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[54] **AUTONOMOUS DEVICE FOR THE STORAGE AND USE OF HYDRAULIC AND/OR PNEUMATIC POWER**


[72] Inventors: **Jacques Harbonn,** Jouars Ponchartrain; **Jean-Pierre Aubert,** Honfleur, both of France

[73] Assignee: **Institute Francais Du Petrole Des Carburants Et Lubrifiants,** Rueil-Malmaison Hauts-de-Seine, France



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[51] **Int. Cl.**.....**F15b 1/02**

[58] **Field of Search**.....60/51



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*Primary Examiner*—Edgar W. Geoghegan

*Attorney*—Craig, Antonelli, Stewart & Hill



[57] **ABSTRACT**

Autonomous device for the storage and use of pressurized fluid comprising one main fluid accumulator connected to a source of pressurized fluid, at least one double-acting jack the two chambers of which are connected to said main accumulator through separate pipes and through a remotely controllable main distributor adapted to connect one or the other of said separate pipes to the main accumulator, a safety accumulator of pressurized fluid connected to a first of said chambers through a safety distributor allowing, in working condition, the communication of said first chamber with the main accumulator and, in emergency condition, the communication of said first chamber with the safety accumulator while discontinuing the communication of any chamber with the main distributor, and means for detecting any failure of the device, adapted to switch the device to the emergency condition in case of failure.


**5 Claims, 5 Drawing Figures**

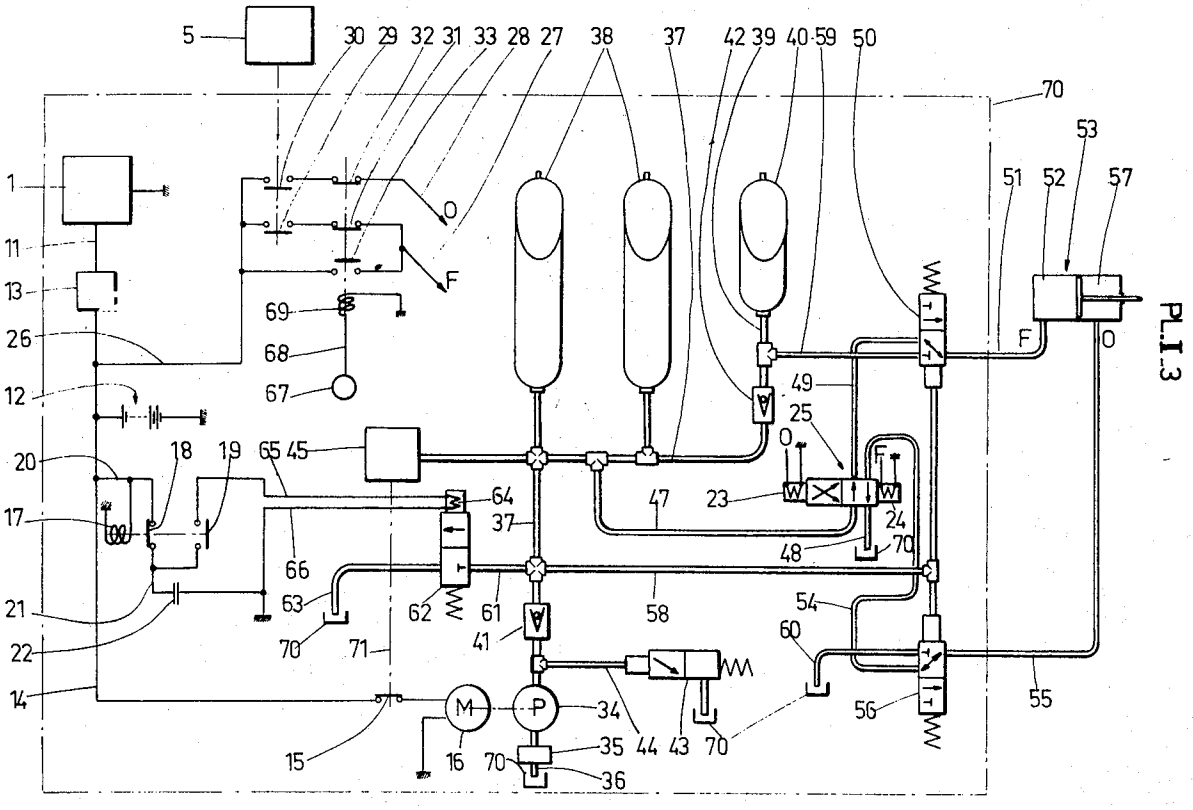



FIG. 3

FIG.1

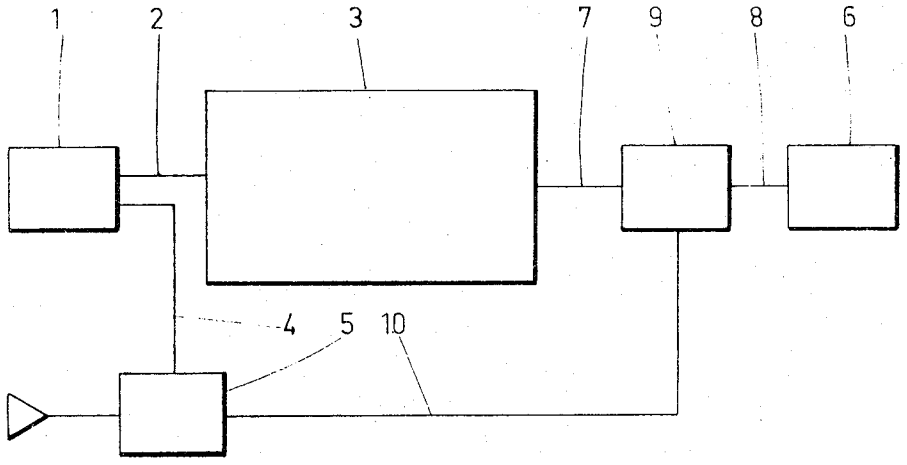
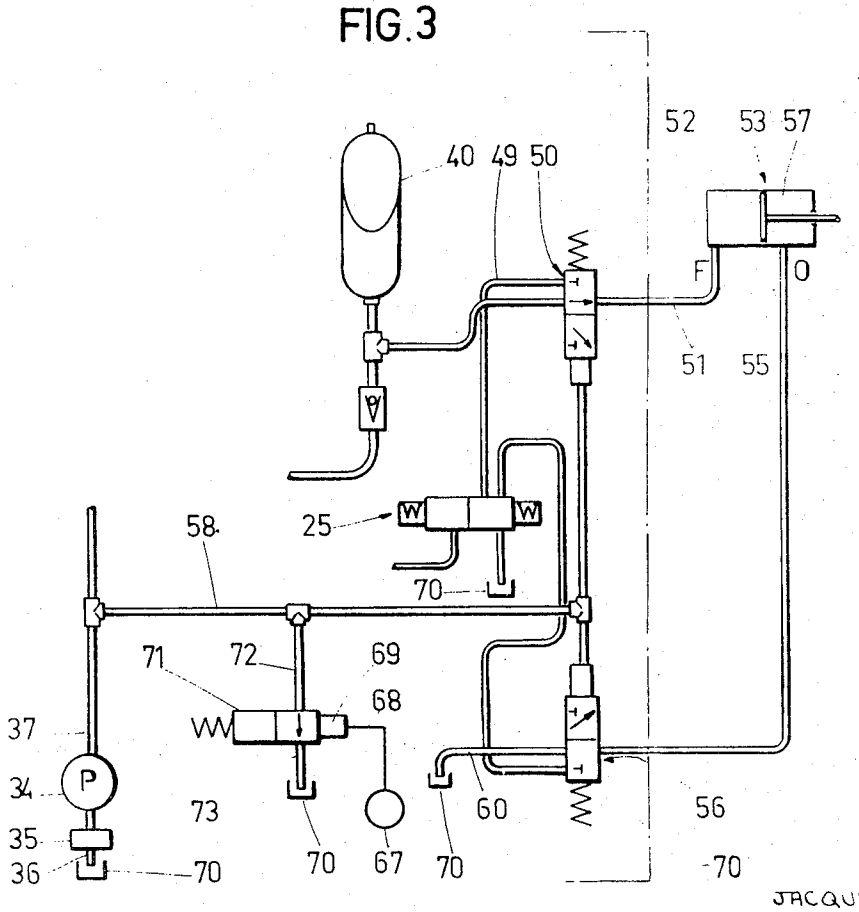



FIG.3




INVENTORS:
JACQUES HARBONN
JEAN-PIERRE AUBERT
BY Craig, Antonelli & Hill
Attorneys

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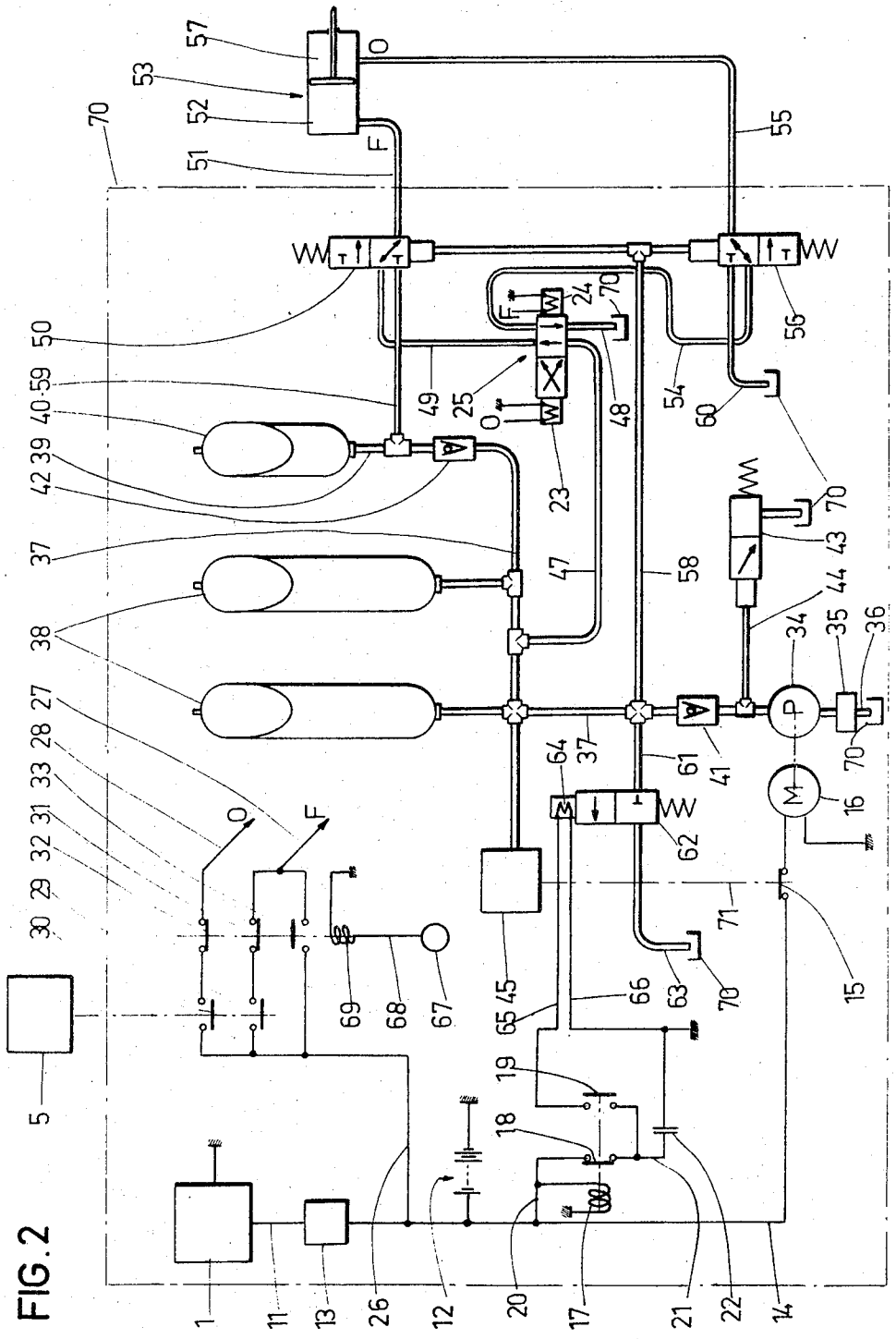


FIG. 2

FIG. 2B

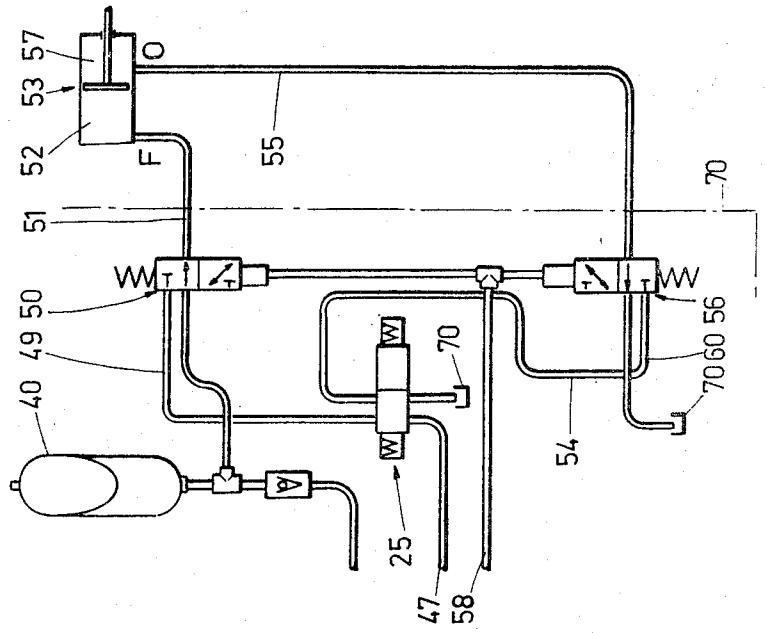
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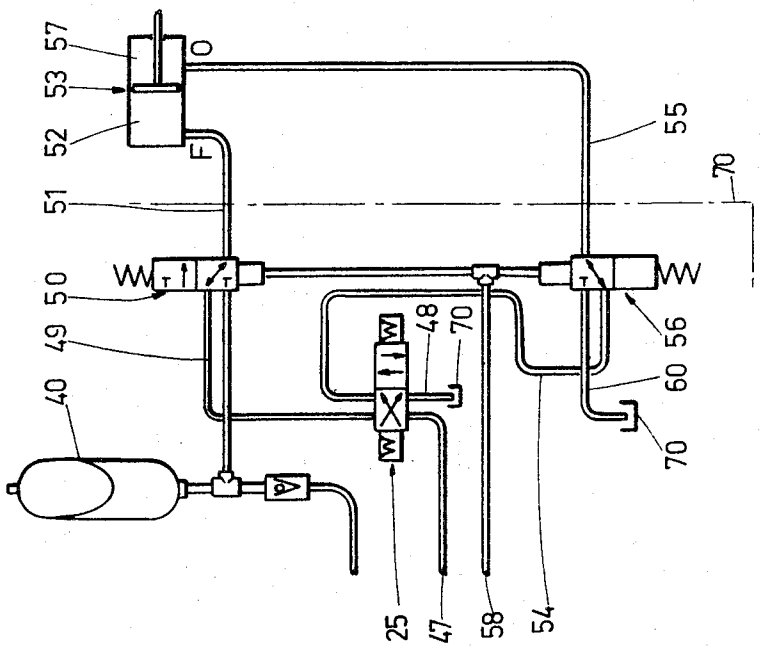
FIG. 2A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# AUTONOMOUS DEVICE FOR THE STORAGE AND USE OF HYDRAULIC AND/OR PNEUMATIC POWER

This invention relates to an autonomous device for the storage and use of hydraulic and/or pneumatic power over a long working period, said device having the advantage of a high security of operation.

In certain installations, such as immersed producing or drilling well heads, the operation of elements, such, for example, as valves, well sealing blocks and the like, is performed hydraulically. For this purpose the controlled installation has to be connected to the controlling installation through flexible conduits for hydraulic remote control. Such an arrangement suffers from serious drawbacks. As a matter of fact, in addition to their high cost, said flexible conduits are difficult to place and require a special watching and maintenance and, in the case of submerged well heads, they have the further disadvantage of congesting the waters.

Anyhow, the material connections between the installations are always a source of trouble for the user and attempts are made presently to reduce or even avoid such material connections. These troubles are the greater when the controlled installation, or secondary installation, is remote from the controlling installation, or main installation.

An improvement has been achieved by the perfecting of hydraulic control devices requiring only a reduced number of flexible hydraulic conduits. Nevertheless a large part of the above-mentioned drawbacks is still present and it is necessary that the device for distributing pressurized fluid, placed on the main installation, be of a sufficient power in view of the pressure losses through the flexible conduits.

It has been suggested, in order to improve these devices, to equip the secondary installation with a hydraulic power generating assembly, comprising hydraulic accumulators fed with a pump actuated by an electric motor. By this way, all of the hydraulic flexible conduits interconnecting the installations, can be omitted, thereby reducing very substantially the pressure losses as a result of a significant decrease in length of the hydraulic flexible conduits. However there still exists a material connection between the installations consisting of the cable feeding with electric power the pump driving motor.

This connection also suffers from drawbacks which, in addition to that of a high cost of the cable, are those of the watching and maintenance requirements and, in the case of a submerged well head also that of congesting the waters.

Additionally, in some cases, the secondary installation is very far from the main installation and, for practical reasons, it might be desirable to avoid the presence of any material connection between the main installation and one or more secondary installations. This can be achieved by the use of known remote control devices. These connections are performed by transmission of acoustic and/or or electromagnetic waves, the selection of the type of transmission depending on the medium wherein are placed the installations. Provisions are then to be made for the power supply to the secondary installations which frequently are difficult of access, which requires the use of an autonomous power source operative over very long periods which may attain several years.



Autonomous power generators, such as isotopic electrical generators, fuel cells and the like, seem to be convenient as power sources for said purpose in spite of their high cost.

These generators may be used for feeding a secondary installation with hydraulic or pneumatic power stored in accumulators forming part of the equipment of the secondary installation. It is thus possible to avoid any material connection between the main installation and one or more secondary installations. But with this arrangement the safety of operation of the autonomous device for the storage and distribution of hydraulic and/or air power has to be insured.

It is therefore an object of this invention to provide an autonomous device for the storage of hydraulic and/or air power, with a high safety of operation.

Another object of this invention is to provide a device of the above-mentioned type so designed that any failure of the device would automatically cause the switching to a security condition of the installation equipped therewith, said device being insensitive to any undesired remote control signal which it might receive after the failure has been detected and as long as the cause of the latter has not been suppressed.

These objects are attained, according to the invention, by means of an autonomous device for the storage and use of pressurized fluid, comprising at least one main fluid accumulator, connected to a source of pressurized fluid, and at least one member using the fluid pressure, including an operating element comprising a first orifice whose feeding with pressurized fluid insures the operation of said using member and a second orifice, whose feeding with pressurized fluid, insures the switching to a security condition of said device, said operating element being connected to said accumulator through a main distributor of pressurized fluid having a first and a second outlet pipes, respectively for the feeding of said first and said second orifices with pressurized fluid from said main accumulator, said distributor being provided with remote control means, said device comprising at least one safety accumulator of pressurized fluid, connected to said second orifice of the operating element, in parallel with said second outlet pipe of the main distributor, through a safety distributor having a working position at which the second orifice of the operating element communicates with said second outlet pipe of the main distributor and a second emergency position at which said safety distributor establishes a communication between said second orifice and said safety accumulator while discontinuing any communication between said orifices of the operating element and said main distributor provided with remote control means, and means for detecting the failures of the device, connected to said safety distributor and adapted to automatically switch the same to an emergency position when a failure of the system is detected.

The invention will be better understood from the following description of a non-limitative embodiment of the device of the invention illustrated by the accompanying drawings wherein:

FIG. 1 shows a simplified diagram of an autonomous device for the production and use of hydraulic power,

FIGS. 2 and 2A diagrammatically illustrate the normal operation of a preferred embodiment of the device of the invention;

FIG. 2 B is a partial view of the device of FIG. 2 in its security position,

FIG. 3 illustrates another embodiment of the device of FIG. 2.

In the following, and by way of non-limitative example, there is contemplated to use the device of the invention for feeding with hydraulic power operating elements of a producing submerged well head, comprising an acoustic transmitting-receiving device which may be of any known type and remotely controlled from a main surface installation, e.g. a floating installation which may be at a distance of several kilometers from the well head.

In this case, the elements to be controlled may be valves and it is desirable that any occuring failure of the equipment would result, for obvious security reasons, in the closure of the valves so as to prevent an uncontrolled production, the consequences of which might be serious.

FIG. 1 shows a simplified diagram of the autonomous device for production and use of hydraulic power, fed with an autonomous power generator such as an isotopic generator, a fuel cell or the like.

In this figure the electricity generator, diagrammatically shown and indicated by reference 1, feeds through a cable 2 the electric motor, now shown of the motor pump unit of a hydraulic accumulator 3. This generator also feeds with electric power, through a cable 4, the transmitter-receiver diagrammatically shown with reference 5.

The hydraulic accumulator provides the fluid necessary for the control of the element 6 , through the hydraulic conduits 7 and 8 and the distributor assembly diagrammatically shown with reference 9 .

The hydraulic distributors 9 are remotely controlled from the main installation by means of the transmitter-receiver 5 which transmits to these distributors, through a cable 10, a signal which is characteristic of the operation to be performed on element 6.

The principle of operation of this assembly is simple. The pump of the motor pump unit is driven in rotation by the motor fed with electric energy by the generator 1 and charges the hydraulic accumulators 3 which may deliver to member 6, when sufficiently charged, the required pressurized fluid, through hydraulic conduits 7 and 8 and distributors 9. The distributors 9 are actuated by a signal delivered by the transmitter-receiver 5 through cable 10.

FIG. 2 diagrammatically shows an embodiment of the device according to the invention in its operating position. The autonomous electricity generator 1 which may consist of an isotopic generator or a fuel cell, produces a direct current which, through cable 11, permanently charges a battery of electric accumulators 12. The charge current of battery 12 is maintained to a substantially constant value by means of a regulator 13, placed in series in the charge circuit of the battery. The value of said current is so selected as to be compatible both with the value of the current which the generator 1 can produce and with the charge current of battery 12 which, as well known by those skilled in the art, depends on the capacity of said battery.

This accumulator battery stores the power supplied by generator 1.

It feeds with electric current:

a motor 16 through cable 14 and switch 15,

a safety relay 17 through cable 20, said relay being controlled by two switches 18 and 19.

a condenser 22 connected in parallel with relay 17, through cable 21 and switch 18,

a first relay 24 of an electro-distributor 25, through cables 26 and 27 and switches 29 and 31 or through cables 26 and 27 and switch 33,

a second relay 23 of the electro-distributor 25, through cables 26 and 28 and switches 30 and 32.

The motor 16 drives in rotation a pump 34 for pressurizing the hydraulic fluid. This pump is connected through a filter 35 and a pipe 36 to a hydraulic fluid tank or cistern 70. The hydraulic fluid, pressurized by the pump 34, is distributed through pipes 37 to working hydraulic accumulators 38, connected in parallel, and through pipe 39 to a safety hydraulic accumulator 40. A non return valve 41 prevents the discharge of accumulators 38 into the pump 34, while a non-return valve 42 prevents the discharge of the safety hydraulic accumulator 40 into the working accumulators 38. In shunt connection at the outlet of pump 34, a security valve 43 connects the outlet of pump 34 to the tank 70 through pipe 44, when the hydraulic fluid pressure at the outlet of the pump exceeds a value P at which the valve 43 has been calibrated.

A pressurestat 45, connected to pipe 37 through pipe 46 and associated to the switch 15 by means of the connection diagrammatically shown and indicated by reference 71, permanently measures the pressure of the hydraulic fluid in accumulators 38. When said pressure is lower than a minimum predetermined value P min , the pressurestat 45 45 controls the closure of the switch 15, thereby allowing the feeding with electric current of the motor 16 driving the pump 34. When this pressure reaches a predetermined maximum valve P max, the pressurestat opens the switch 15, thereby discontinuing the operation of motor 16 and pump 34.

The working hydraulic accumulators 38 are connected through a pipe 47 to a number of control electro-distributors 25 (only one of these distributors being shown on the drawing for sake of clarity).

The electro-distributor is also connected through a pipe 48 to the tank 70.

The electro-distributor 25 is a four-ways and two-pistons distributor, controlled by two electrical relays 23 and 24. In the operating condition illustrated in FIG. 2, one of the outlets of the electro-distributor 25 is connected, through pipe 49, a safety hydraulic distributor 50 and a pipe 51, to one of the chambers 52 of a double-acting jack 53 which actuates the element to be operated (not shown) of the well head. The other outlet of the distributor 15 is similarly connected, through conduits 54 and 55 and safety hydraulic distributor 56 to the second chamber 57 of the double-acting jack 53.

The safety hydraulic distributors 50 and 56 are two-ways distributors with two positions hydraulically controlled by means of a single acting piston and comprising a return spring.

The pressure of the working hydraulic accumulators 38 is applied onto the control pistons of the safety hydraulic distributors 50 and 56 , through pipe 58 . During the normal operating phase , the distributors 50 and 56 are in the position shown in FIG. 2.

The safety hydraulic accumulator 40 is connected through pipe 59 to a second inlet of the safety distribu-

tor 50, while a pipe 60 connects the tank 70 to the second inlet of distributor 56.

The working hydraulic accumulators 38 are connected, through pipe 61, to the inlet of an electrical safety electro-distributor 62, having one way and two positions.

The outlet of distributor 62 is connected through pipe 63 to the tank 70. The electro-distributor 62 is actuated by a relay 64 connected to the terminals of condenser 22 through conductors 65 and 66 and switch 19.

Detectors 67 (only one of which is shown in the drawings) are used for measuring the characteristic parameters of the well operation such as the pressure, the temperature etc... and, in response to abnormal values of these parameters, deliver a signal which is transmitted, through cable 68 to relay 69 which actuates the opening of switches 31, 32 and the closure of switch 33.

Switches 29 and 30 are controlled by the transmitter-receiver 5 as hereinafter indicated.

According to the preferred embodiment, all the above-described elements, with the exception of the transmitter-receiver 5, the piston 53 and the detectors 67, are contained in a single tight caisson 70, forming the hydraulic fluid tank.

In order to avoid any liability of explosion, which might result from an accidental diffusion of hydrogen through the shielding of battery 12, there is added to this caisson a neutral gas such as argon and a redox catalyst favoring the conversion to water of oxygen traces, if any, in the presence of hydrogen.

The operation of the device according to the invention is described hereinafter.

The generator 1 permanently charges the battery 12 of electrical accumulators with a current maintained constant by regulator 13. The battery 12 feeds relay 17 which maintains the switches 18 and 19 in the position shown in FIG. 2, thereby allowing the condenser 22 to be charged through conductor 20, switch 18 and conductor 21, the electro-distributor 62 then being in the position shown in said figure. The switch 15 being closed by the pressurestat 45, the motor 16 is fed with electric current from battery 12, through cable 14.

The motor 16 drives the pump 34 which pressurizes the hydraulic fluid and feeds, through pipes 37 and 39 and non-return valves 41, 42, the working hydraulic accumulators 38 and the safety hydraulic accumulator 40. When the pressure is accumulators 38 and 40 reaches the predetermined maximum value Pmax, the pressurestat 45 opens the switch 15 for discontinuing the motor feed and stopping the pump 34. The non-return valve 42 prevents any discharge of accumulator 40 in the circuit of accumulators 38 and the valve 41 prevents the discharge of accumulators 38 into the pump 34. When the pressure in accumulators 38 decreases and reaches a predetermined minimal value different from zero, P min., the pressurestat closes the switch 15, thus allowing again the pressurization of accumulators 38 by the pump 34.

For reasons of security, the minimal pressure of operation, P min, has been so selected as to be sufficient for simultaneously insuring the closure of all the controlled elements.

The operating pressure of accumulators 38, transmitted through pipes 37 and 58, is applied onto two control pistons of the safety hydraulic distributors 50 and 56 which are then in the position shown in FIG. 2. In this position the distributors 50 and 56 establish a communication respectively between pipes 49 and 51 and pipes 54 and 55.

In the following explanation of the operation it will be assumed that the element to be controlled is initially in its open position (O).

At the reception of an order from the main installation, the transmitter-receiver 5 actuates the switches 29 and 30.

When the order is for closure (F) of the element to be controlled, the transmitter-receiver 5 opens the switch 30 and closes the switch 29 and vice-versa in the case of an order for opening (O).

When the switch 29 is closed, the relay 24 of electro-distributor 25 is fed with electric current through cables 26 and 27 and switches 29 and 31. The relay 24 than switches the electro-distributor to the position shown in FIG. 2 and the chamber 52 of the double-acting jack 53 is fed with pressurized fluid through pipes 47, 49 and 51, whereas chamber 57 is connected to the tank 70 through pipes 55, 54 and 48. The piston of the double-acting jack moves in such a direction as to result in the closure of the element to be controlled.

When the transmitter-receiver 5 receives an order of opening, it opens the switch 30 and the relay 23 of the electro-distributor 25 is then fed with current through cables 26 and 28 and switches 30 and 32.

This relay switches the distributor 25 to the position shown in FIG. 2A, i.e. where chamber 57 of piston 53 is fed with pressurized fluid through pipes 47, 54 and 55, whereas chamber 52 is connected with tank 70 through pipes 51, 49 and 48. The piston is then moved in the direction where it produces the closure of the controlled element.

As previously mentioned, it is desired that any failure of the device for the storage and use of hydraulic power, as described, results automatically in the switch to a security condition of all the controlled elements. In the considered particular case of a producing well head, the security condition has been defined as that of closure of the well head valves.

When, for example as a result of a leakage of the hydraulic circuit, the operating pressure of accumulators 38, falls below the above defined P min pressure, the return springs, conveniently calibrated of the safety distributors 50 and 56, switch said distributors to the position illustrated in FIG. 2B. By this way, the communications between pipes 49 and 51 on the one hand and between pipes 54 and 55 on the other hand, are interrupted, and pipes 51 and 55 are respectively connected to pipes 59 and 60.

Accordingly, as it is easy to see in FIG. 2B, the chamber 52 receives the previously stored pressurized fluid, as above indicated, in the safety hydraulic accumulator 40, whereas chamber 57 is connected to tank 70 and the piston of jack 53 moves in a direction where it results in the closure of the valve. Any remote control of piston 53 by means of receiver 5 than becomes impossible and the valves are kept closed.

When the anomaly having produced the pressure decrease below the P min value has disappeared and when the operating pressure of accumulators 38 again reaches a value between P min and P max, the distribu-

tors 50 and 56 are shifted back to their position shown in FIGS. 2 and 2A in the already indicated manner.

When the charge of the battery of electric accumulators 12 decreases below a value at which the voltage is lower than a predetermined value U min, the relay 17 is no longer fed sufficiently and the switch 18 opens, whereas the switch 19 closes. Accordingly, the condenser 22 is discharged in the relay of distributor 62 which is then switched to a position at which it discharges the hydraulic accumulators 38 by connecting the same with the tank 70, through pipes 37, 61 and 63, whereby the valves operated by pistons 53 are closed by the action of the safety hydraulic distributors 50 and 56, as above indicated.

Detectors such as 67 are permanently measuring certain parameters such as the pressure and the temperature in the producing well. When a parameter takes an abnormal value which may be dangerous for the well operation (e.g., a too high pressure), the corresponding detector delivers a signal which, through conductor 68, feeds the relay 69. This relay 69 opens the switches 31 and 32, thus preventing the execution of an order received by the transmitter-receiver 5, and closes the relay 33, this resulting, through nonconductor 26 and 27 and switch 33, in the feeding of the relay 24 of the electro-distributor, thereby causing, as above indicated, the switch of the valve to a closure position.

Other safety devices can be used. For example a distributor 43, provided at the outlet of pump 34, may be used for connecting the latter to the tank 70 when the pressure at the pump outlet reaches a value higher than the above defined predetermined value P max.

FIG. 3 illustrates another embodiment of the device shown in FIG. 2.

In this embodiment the detector 67 actuates a distributor or a discharge device 71, having one way and two positions. When the detector 67 delivers a security signal to relay 67 of said distributor 71, through cable 68, the distributor 71 takes the position shown in FIG. 3 where the conduit 58 is connected to the tank 70 through pipes 72 and 73, thereby causing, through the above-described procedure, the switch to their security position of the distributors 50 and 56 and the closure of the valves by the safety accumulator 40.

Modifications can be brought to the invention without departing from the spirit thereof. For example the distributors 50 and 56, shown separately in the drawings, may be replaced by a single safety distributor performing the same function.

The capacity of accumulator 40 will be selected great enough for insuring the simultaneous closure of all the elements. The hydraulic fluid will be selected by the user in accordance with the operating and the prevailing conditions (e.g., the ambient temperature). Furthermore, control devices, not shown in the drawings, may be used for transmitting position or operation data through the 5, from the device to the main installation.

What we claim as this invention is:

1. An autonomous device for the storage and use of a pressurized fluid, comprising at least one main fluid accumulator, connected to a source of pressurized fluid, and at least one member using the pressure of said fluid, having one operating element (53) comprising a first orifice (O), the feeding of which with pressurized fluid insures the operation of said member, and a second orifice (F), the feeding of which insures the switching to a security position of said member, said operating element being connected to said accumulator through a main distributor (25) of pressurized fluid having a first (54) and a second (49) outlet ducts, respectively feeding said first (O) and said second (F) orifices with pressurized fluid from said main accumulator (38), said distributor being provided with remote control means, said device comprising a safety accumulator (40) of pressurized fluid, wherein said safety accumulator (40) is connected to said second orifice (F) of the operating element (53) in parallel with said second outlet duct (49) of the main distributor, through a safety distributor (50, 56) having a working position at which said second orifice (F) of the operating element (53) communicates with said second outlet duct (49) of the main distributor and an emergency position at which said safety distributor establishes a communication between said second orifice and said safety accumulator while discontinuing any communication between said orifices of the operating element and said main distributor equipped with remote control means, and wherein means for detecting failures of the device, connected to said safety distributor are adapted to automatically switch the latter to the emergency position in case of failure of the device.

2. A device according to claim 1, wherein said means for detecting the failures of the device comprise hydraulic means for controlling said safety distributor, said means being connected (58) to said main hydraulic accumulator and being adapted to maintain said safety distributor (50, 56) against the antagonistic action of repelling means, in said working position for values of the hydraulic fluid pressure in said main accumulator at least equal to a predetermined value P min.

3. A device according to claim 2, comprising at least one hydraulic discharge device (62, FIG. 2 ; 71, FIG. 3) the inlet of which is connected to the main hydraulic accumulator (38) and adapted, in response to a control signal, to switch to the emergency position said safety distributor (50, 56), by decreasing the hydraulic pressure feeding said hydraulic means for controlling said safety distributor (50, 56).

4. A device according to claim 3, comprising an autonomous power source feeding a battery of electrical accumulators (12) which supplies a current to a motor (M) driving a pump (P1 for pressurizing the fluid, comprising an electrical relay (17) fed by said electrical battery (12) and actuating two switches (18, 19) a first one of which (18) connects a condenser (22) to the terminals of the electrical battery (12) and the second one (19) connects said condenser (22) to the terminals of a relay (64) for controlling said hydraulic discharge device (62), said relay (64) being, for a value of the voltage at the battery terminals greater than a predetermined value Um, adapted to close said first switch (18) and to maintain open said second switch (19), thus allowing the capacity to be charged, and conversely, for a value of the voltage at the battery terminals lower than said predetermined value Um, to open said first switch (18) and to close said second switch (19), thereby allowing the discharge device (62) to be controlled by the discharge of condenser (22) in said control relay (64) so as to place said discharge device 62 in a posi-

tion at which the pressure drop acting on said controlling jack causes the switch to the emergency position of said safety distributor (50, 56).

5. Device according to claim 3, comprising detectors (67) for controlling the characteristic operation parameters of the device, wherein said detectors are adapted (FIG. 3) to deliver an order signal for abnormal values of the parameters, said signal being adapted to switch said discharge device (71) to a position at which said hydraulic pressure drop, acting on said hydraulic control means, causes the switching of said safety distributor (50, 56) to the emergency position.

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