de chacune desdites paires de distributeurs du premier groupe, ladite seconde conduite hydraulique étant reliée entre ladite source et l'entrée de chacune desdites paires de distributeurs dans ledit second groupe, la sortie de chacune desdites paires de distributeurs du premier groupe étant reliée à une première entrée de chacune desdites portes dans une colonne correspondante, la sortie de chacune desdites paires de distributeurs du second groupe étant reliée à une seconde entrée de chacune desdites portes dans une rangée correspondante coupant ladite colonne et la sortie de chacune desdites portes étant reliée à l'un correspondant desdits dispositifs d'actionnement sous-marins.

13. Appareil de commande individuel à distance de plusieurs dispositifs d'actionnement sous-marins, actionnés hydrauliquement (comme 32a, b, c) utilisant un nombre de conduites hydrauliques entre deux commandes en surface et un dispositif de forage sous-marin contenant les dispositifs d'actionnement, ledit nombre des conduites hydrauliques étant inférieur au nombre desdits dispositifs d'actionnement, ledit appareil étant caractérisé par lesdites conduites hydrauliques comprenant une première et une seconde conduite de signaux (91a, 91b) et une conduite d'alimentation (90) constituant une source hydraulique, et caractérisé en outre par un distributeur de commutation (92) à positions multiples comprenant un orifice d'entrée et plusieurs orifices de sortie, un dispositif de commande (S1) pour coupler sélectivement ledit orifice d'entrée dudit commutateur à positions multiples avec ladite source hydraulique, un distributeur de commutation (93) à modes multiples et sections multiples comprenant plusieurs orifices d'entrée et plusieurs orifices de sortie, chacun desdits orifices d'entrée dudit distributeur à sections multiples (93) étant couplé avec l'un correspondant des orifices de sortie dudit distributeur à positions multiples (92), chacun desdits orifices de sortie dudit distributeur à sections multiples (93) étant relié à l'un desdits dispositifs d'actionnement, un commutateur (S2) dans l'une desdites conduites de pression (91a) pour commuter sélectivement ledit distributeur à positions multiples dans une position sélectionnée et un commutateur (S3) dans



l'autre desdites conduites de pression (91b) pour commuter sélectivement ledit distributeur à sections multiples dans un mode sélectionné pour coupler un dispositif d'actionnement sélectionné avec ladite conduite d'entrée dudit distributeur à positions multiples.

14. Appareil selon la revendication 13, caractérisé par une première et une seconde sections pilotée (104a, 104b), ladite première section pilote (104a) étant reliée audit distributeur à positions multiples (92) de manière que l'excitation de ladite première section pilote entraîne le passage dudit distributeur à positions multiples d'une position à une autre, ladite seconde section pilote (104b) étant reliée audit distributeur à sections multiples (93) de manière que l'excitation de ladite seconde section pilote (104b) fasse passer le distributeur à sections multiples d'un mode à un autre.

Patentansprüche

1. Einrichtung für die ferngesteuerte individuelle Regelung einer Vielzahl von hydraulischen Untersee-Einrichtungen (31a, b, c) mit hydraulischen Leitungen zwischen an der Oberfläche befindlicher zentraler Steuerstation und Unterwasserbohrereinrichtung, welche die hydraulischen Untersee-Einrichtungen enthält, wobei die Anzahl der hydraulischen Leitungen geringer als die der Untersee-Einrichtungen (31a, b, c) ist, dadurch gekennzeichnet, daß die hydraulischen Leitungen erste und zweite Signalleitungen (A, B) und eine Druckleitung (P) umfassen, mit einer Vielzahl von hydraulischen UND-Gattern (G1—G25) mit ersten und zweiten Signaleingängen (AL1, BL1—AL5, BL5) und einem Druckleitungseingang (R1—R25) und -ausgang (O1—O25), wobei die Gatter in einer Matrix aus Reihen und Spalten angeordnet sind, Steuereinrichtungen zum Aufschalten vorbestimmter Fluid-Druckwerte einer Fluidquelle (37) auf besagte erste und zweite Signalleitung, Ventileinrichtungen (V1—V5) zum Aufbringen von Signalen von der ersten Druckleitung zum ersten Eingang der Gatter in einer vorbestimmten Spalte für den Fall, daß der Druck in der ersten Signalleitung innerhalb eines vorbestimmten korrespondierenden Bereiches ist, sowie Ventileinrichtungen (V6—V10) zum Aufschalten von Signalen der zweiten Signalleitung zu den zweiten Eingängen der Gatter einer vorbestimmten Reihe, welche sich mit der vorbestimmten Spalte schneidet für den Fall, daß der Druck in der zweiten Leitung innerhalb eines korrespondierenden vorbestimmten zweiten Bereiches liegt, wobei der Ausgang der betreffenden Gatter mit einer korrespondierenden Untersee-Einrichtung verbunden wird.

2. Einrichtung nach Anspruch 1, dadurch gekennzeichnet, daß die Steuereinrichtungen erste Einrichtungen (35) zum Einstellen des Druckwertes in der ersten Signalleitung und zweite Einrichtungen (36) zum Einstellen des Druckwertes in der zweiten Signalleitung enthalten.

3. Einrichtung nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß jede der Einstelleinrichtung eine Fluid-Flußsteuereinheit (35, 36) sowie Einrichtungen (40, 41) zum Verbinden der Steuereinrichtung zwischen der Fluid-Druckquelle und einer korrespondierenden Leitung der ersten und zweiten Signalleitungen (A, B) enthält.

4. Einrichtung nach Anspruch 3, dadurch gekennzeichnet, daß die Verbindungseinrichtungen einen hydraulischen Schalter (40, 41) zwischen der Fluid-Druckquelle (37) und der Fluid-Flußsteuereinheit (35, 36) aufweisen.

5. Einrichtung nach einem oder mehreren der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die Ventileinrichtungen zum Schalten der Signale der ersten und zweiten Signalleitungen eine Vielzahl von Ventilpaaren (V1—V10) in Serienschaltung zum Leiten von Fluid vom Eingang zum Ausgang aufweisen, für den Fall daß der auf ein bestimmtes Ventilpaar aufgeschaltete Druck zwischen einem vorbestimmten unteren und oberen Grenzwert ist, wobei die Ventilpaare in eine erste Gruppe (V1—V5) und eine zweite Gruppe (V6—V10) getrennt und die erste Signalleitung mit den Eingängen der Ventilpaare der ersten Gruppe verbunden ist und die zweite Signalleitung mit den Eingängen der Ventilpaare der zweiten Gruppe, der Ausgang der ersten Gruppe von Ventilpaaren ist mit dem ersten Eingang der Gatter in der korrespondierenden Reihe verbunden und der Ausgang der zweiten Gruppe der Ventilpaare ist mit dem zweiten Eingang der Gatter in der korrespondierenden Spalte verbunden.

6. Einrichtung nach Anspruch 5, dadurch gekennzeichnet, daß die Ventilpaare erste und zweite drucksensitive Ventile aufweisen und der Ausgang der ersten drucksensitiven Ventile mit dem Eingang der zweiten drucksensitiven Ventile verbunden ist, wobei die ersten Ventile dann öffnen, wenn der Druck am Eingang der ersten Ventile oberhalb eines vorbestimmten ersten Wertes liegt und wobei die zweiten Ventile dann öffnen, wenn der Druck an den zweiten Ventilen oberhalb eines vorbestimmten zweiten Wertes liegt.

7. Einrichtung nach einem oder mehreren der vorhergehenden Ansprüche, gekennzeichnet durch Einrichtungen zum Verbinden der hydraulischen Druckleitung zwischen der Fluid-Quelle und dem Druckeingang jeden UND-Gatters, wobei der Ausgang jedes ausgewählten UND-Gatters mit den Verbindungseinrichtungen über erste und zweite Drucksignale kommuniziert wobei jeder der ausgewählten Werte simultan zu den ersten und zweiten Eingängen des ausgewählten UND-Gatters aufgeschaltet wird.

8. Einrichtung nach Anspruch 1, gekennzeichnet, durch Einrichtungen (68, 69) zum Aufschalten eines Statussignals von der Untersee-Einrichtung auf die erste Signalleitung, wobei



die Statussignal die Offen- oder Geschlossenposition der Untersee-Einrichtung anzeigt.

9. Einrichtung nach Anspruch 8, dadurch gekennzeichnet, daß die Einrichtungen zum Aufschalten eines Statussignals ein Rücklaufventil (65) aufweisen, welches mit der Untersee-Einrichtung verbunden ist und die erste und zweite hydraulische Signalleitung oder andere Paare hydraulischen Drucks, das Rücklaufventil eine erste hydraulische Druck-Quelle mit der ersten Signalleitung (A) verbinden, wenn die Untersee-Einrichtung in einer ersten Position befindlich ist und wobei das Rücklaufventil eine zweite hydraulische Druck-Quelle mit der ersten Signalleitung verbindet, wenn die Untersee-Einrichtung in einer zweiten Position ist.

10. Einrichtung nach Anspruch 9, dadurch gekennzeichnet, daß die erste Signalleitung von der Hydraulic-Fluid-Versorgung weggeschaltet ist, wenn die Statussignale auf die erste Signalleitung aufgeschaltet sind.

11. Einrichtung nach Anspruch 1, dadurch gekennzeichnet, daß die ersten und zweiten Signalaufschalteinrichtungen eine Vielzahl von in Serie geschalteten Ventilpaaren (V1—V10) zum Leiten des Fluids von einem Eingang zum einem Ausgang aufweisen, für den Fall, daß der zu einem vorbestimmten Ventilpaar geleitete Druck zwischen einem vorgegebenen unteren und oberen Grenzwert ist, wobei die Ventilpaare in erste und zweite Gruppen (V1—V5, V6—V10) getrennt sind, daß die erste Signalleitung von der hydraulischen Druckversorgung (37) zu den Eingängen der Ventilpaare der ersten Gruppe geführt wird, daß die zweite Signalleitung von der Druckquelle zu den Ventilpaaren in der zweiten Gruppe führt, daß der Ausgang der ersten Gruppe von Ventilpaaren verbunden ist mit dem ersten Eingang der Gatter einer korrespondierenden Spalte, der Ausgang der Ventilpaare der zweiten Gruppe verbunden ist mit dem zweiten Eingang der Gatter in einer korrespondierenden Reihe, welche sich mit der Spalteschneidet und daß der Ausgang der Gatter mit der korrespondierenden Untersee-Einrichtung verbunden ist.

12. Einrichtung für die ferngesteuerte individuelle Regelung einer Vielzahl von hydraulischen Untersee-Einrichtungen (32a, b, c) über erste und zweite hydraulische Leitungen (A, B) zwischen an der Oberfläche befindlicher zentraler Steuerstation und Unterwasserbohrereinrichtung welche die Untersee-Einrichtungen enthält, wobei die erste und zweite Hydraulikleitung (A, B) eine wesentlich größere Anzahl von Untersee-Einrichtungen bedienen, gekennzeichnet durch eine Vielzahl von hydraulischen UND-Gattern (G1—G25) deren jedes einen Ausgang und ein Paar von Eingängen aufweist, wobei die Gatter in Zeilen und Spalten angeordnet sind, eine Vielzahl von in Serie geschalteten Ventilpaaren (V1—V10) zum Leiten von Fluid von einem Eingang zu einem Ausgang wenn der aufgeschaltete Druck auf ein vorbestimmtes Ventilpaar zwischen einem

vorgegebenen unteren und oberen Grenzwert ist, wobei die Ventilpaare in erste und zweite Gruppen (V1—V5, V6—V10) getrennt sind, wobei die erste Hydraulikleitung die hydraulische Druckversorgung (37) zu den Eingängen der Ventilpaare der ersten Gruppe und die zweite Hydraulikleitung die hydraulische Druckversorgung mit den Eingängen der Ventilpaare der zweiten Gruppe verbindet, der Eingang der ersten Gruppe der Ventilpaare ist mit einem ersten Eingang der Gatter einer korrespondierenden Spalte, der Ausgang der zweiten Gruppe der Ventilpaare ist mit dem zweiten Eingang der Gatter in einer korrespondierenden Reihe verbunden, welche sich mit der Spalte schneidet und der Ausgang der Gatter ist mit der korrespondierenden Untersee-Einrichtung verbunden.

13. Einrichtung für die ferngesteuerte individuelle Regelung einer Vielzahl von hydraulischen Untersee-Einrichtungen (32a, b, c) mit hydraulischen Leitungen zwischen an der Oberfläche befindlicher zentraler Steuerstation und Unterwasserbohrereinrichtung welche die Untersee-Einrichtung beinhaltet, wobei die Anzahl der Hydraulikleitungen geringer als die Anzahl der Untersee-Einrichtungen ist, dadurch gekennzeichnet, daß die Hydraulikleitungen eine erste und zweite Signalleitung (91a, 91b) und eine Druckleitung (90) für die Hydraulikversorgung aufweisen, mit einem Mehrstellungsventil (92) welches einen Eingang und eine Vielzahl von Ausgängen aufweist, Steuereinrichtungen (S1) zum selektiven Verbinden des Eingangs der Mehrstellungsschalters mit der Hydraulikversorgung, einem Vielfach-Mode Schaltventil (93) mit einer Vielzahl von Eingängen und einer Vielzahl von Ausgängen wobei die Eingänge des Vielfachventils (93) mit den korrespondierenden Ausgängen des Vielfachventils (92) verbunden sind, daß die Ausgänge des Vielfachventils (93) verbunden sind mit einer der Untersee-Einrichtungen, mit einem Schalter (S2) in einer der Druckleitungen (91a) zum selektiven Schalten des Vielfachventils in eine ausgewählte Stellung und mit einem Schalter (S3) in der anderen Druckleitung (91b) zum selektiven Schalten des Vielfachventils in einen zweiten ausgewählten Mode um eine ausgewählte Untersee-Einrichtung an die Eingangsleitung des Vielfach-Stellungsventils zu schalten.

14. Einrichtung nach Anspruch 13, gekennzeichnet durch erste und zweite Pilotbereiche (104a, 104b), wobei der erste Pilotbereich (104a) derart mit dem Vielfach-Stellungsventil (92) verbunden ist, daß die Aktivierung des ersten Pilotbereiches das Vielfach-Stellungsventil zum Schalten von einer Position in die andere veranlaßt, daß der zweite Pilotbereich (104b) mit dem Vielfach-Bereichventil (93) verbunden ist, so daß Aktivierung des zweiten Pilotbereichs (104b) das Vielfach-Bereichventil veranlaßt von einem Mode in den anderen zu schalten.

