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(54) Acoustic impulse gun

(57) An acoustic impulse gun (10) and associated methods of transmitting signals to equipment positioned in a subterranean well permits the signals to be transmitted in a safe, economical, convenient and efficient manner. The acoustic impulse gun (10) includes an accumulator (12), which is momentarily placed in fluid communication with the well when fluid pressure is applied to a device (20) interconnected between the accumulator (12) and the well. The device (20) includes a shuttle (32) which displaces relative to an inlet port (16) in fluid communication with the accumulator (12), and a discharge port (18) in fluid communication with the well. Fluid pressure is applied to the device (20) in a pattern by a signal control system, thereby causing the shuttle (32) to successively and rapidly permit fluid pressure pulses to be applied to the well.

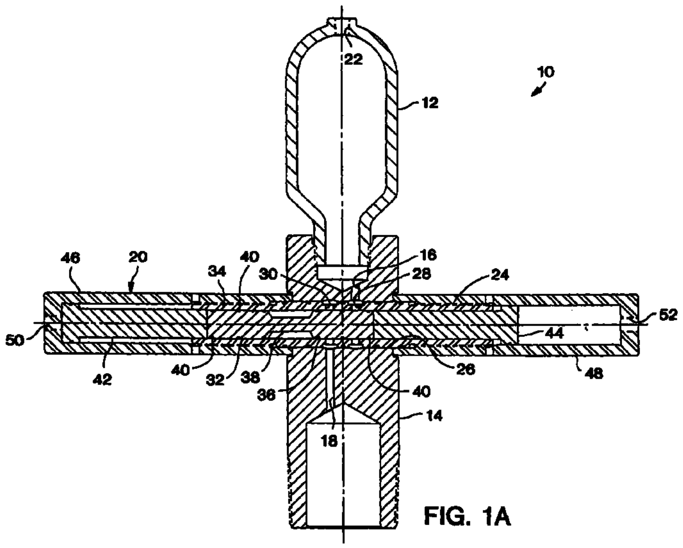

FIG. 1A

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Description

[0001] The present invention relates generally to operations performed, and equipment utilized, in conjunction with subterranean wells and, more particularly, relates to an acoustic impulse gun and methods associated therewith.

[0002] Many times the level of fluid in a tubing string is determined by sending a pressure pulse down the interior of the tubing string and recording the time it takes for the pressure pulse to be reflected back off of the fluid. Knowing the speed of the pressure pulse and the time of travel, a simple mathematical equation yields the fluid level in the tubing string. It would, however, be advantageous to use a succession of pressure pulses to transmit signals (data, commands, etc.) to equipment in a subterranean well, for example, to activate the equipment, regulate the equipment, change an item of equipment's configuration, etc.

[0003] In order to transmit pressure pulse signals, an apparatus would preferably have the capability of producing a rapid succession of pulses, which would permit transmission of signals in a manner similar to that used in electronic circuits. The produced pressure pulse should have a steep ramp up to a desired level, and then a steep ramp down from that level. The duration and magnitude of the pulses should be easily controllable.

[0004] For safety at the wellsite, the apparatus should not require any electrical equipment in close proximity to the wellhead. For economics reasons, the apparatus should be relatively inexpensive to produce, compact, easily transportable, reliable and easy to maintain.

[0005] In carrying out the principles of the present invention, in accordance with an embodiment thereof an acoustic impulse gun is provided which permits a rapid succession of well-defined pressure pulses to be applied to a subterranean well. The pressure pulses are capable of carrying data, commands, etc. in a recognizable form to equipment in the well. Associated methods are also provided.

[0006] In broad terms, an apparatus is provided which includes a device responsive to a pattern of fluid pressures applied thereto. A member of the device displaces relative to inlet and discharge ports of the apparatus in response to the pattern of fluid pressures, to thereby apply pressure pulses to a well. The pattern of fluid pressures corresponds to a desired signal, which also corresponds to the pressure pulses applied to the well. A signal control system is utilized to generate the required pattern of fluid pressures, so that the desired signal is produced by the apparatus.

[0007] In one aspect of the present invention, the apparatus includes an accumulator in fluid communication with the inlet port. The accumulator is continuously supplied with fluid pressure from a fluid pressure source, such as a relatively high pressure nitrogen bottle. The accumulator ensures that a ready supply of pressurized fluid is available to apply a pressure pulse to the well.

[0008] In another aspect of the present invention, the member of the device is a shuttle having a reduced diameter portion positioned between enlarged diameter portions. The enlarged diameter portions may be sealingly disposed between the inlet and discharge ports, so that, when the shuttle is displaced, one of the enlarged diameter portions initially prevents fluid communication between the inlet and discharge ports, the reduced diameter portion then momentarily permits fluid communication between the inlet and discharge ports, and then the other enlarged diameter portion again prevents fluid communication between the inlet and discharge ports. In this manner, a well-defined pressure pulse is applied to the well. The shuttle may be reciprocated to generate a rapid succession of the pressure pulses.

[0009] In yet another aspect of the present invention, the signal control system includes an electronic device, such as a computer, interconnected to a valve. The valve is interconnected between a relatively low fluid pressure source, such as pressurized air, and the device. An operator may select, via the computer, a desired signal to be sent to the equipment in the well, and the computer causes the valve to apply an appropriate corresponding pattern of fluid pressures to the device.

[0010] According to another aspect of the invention there is provided apparatus operatively connectable to a subterranean well, the apparatus comprising: a first fluid pressure source; an inlet fluid passage; a discharge fluid passage; and a device having fluid pressure continuously applied thereto from the first fluid pressure source via the inlet fluid passage, the device including a member displaceable relative to the discharge fluid passage to thereby intermittently permit fluid communication between the inlet and discharge fluid passages.

[0011] In an embodiment, the device is interconnected to a second fluid pressure source, the member alternately permitting and preventing fluid communication between the inlet and discharge fluid passages in response to fluid pressure applied to the device from the second fluid pressure source. The member may displace in a first direction when fluid pressure is applied to a first portion of the device, and the member displaces in a second direction opposite to the first direction when fluid pressure is applied to a second portion of the device. The first portion may include a first piston, and the second portion may include a second piston, the first and second pistons being operative to displace the member in the first and second directions, respectively.

[0012] The device may be interconnected to the second fluid pressure source via a signal control system, the signal control system controlling application of fluid pressure to the device from the second fluid pressure source. The signal control system may cause signals to be transmitted via alternately permitting and preventing fluid communication between the inlet and discharge fluid passages. The signal control system may include a valve, the valve controlling application of fluid pressure from the second fluid pressure source to the device. The signal control system may cause fluid pressure to be applied from the second fluid pressure source to the device in patterns corresponding to resulting signals transmitted via fluid communication between the inlet and discharge fluid passages.

[0013] According to another aspect of the invention there is provided an acoustic impulse gun, comprising: an accumulator; a discharge port; and a shuttle having first, second and third portions, and the shuttle being selectively reciprocably positionable in first, second and third positions relative to the accumulator and discharge port, in the first position the first portion preventing fluid communication between the accumulator and the discharge port, in the second position the second portion permitting fluid communication between the accumulator and the discharge port, and in the third position the third portion preventing fluid communication between the accumulator and the discharge port.

[0014] In an embodiment, the acoustic impulse gun further comprises a first piston, the first piston biasing the shuttle to displace to the first position in response to fluid pressure applied to the first piston. The first piston may be separately formed from the shuttle.

[0015] In an embodiment, the acoustic impulse gun further comprises a second piston, the second piston biasing the shuttle to displace to the third position in response to fluid pressure applied to the second piston.

[0016] In an embodiment, the acoustic impulse gun further comprises a valve, the valve selectively applying fluid pressure alternately to the first and second pistons. The valve may be a solenoid valve.

[0017] In an embodiment, the valve is interconnected to an electronic device, the electronic device causing the valve to selectively apply fluid pressure to the first and second pistons to thereby transmit signals via discharges from the discharge port.

[0018] According to another aspect of the invention there is provided apparatus for transmitting signals to remotely positioned equipment in a subterranean well, the apparatus comprising: first and second fluid pressure sources; an inlet port fluid communicable with the first fluid pressure source; a discharge port communicable with the equipment; and a device alternately permitting and preventing fluid communication between the inlet port and the discharge port in response to fluid pressure applied to the device from the second fluid pressure source.

[0019] In an embodiment, fluid pressure is applied to the device from the second fluid pressure source via a valve, the valve alternately applying fluid pressure to the device and venting fluid pressure from the device. The valve may be interconnected to an electronic device, the electronic device causing the valve to apply and vent fluid pressure from the device to thereby transmit signals to the equipment.

[0020] In an embodiment, the device includes a member having first and second portions thereof, and first and second positions relative to the inlet and discharge ports, in the first position the first portion preventing fluid communication between the inlet and discharge ports, and in the second position the second portion permitting fluid communication between the inlet and discharge ports. The member further may have a third portion thereof, and a third position relative to the inlet and discharge ports, in the third position the third portion preventing fluid communication between the inlet and discharge ports. The second portion may be positioned between the first and third portions. The member may be axially reciprocably displaceable between the first, second and third positions.

[0021] According to another aspect of the invention there is provided a method of transmitting a signal to equipment positioned in a subterranean well, the method comprising the steps of: interconnecting an apparatus to the well, the apparatus including an accumulator; and activating the apparatus, causing the accumulator to be intermittently placed in fluid communication with the well, and thereby transmitting the signal to the equipment.

[0022] In an embodiment, the activating step further comprises alternately applying and releasing fluid pressure from a portion of the apparatus.

[0023] In an embodiment, the method further comprises the step of interconnecting the apparatus to a fluid pressure source, and the activating step further comprises placing the fluid pressure source in fluid communication with the apparatus.

[0024] In an embodiment, the apparatus further includes a device operative to selectively permit and prevent fluid communication between the accumulator and the well. The method may further comprise the step of interconnecting the accumulator to a first fluid pressure source, and interconnecting the device to a second fluid pressure source. The apparatus may further include a signal control system, and the method may further comprise the step of interconnecting the signal control system to the second fluid pressure source and the device.

[0025] In an embodiment, the activating step further comprises activating the signal control system to cause fluid pressure to be applied from the second fluid pressure source to the device in a pattern corresponding to the transmitted signal.

[0026] In an embodiment, the activating step further comprises activating the signal control system to cause fluid pressure to be alternately applied to and released from a first portion of the device. The activating step may further comprise activating the signal control system to cause fluid pressure to be alternately applied to and released from a second portion of the device. In the activating step, fluid communication may be momentarily permitted between the accumulator and the well when fluid pressure is applied to the first portion of the device by the signal control system, and fluid communication may be momentarily permitted between the accumulator and the well when fluid pressure is applied to the second portion of the device by the signal control system.

[0027] According to another aspect of the invention there is provided a method of transmitting a signal to equipment positioned in a subterranean well, the method comprising the step of: applying a relatively rapid succession of fluid pressure pulses to the well, the pressure pulses being applied in response to displacement of a member relative to an inlet port and a discharge port of a device, and displacement of the member being controlled by a signal control system, the signal control system causing fluid pressure to be applied to the device in a pattern corresponding to the succession of fluid pressure pulses.

[0028] In an embodiment, each application of fluid pressure to the device results in a fluid pressure pulse being applied to the well.

[0029] In an embodiment, the member is displaced relatively rapidly from a position in which the member prevents fluid communication between the inlet and discharge ports to a position in which the member permits fluid communication between the inlet and discharge ports, in response to fluid pressure applied to the device by the signal control system.

[0030] In an embodiment, the method further comprises the step of continuously applying fluid pressure to the inlet port from a first fluid pressure source during the step of applying fluid pressure pulses to the well. The step of applying fluid pressure pulses to the well further may comprise utilizing the signal control system to selectively permit fluid communication between a second fluid pressure source and the device.

[0031] Reference is now made to the accompanying drawings, in which:

FIG. 1A is a cross-sectional view of an embodiment of an acoustic impulse gun according to the present invention, the gun being shown in a first configuration;

FIG. 1B is a cross-sectional view of the acoustic impulse gun of FIG. 1A, the gun being shown in a second configuration; and

FIG. 2 is a schematic view of a method of transmitting signals to equipment in a well, according to the present invention.

[0032] Representatively illustrated in FIGS. 1A&B is an acoustic impulse gun 10 which embodies principles of the present invention. In the following description of the gun 10 and other apparatus and methods described herein, directional terms, such as "above" "below", "upper", "lower", etc., are used for convenience in referring to the accompanying drawings. Additionally, it is to be understood that the various embodiments of the present invention described herein may be utilized in various orientations, such as inclined, inverted, horizontal, vertical, etc., without departing from the principles of the present invention.

[0033] The gun 10 includes a generally bottle-shaped accumulator 12 threadedly and sealingly attached to a generally cylindrical body 14. The body 14 has an inlet pod or fluid passage 16 formed therein in fluid communication with the accumulator 12, and a discharge pod or fluid passage 18 formed therein in fluid communication with a lower end of the body. The lower end of the body 14 is provided with threads for attachment to a wellhead or tubular member of a well, as will be described more fully below. The accumulator 12 is provided with a port 22 for connection to a fluid pressure source, as described in further detail below.

[0034] It is to be clearly understood that the specific construction details of the gun 10 described herein may be varied without departing from the principles of the present invention. For example, it is not necessary for the accumulator 12 to be shaped as shown in the drawings, attachment means other than threads, such as a flange, may be utilized for attaching the body 14 to the well, etc. Note that the accumulator 12 provides a ready source of pressurized fluid in a volume suitable for the intended use of the gun 10, and that the accumulator could be another type of member, such as a hose or line attached to the body, if that member is capable of supplying an adequate volume of pressurized fluid to the gun.

[0035] A device 20 is inserted laterally through the body 14. The device 20 is utilized to momentarily permit fluid communication between the accumulator 12 (or other fluid pressure source) and the well. This is accomplished, when the body 14 is attached to the well, by permitting momentary fluid communication between the inlet and discharge ports 16, 18. Thus, the inlet and discharge ports 16,18 are initially isolated from each other, momentarily placed in fluid communication with each other, and then again isolated from each other.

[0036] The device 20 includes a sleeve 24 sealingly installed in a bore 26 of the body 14, which intersects both of the inlet and discharge ports 16, 18. Note that the inlet port 16 is laterally spaced apart from the discharge port 18, and that the sleeve 24 is sealingly engaged in the bore 26 between the inlet and discharge ports, and to either side of the inlet and discharge ports. Openings 28 formed through the sleeve 24 permit fluid communication between the inlet port 16 and the interior of the sleeve, and openings 30 formed through the sleeve permit fluid communication between the discharge port 18 and the interior of the sleeve.

[0037] A generally cylindrical member or shuttle 32 is reciprocably slidingly and sealingly received in the interior of the sleeve 24. The shuttle 32 includes two radially enlarged portions 34, 36 at its opposite ends, and a radially reduced portion 38 formed between the radially enlarged portions. Each of the radially enlarged portions 34, 36 carries seals 40 thereon which sealingly engage between the shuttle 32 and the interior of the sleeve 24. Thus, with the shuttle 32 positioned as shown in FIG. 1A, the seals 40 on the radially enlarged portion 36 prevent fluid communication between the inlet and discharge ports 16, 18. With the shuttle 32 positioned as shown in FIG. 1B, the seals 40 on the radially enlarged portion 34 prevent fluid communication between the inlet and discharge ports 16, 18. Note that it is not necessary for the seals 40 to be configured as shown, or for the seals to be carried on the shuttle 32, for example, the seals could be installed internally in the sleeve 24, so that the seals do not displace with the shuttle, a fewer or greater number of seals could be used, etc.

[0038] When the shuttle 32 is between the positions shown in FIGS. 1A&B, the radially reduced portion 38 permits fluid communication between the inlet and discharge ports 16, 18, that is, between openings 28 and openings 30. At that point, fluid pressure may be discharged from the accumulator 12 to the well via the discharge port 18, thereby applying a pressure pulse to the well. Thus, if the shuttle 32 is rapidly reciprocated between the positions shown in FIGS. 1A&B, a rapid succession of pressure pulses will be applied to the well. Additionally, by timing the succession of pressure pulses appropriately, adjusting the duration of the pressure pulses individually or collectively, or adjusting other characteristics of the pressure pulses, it will be readily appreciated by one skilled in the art that signals may be transmitted by the gun 10 in a manner similar to that in which signals are transmitted in digital electronic circuits.

[0039] To displace the shuttle 32 relative to the inlet and discharge ports 16, 18, pistons 42, 44 are disposed adjacent opposite lateral ends of the shuttle. Each of the pistons 42, 44 is sealingly and reciprocably received in a generally tubular cylinder, 46, 48, respectively. The cylinders 46, 48 are threadedly attached to opposite ends of the sleeve 24. Note that, although the pistons 42, 44 are representatively illustrated as being separate from the shuttle 32, they could easily be formed integrally therewith.

[0040] To displace the shuttle 32 laterally to the right as viewed in FIGS. 1A&B, fluid pressure is applied to a port 50 formed through an end of the cylinder 46. This fluid pressure may be of a relatively low level, such as compressed air pressure commonly available at wellsites (about 80-100 psi {552 to 689 kPa}). The fluid pressure applied to port 50 biases the piston 42 to the right, and the piston, in turn, biases the shuttle 32 to the right.

[0041] To displace the shuttle 32 laterally to the left as viewed in FIGS. 1A&B, fluid pressure is applied to a port 52 formed through an end of the cylinder 48. This fluid pressure may also be of a relatively low level. The fluid pressure applied to port 52 biases the piston 44 to the left, thereby biasing the shuttle 32 to the left as well.

[0042] Thus, to reciprocate the shuttle 32 laterally within the sleeve 24 and cause a succession of pressure pulses to be delivered to the discharge port 18, fluid pressure may be applied alternately to the ports 50, 52. Note that fluid pressure is preferably not applied to the ports 50, 52 simultaneously, although a device in which fluid pressure is applied simultaneously to ports could be constructed in accordance with the principles of the present invention. Preferably, fluid pressure in one of the cylinders 46, 48 is vented to atmosphere when fluid pressure is applied to the other cylinder.

[0043] Additionally, it is not essential for two ports 50, 52 to be utilized for admitting fluid pressure to the device 20. For example, a single port, cylinder and piston could be used to bias the shuttle 32 in one direction, and a biasing member, such as a spring, could be used to bias the shuttle in another direction. Thus, the device 20 may be constructed in any of a variety of different ways, without departing from the principles of the present invention.

[0044] Referring additionally now to FIG. 2, the gun 10 is representatively illustrated sealingly attached to a tubular string 62 extending into a subterranean well, in a method 60 of transmitting signals to equipment within the well. Note that the gun 10 could be otherwise positioned and attached to the well. For example, the gun 10 could be attached directly to a wellhead 64 of the well, could be positioned within the well, etc., without departing from the principles of the present invention.

[0045] The tubular string 62 has equipment attached thereto, representatively, a packer 66 and a valve 68. These items of equipment are specially configured to be responsive to signals transmitted via pressure pulses applied to the well. For example, the packer 66 may be set within casing 70 of the well by transmitting a first pressure pulse signal, the packer may be unset by transmitting a second pressure pulse signal, the valve 68 may be opened by transmitting a third pressure pulse signal, and the valve may be closed by transmitting a fourth pressure pulse signal. Examples of equipment responsive to pressure pulse signals transmitted in wells, and manners of receiving such transmitted pressure pulse signals by equipment positioned within wells, may be found in U.S. patent application serial no. 09/056,053 filed April 6, 1998, entitled Pressure Impulse Telemetry Apparatus and Method, having Kenneth J. Carstensen, Neal G. Skinner and Charles M. Pool as inventors thereof, and U.S. patent application serial no. 09/056,055 filed April 6, 1998, entitled High Impact Communication and Control System, having Kenneth J. Carstensen as inventor thereof Of course, equipment other than packers and valves may be controlled by transmission of pressure pulse signals within wells, without departing from the principles of the present invention.

[0046] A relatively high pressure fluid pressure source 72, such as a bottle of compressed nitrogen (approximately 2,000-2,500 psi {13.8 to 17.2 MPa}) is interconnected via a line 74 to port 22 of the accumulator 12. A conventional regulator 75 interconnected between the fluid pressure source 72 and the line 74 controls the fluid pressure applied to the accumulator 12. In the method 60, the fluid pressure source 72 is continuously in fluid communication with the accumulator 12, so that the accumulator is continuously supplied with a relatively high fluid pressure, and that relatively high fluid pressure is continuously available in sufficient volume for generation of pressure pulse signals by the device 20. However, it is to be clearly understood that relatively high fluid pressure may be made available to the device 20 in other manners, without departing from the principles of the present invention.

[0047] A line 76 is interconnected to another fluid pressure source at a relatively low pressure, such as a rig compressed air supply. Other fluid pressure sources could be utilized, however. For example, the line 76 could be connected to the nitrogen bottle 72, and could be at a relatively high pressure, or a regulator could be used to reduce the pressure of the nitrogen to a lower level, etc.

[0048] The line 76 is interconnected to a valve 78, representatively a four-way solenoid valve. The valve 78 is a portion of a signal control system 80, which also includes an electronic device 82 and a driver 84 interconnected between the electronic device and the valve. The electronic device 82 is representatively a computer, but it could be another type of electronic device capable of generating desired signals in response to human input, or input from other electronic devices, mechanical devices, etc. The driver 84 is of conventional design and may be separate from the computer 82, a circuit board within the computer, etc. The driver 84 activates the valve 78 in response to the signals generated by the computer 82.

[0049] Lines 86, 88 interconnect the valve 78 to the ports 50, 52, respectively, of the device 20. As shown in FIG. 2, the valve 78 directs fluid pressure in line 76 to port 52, and vents fluid pressure from port 50 to atmosphere. The valve 78 is also configured to direct fluid pressure in line 76 to port 50, while venting fluid pressure from port 52 to atmosphere. Thus, by alternately energizing and de-energizing the solenoid valve 78, fluid pressure may be alternately applied to, and vented from, ports 50, 52. As described above, such alternate application of fluid pressure to the ports 50, 52 causes the device 20 to generate pressure pulses which, since the body 14 is connected to the tubular string 62, will cause the pressure pulses to be transmitted in the well. A desired relatively rapid succession of pressure pulses may be produced by relatively rapid alternate application of fluid pressure to the ports 50, 52. Other types of valves may be used in the signal control system 80, and other types of signal control systems may be utilized in the method 60, without departing from the principles of the present invention.

[0050] In order to transmit a desired signal to an item of equipment in the well, such as the first signal described above to set the packer 66, an operator could select a packer setting command from a menu on the computer 82, the computer would send an appropriate signal to the driver 84, the driver would activate the valve 78 to apply a corresponding pattern of alternating fluid pressures to the ports 50, 52, in response the device 20 would send a corresponding pattern of pressure pulses into the well, and the packer would receive the transmitted pressure pulse signal and set in the casing 70.

[0051] Note that, in the method 60, no electrical devices need be in close proximity to the wellhead 64. The valve 78, computer 82 and driver 84 are preferably, although not necessarily, located remote from the wellhead 64, thereby decreasing any danger of ignition of flammable fluids near the wellhead. Thus, it will be readily appreciated that the method 60 permits equipment in the well to be remotely activated, operated, etc. in a safe, convenient and efficient manner.

[0052] It will be appreciated that the invention described above may be modified.

Claims

1. Apparatus (10) operatively connectable to a subterranean well, the apparatus (10) comprising: a first fluid pressure source (72); an inlet fluid passage (16); a discharge fluid passage (18); and a device (20) having fluid pressure continuously applied thereto from the first fluid pressure source (72) via the inlet fluid passage (16), the device including a member (32) displaceable relative to the discharge fluid passage (18) to thereby intermittently permit fluid communication between the inlet and discharge fluid passages (16,18).

2. Apparatus (10) according to Claim 1, wherein the device (20) is interconnected to a second fluid pressure source, the member (32) alternately permitting and preventing fluid communication between the inlet and discharge fluid passages (16,18) in response to fluid pressure applied to the device (20) from the second fluid pressure source.

3. An acoustic impulse gun (10), comprising: an accumulator (12); a discharge port (18); and a shuttle (32) having first, second and third portions (34,38,36), and the shuttle (32) being selectively reciprocably positionable in first, second and third positions relative to the accumulator (12) and discharge port (18), in the first position the first portion (34) preventing fluid communication between the accumulator (12) and the discharge port (18), in the second position the second portion (38) permitting fluid communication between the accumulator (12) and the discharge port (18), and in the third position

the third portion (36) preventing fluid communication between the accumulator (12) and the discharge port (18).

4. An acoustic impulse gun (10) according to Claim 3, further comprising a first piston (42), the first piston (42) biasing the shuttle (32) to displace to the first position in response to fluid pressure applied to the first piston (42).

5. Apparatus for transmitting signals to remotely positioned equipment (66,68) in a subterranean well, the apparatus comprising: first (72) and second fluid pressure sources; an inlet port (16) fluid communicable with the first fluid pressure source (72); a discharge port (18) communicable with the equipment (66,68); and a device (20) alternately permitting and preventing fluid communication between the inlet port (16) and the discharge pod (18) in response to fluid pressure applied to the device (20) from the second fluid pressure source.

6. Apparatus according to Claim 5, wherein fluid pressure is applied to the device (20) from the second fluid pressure source via a valve (78), the valve (78) alternately applying fluid pressure to the device (20) and venting fluid pressure from the device (20).

7. A method of transmitting a signal to equipment (66,68) positioned in a subterranean well, the method comprising the steps of: interconnecting an apparatus (10) to the well, the apparatus (10) including an accumulator (12); and activating the apparatus (10), causing the accumulator (12) to be intermittently placed in fluid communication with the well, and thereby transmitting the signal to the equipment (66,68).

8. A method according to Claim 7, wherein the apparatus (10) further includes a device (20) operative to selectively permit and prevent fluid communication between the accumulator (12) and the well, and further comprising the steps of interconnecting the accumulator (12) to a first fluid pressure source (72), and interconnecting the device to a second fluid pressure source.

9. A method of transmitting a signal to equipment (66,68) positioned in a subterranean well, the method comprising the step of applying a relatively rapid succession of fluid pressure pulses to the well, the pressure pulses being applied in response to displacement of a member (32) relative to an inlet port (16) and a discharge port (18) of a device (20), and displacement of the member (32) being controlled by a signal control system, the signal control system causing fluid pressure to be applied to the device (20) in a pattern corresponding to the succession of fluid pressure pulses.

10. A method according to Claim 9, further comprising the step of continuously applying fluid pressure to the inlet port (16) from a first fluid pressure source (12) during the step of applying fluid pressure pulses to the well.

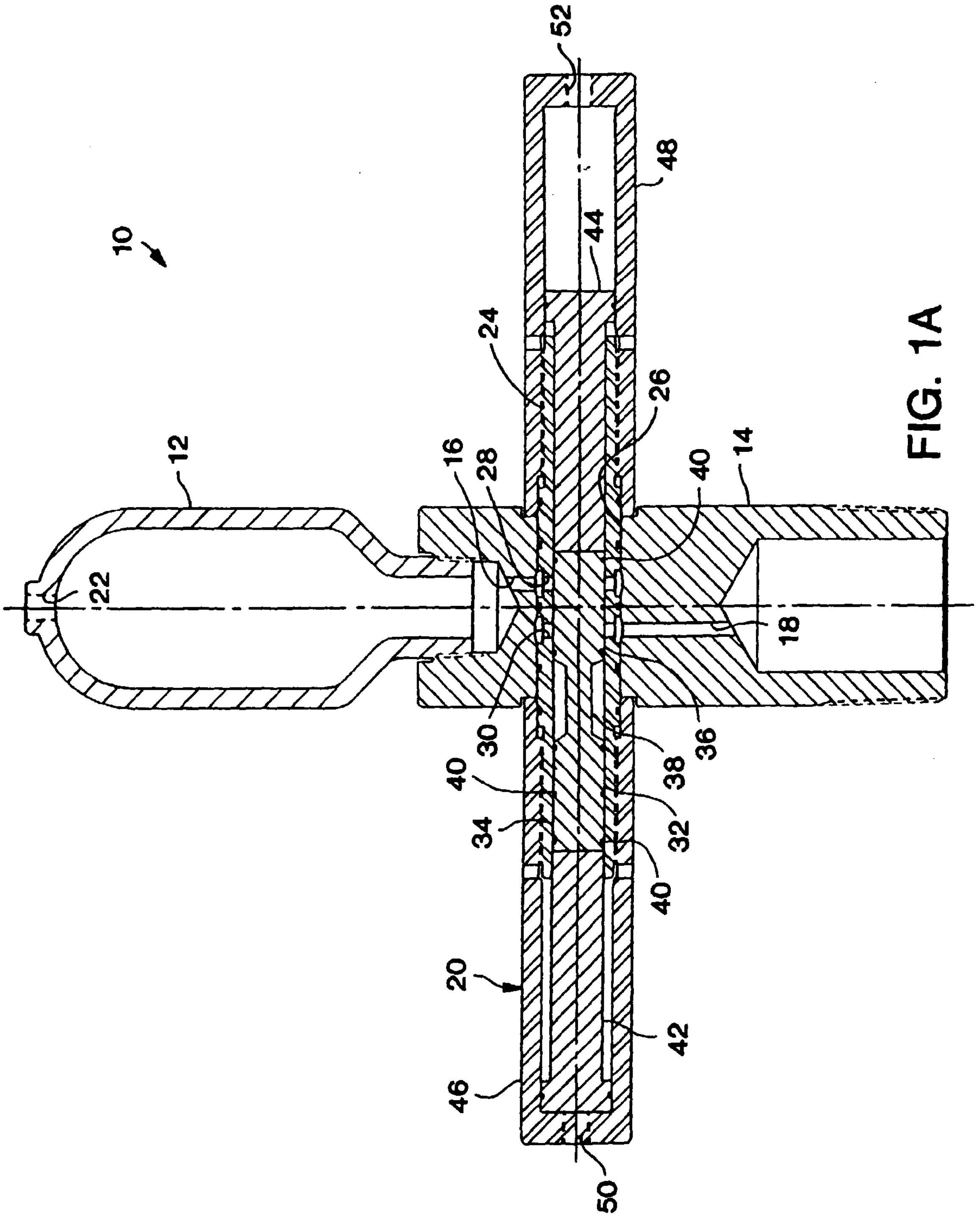

FIG. 1A

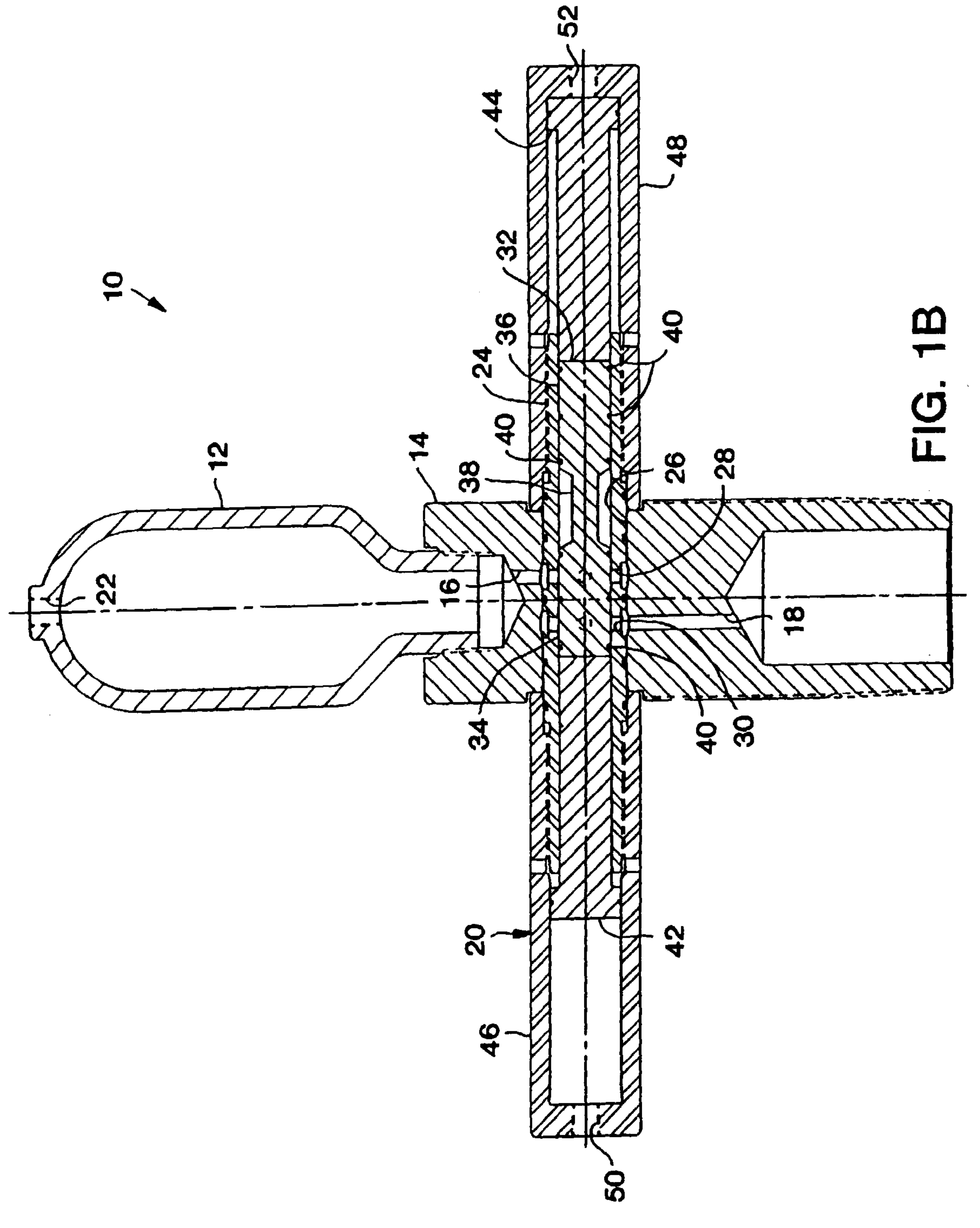
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FIG. 1B

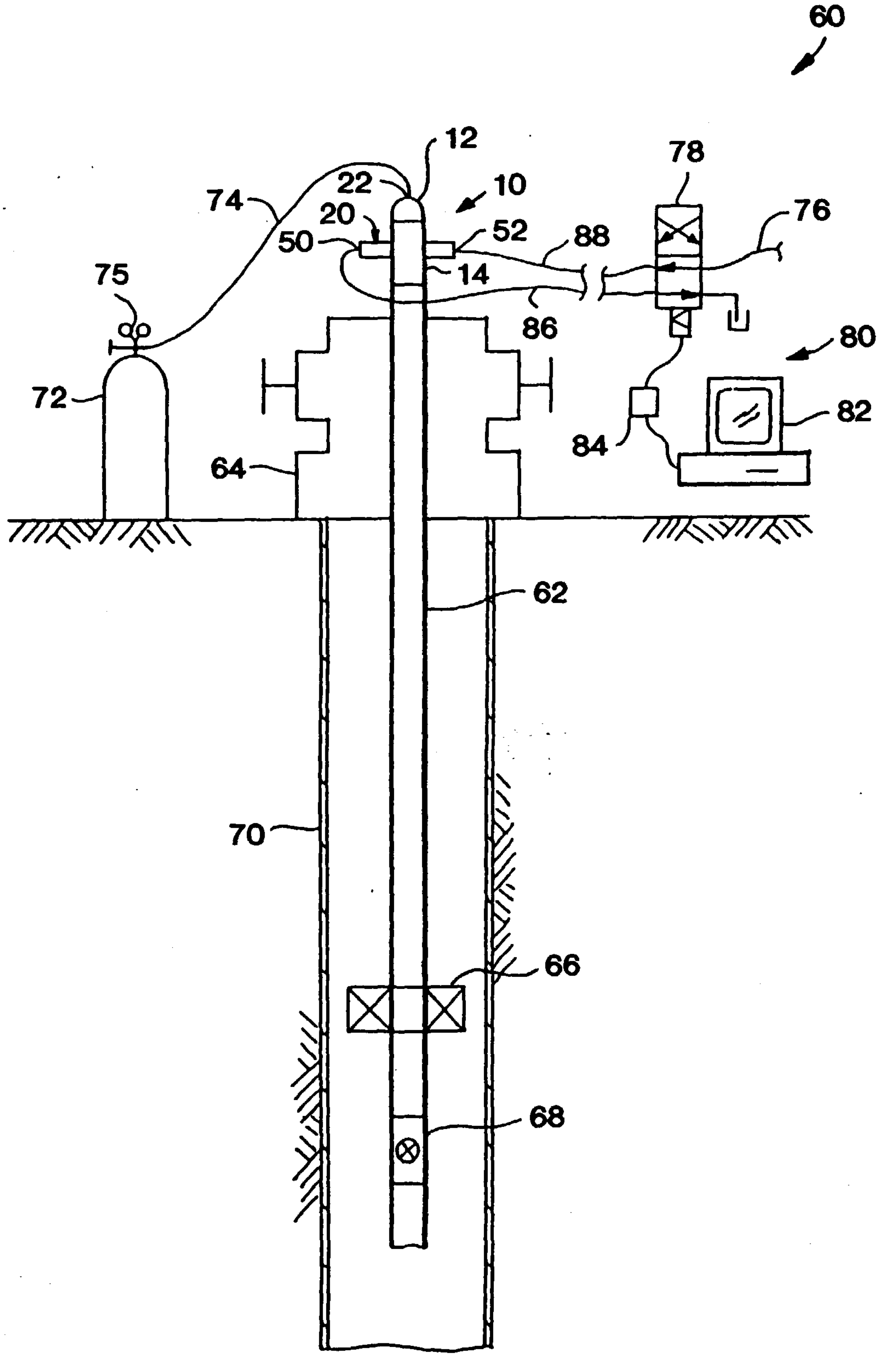

FIG. 2

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 99 30 8253

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	WO 98 45731 A (CARSTENSEN KENNETH J) 15 October 1998 (1998-10-15) * page 4, paragraph 1 *	1,7,9,10	E21B47/18
Y	* page 7, line 1 - page 9, line 10; figures *	2,5,6,8	
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Y	* abstract; figure A *	2,5,6,8	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			E21B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	2 February 2000	Weiand, T

CATEGORY OF CITED DOCUMENTS

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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 99 30 8253

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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02-02-2000

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