Sept. 20, 1966 R. W. DER MOTT 3,273,645

WELL COMPLETION APPARATUS

Filed July 23, 1962 3 Sheets-Sheet 1

Fig. 1

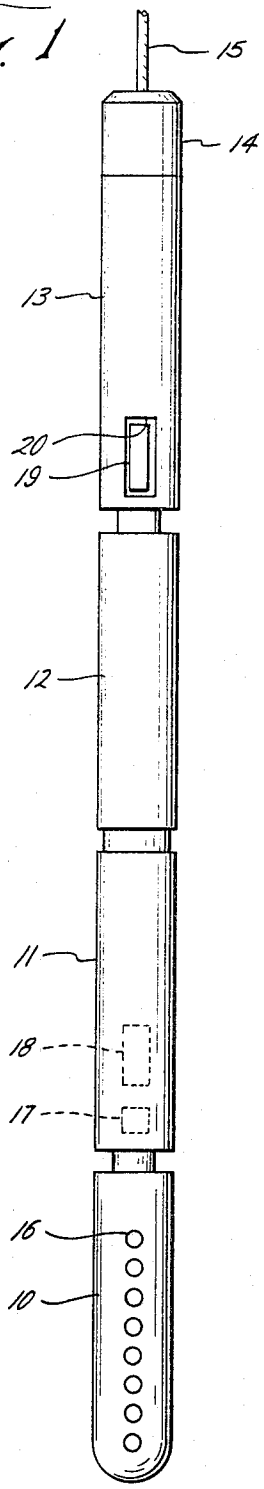


Fig. 2

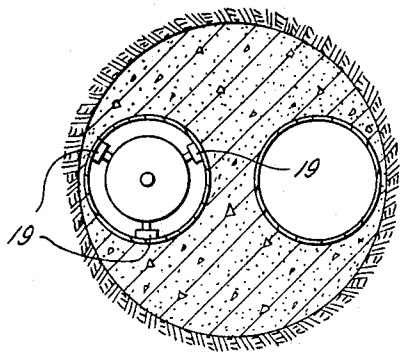
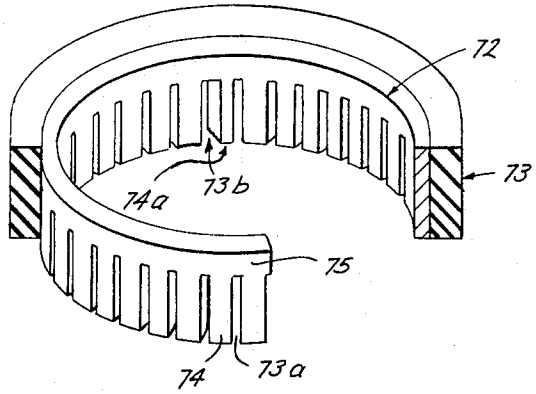


Fig. 5



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WELL COMPLETION APPARATUS

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Fig. 3

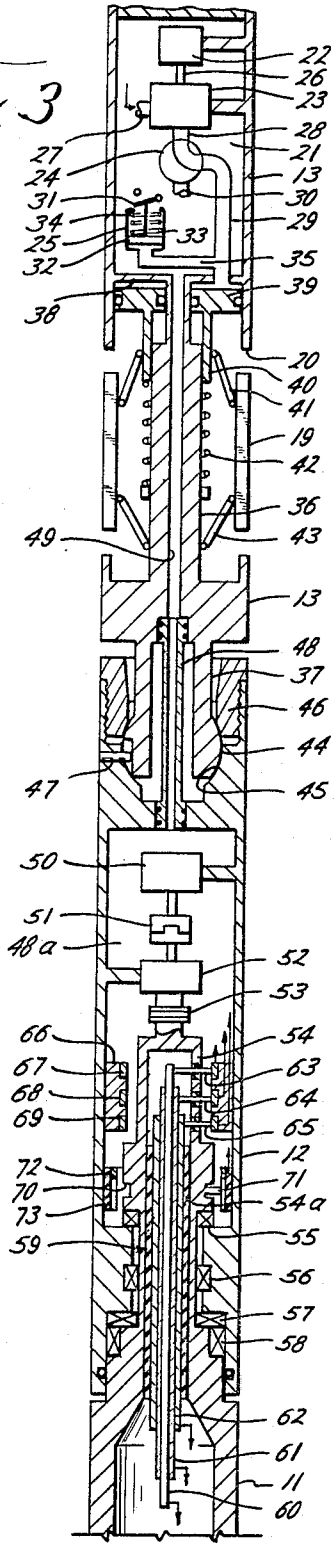
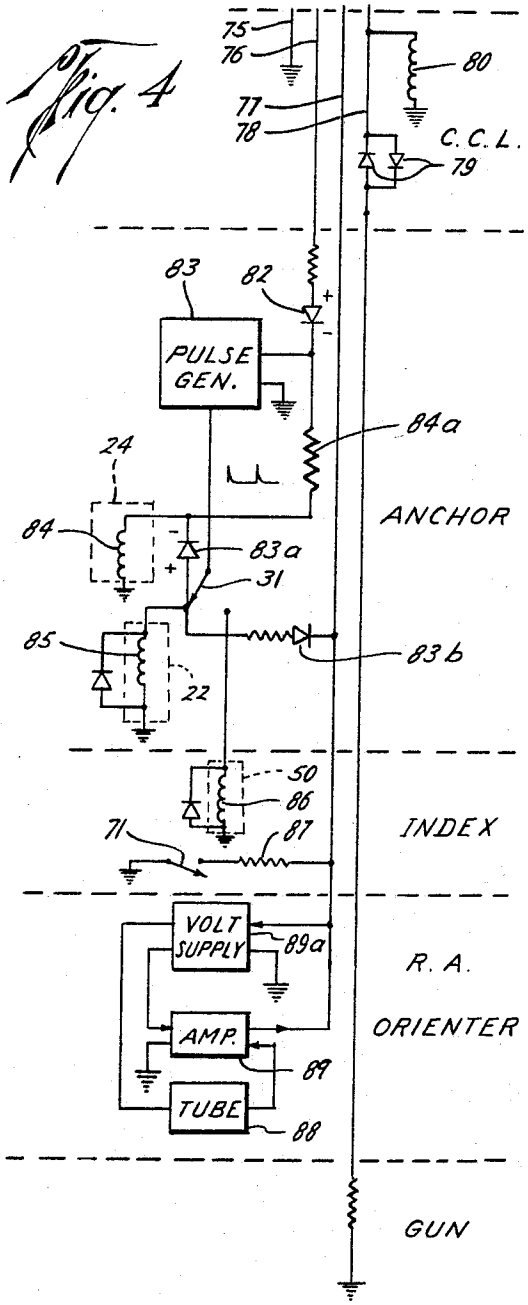


Fig. 4



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WELL COMPLETION APPARATUS

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Fig. 6A

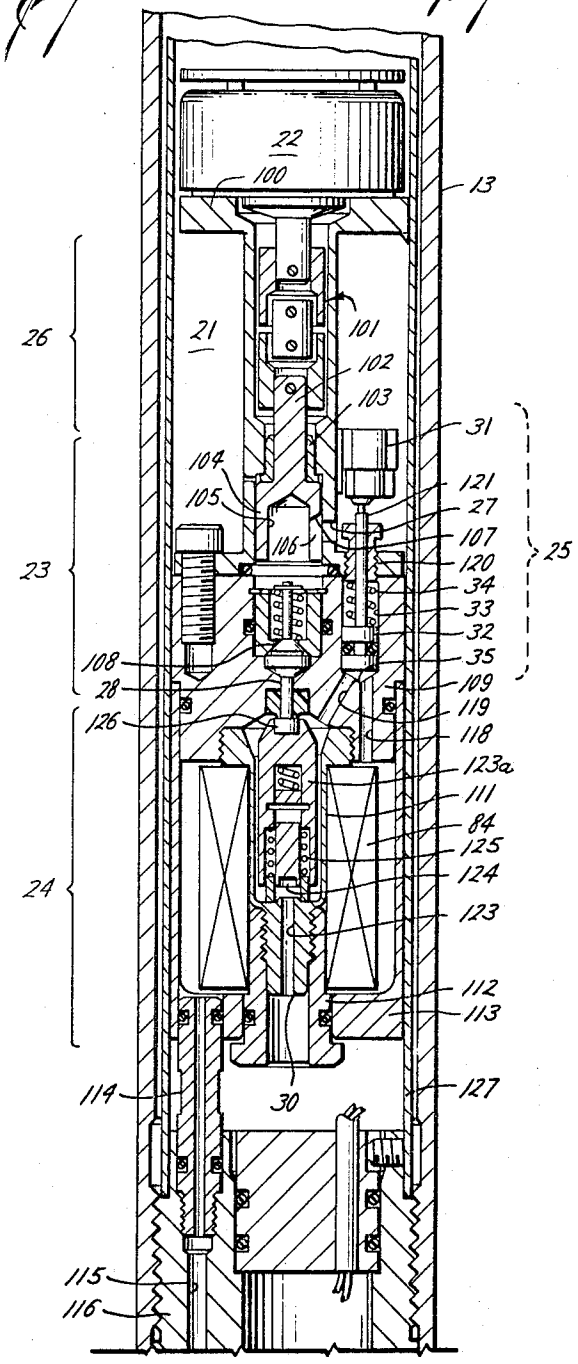
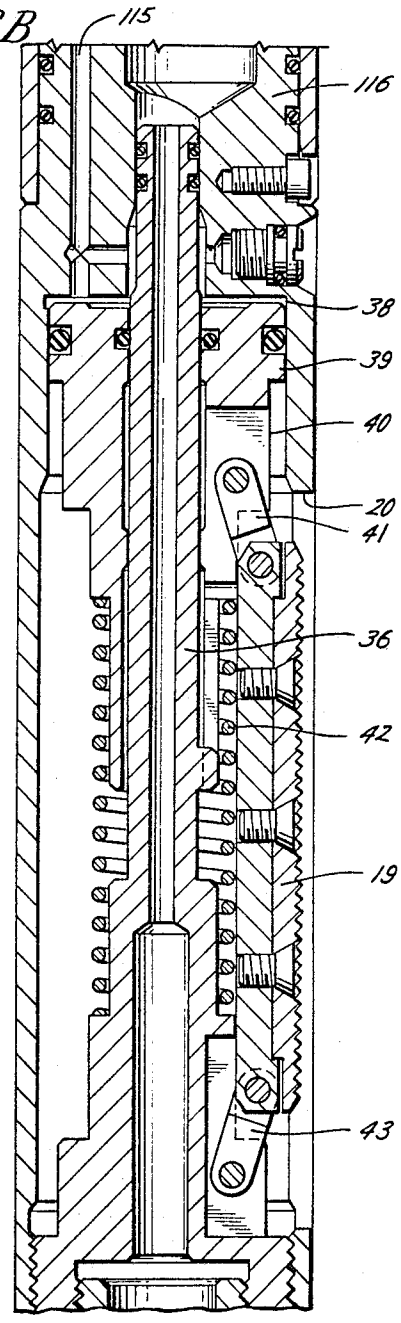


Fig. 6B



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3,273,645

WELL COMPLETION APPARATUS

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Filed July 23, 1962, Ser. No. 211,525
14 Claims. (Cl. 166—55.1)

This invention relates to well completion apparatus, and more particularly, to multiple well completion apparatus useful in completing one pipe string independently of other pipe strings in a well bore.

In multiple well completion a plurality of tubing or casing strings generally extend to different formations at different depths in a well bore, the pipe strings often times being cemented in the well bore. It is desired to place only one pipe string in fluid communication with a selected formation of interest by means of a selectively oriented perforating device so that independent production of hydrocarbon fluids is obtained through the separate tubing strings. It is easily appreciated that a primary requirement of this completion technique is the proper orientation and firing of a perforating apparatus to complete only one pipe string independently of the remaining pipe strings. Mechanical devices heretofore used for orienting of the perforating apparatus have worked successfully but occasionally present some operating difficulties and thus fail to provide the well owners with complete confidence that the operation can be successfully conducted.

Accordingly, it is an object of the present invention to provide new and improved orienting apparatus adapted for use in multiple completions having an increased reliability of operation.

A further object of the present invention is to provide new and improved orienting apparatus for well perforating arranged for attachment to a tubing string and for positively orienting the direction of firing while the supporting cable remains stationary.

A still further object of the present invention is to provide new and improved orienting apparatus for well perforating wherein a plurality of electrical circuits are utilized for gun orienting and firing purposes while maintaining complete operating safety.

These and other objects are obtained in accordance with the invention by apparatus including hydraulically actuated anchor means for anchoring to a pipe string and motor driven rotating means for rotating a perforating device relative to the anchor means. The device is arranged so that the hydraulic anchor means first securely attaches to the pipe string and then a motor (in the rotating means) is actuated. If at any time the anchor fails, the motor will discontinue rotation. Means are also provided to isolate the firing circuit conductor for the perforating device from other electrical conductors so that should a conductor in the firing circuit become damaged, any false firing current resulting from current in adjacent electrical conductors would pass to ground rather than cause accidental operation of the perforating device.

The novel features of the present invention are set forth with particularity in the appended claims. The present invention, both as to its organization and manner of operation together with further objects and advantages thereof, may best be understood by way of illustration and example of certain embodiments when taken in conjunction with the accompanying drawings in which:

FIG. 1 is a view of apparatus embodying the present invention;

FIG. 2 is a view in cross-section through a borehole in which tubing strings are cemented and illustrates schematically, the tool anchored in a tubing string;

FIG. 3 is part schematic and part detailed view of the combined hydraulic anchor and motor operating system;

FIG. 4 is a diagram of the electrical circuitry for operating the apparatus;

FIG. 5 is a perspective view of a part of the apparatus; and

FIGS. 6A and 6B are cross-sectional views taken along the length of the hydraulic anchoring section showing in detail the construction and organization of the hydraulic anchoring section.

Referring now to FIG. 1, a tool assembly is illustrated which is comprised of a perforator section **10**, a radioactivity orienting section **11**, a rotator section **12** and anchor section **13**, and connected at the top of the anchor section **13**, a casing collar locator **14**. It will be noted that the tool assembly is jointed along its length to provide short articulated lengths tiltable relative to one another to permit passage through tortuously disposed tubing or casing strings. While a jointed tool is preferable because it will operate under most any and all pipe string conditions, the tool could be made in an integral assembly in accordance with the principles hereinafter described.

The entire tool assembly is, of course, sized to be passed through a small diameter pipe string by means of a support cable **15** spooled on a surface located winch (not shown), the tool assembly being located at any specific depth in a well-known manner.

Perforator **10** may be provided with shaped charges **16** preferably aligned in a vertical array to fire in a single lateral direction away from the central axis of the tool assembly. Radioactive orienting section **11** includes a radioactive source **17**, such as cesium-137 or other low energy gamma-emitter, and a suitably spaced radioactivity detector **18**, both of which are collimated by radioactive shielding material provided with suitable rectangular shaped openings arranged to face in a lateral direction aligned or oriented in a prescribed manner with respect to the direction of fire of the perforating apparatus. Also contained in the section **11** are the electrical components necessary to transmit the response of the radioactivity detector to the surface. The type of radioactivity system used may, for example, be a γ-γ type well known in the art.

Rotator section **12** contains a driving mechanism to simultaneously rotate the interconnected radioactivity section **11** and a perforator **10** relative to the anchor section **13**. Anchor section **13** has anchor pads **19** spaced about its circumference (shown in FIG. 2) the anchor pads being adapted to be urged outwardly into firm attachment with the tubing string through suitable openings **20** in the section **13**.

Reference is now to FIG. 3 where the anchor section **13** is schematically illustrated and details of rotator section **12** are disclosed. Anchor section **13** includes a support or housing with an upper fluid reservoir chamber **21** containing a fluid, the reservoir **21** also containing a pump motor **22**, a motor driven pump **23**, a flow control valve **24** and a pressure operated switch means **25**, all of which are suitably attached to the support. Pump **23** is driven by a shaft **26** from the motor **22** and also has an inlet **27** to the reservoir fluid and an outlet **28** connected to the valve **24**. Valve **24** in one position connects the pump outlet **28** to a conduit **29**. In another position of the valve **24**, the conduit **29** is connected to a discharge outlet **30** opening to the reservoir fluid.

Pressure responsive switch means **25** includes a microswitch **31** operatively connected to a piston **32** in a cylinder **33**, the piston **32** being urged downwardly under the influence of the spring **34** to hold the microswitch **31** in one position. Cylinder **33** opens to the reservoir fluid on the side of the piston upon which the spring **34** bears while the other end of the cylinder **33** is connected by a conduit **35** to the conduit **29**.

Below fluid reservoir chamber **21**, the support of the housing section **13** has a central tubular portion **36** which extends downwardly to a lower connecting end **37** received in the upper end of rotator section **12**. An upper portion of the tubular section **36** and depending tubular portion of the support form an annular pressure cylinder **38** which opens to conduit **29** and in which an annular piston **39** is slidably received. Piston **39** has a tubular extension **40** slidably received over the central tubular member **36** and toggle bars **41** respectively attach one end of the anchor pads **19** to the piston extension **40**. Piston **39** is resiliently urged toward its uppermost position in the annular cylinder **38** by means of a spring **42** about the central tubular member **36**. The lower end of the anchor pads **19** are respectively connected by toggle members **43** to central tubular member **36**.

The anchor section above described will hereinafter be more fully explained in connection with FIGS. 6A and 6B.

The lower connecting end **37** of housing section **13** has a spherically shaped portion **44** received in a spherically shaped seat **45** in rotator section **12**, and a locking nut **46** is provided to hold spherically shaped portions together. Hence, the ball type joint described permits free tilting movement of the housing section **13** relative to section **12**. To prevent relative rotation between the housing sections **13** and **12**, a locking pin **47** is provided which extends into a lengthwise elongated slot in spherically shaped portion **44**, the pin **47** being sized to the width of the slot and located on the central axis of rotation for the spherical section so as not to impede the relative tilting movement. A tubular connecting member **48** extends between a conduit **49** in the central tubular section **36** and a reservoir chamber **48***a* in the motor orientor section. The tubular member **48** and conduit **49** open to the reservoir **21** in the housing section **13**, and to the reservoir **48***a* in the housing section **12**.

In the reservoir chamber **48***a*, a motor **50** is connected by a coupling **51** to a gear train **52**, the gear train **52** being connected by a clutch **53** to a drive housing **54**. The motor **50** and gear train are suitably supported in the section **12**. Drive housing **54** is actually the upper part of orienting section **11** and is supported in the rotator section **12** by bearings **55**, **56**, **57** and **58**.

Drive housing **54** has a cylindrical bore **54***a* therein in which a coaxial conductor assembly **59** is received. The coaxial assembly **59** includes a central electrical conductor **60**, a grounded coaxial electrical conductor shield **61**, and a second coaxial conductor **62**, each of the conductors being separated from one another by electrical insulation material and the outer, second coaxial conductor **62** being electrically isolated from the housing and secured thereto by an electrical insulation and bonding material such as an epoxy resin. At the upper and lower ends of the coaxial assembly **59**, portions of the coaxial conductor are peeled away so that separate electrical inputs and outputs can be connected to each conductor. At the upper end of coaxial assembly **59**, three conductor rods **63–65** are respectively disposed perpendicular to the assembly **59** and used to connect the respective conductors **60–62** to a collector ring **66**. The conductor rods **63–65** are suitably electrically insulated and attached to the housing **54**. An electrical distribution ring **66** is provided in the section **12** and contains three longitudinally spaced annular conductive elements **67–69** which are electrically insulated from one another and supported in a non-conductive material forming the ring **66**. The individual conductive ring elements **67–69** are connected to individual conductor wires (schematically shown).

The housing **54** just below the conductor rods **63–65**, has an annular groove **70** in which a spring-like electrical contactor **71** is connected. The outer end of the spring contactor member **71** engages an annular collector ring **72** which is suitably supported in the housing section **12**

on an electrically insulated body **73**. The collector ring **72** (shown in enlarged view in FIG. 5) is provided with peripherally spaced narrow width slots **73***a*, preferably angularly spaced at **10** degrees relative to one another to form fingers **74** depending from a common ring **75**. One such a slot **73***b* has a greater width than the other slots forming a finger **74***a* with a smaller width so that a reference point is provided on the ring **72**. The spring contactor member **71** thus makes electrical contact with the individual depending fingers **74** of the collector ring **72** and the slots **73***a* therebetween break electrical contact as the spring moves from one finger to another. Ring **72** is connected in an electrical indicating circuit as will hereafter be explained.

In the general operation of the above-described apparatus, the assembled tool shown in FIG. 1 is lowered into a tubing string (as shown in FIG. 2) to a depth at which perforations are desired. While going through the tubing to the selected depth, the casing collar locator **14** provides indications when the tool passes collars so that the depth location of the tool is accurately determined. When the tool is at the selected depth for operation, the motor **22** is actuated (from a surface control not shown) and the valve **24** is set to connect the pump **23** to the conduit **29**. Pump **23** withdraws fluid from the reservoir chamber **21** via inlet **27** and supplies fluid under pressure to pressure cylinder **38** via conduit **29**. Piston **39** is moved by the fluid pressure in cylinder **38** to extend the pads **19** into engaging contact with the tubing wall. At this time, pressure of the fluid increases and switch **31** is actuated. As will hereinafter be made apparent, switch **31** when actuated conditions motor **50** for operation and causes motor **22** to stop operation. Motor **50** in operation rotates the radioactivity orienting section **11** and perforator **10** in unison.

Preferred details of the present invention as well as more specific operational characteristics will now be more fully explained.

Referring now to FIG. 4, the electrical system for the apparatus is illustrated. The conductors required to translate signals and power between the earth's surface and the tool are a ground wire **75**, a wire **76** for translating current to the hydraulic actuator motor **22** and rotator motor **50**, a wire **77** for translating electrical signals and power from and to the radioactivity section and a wire **78** for translating current to the perforator. A three wire cable where the armor wire is used for a ground return is suitable for providing the required conductors.

The wire **78** that connects to the perforator has reversely connected diodes **79** to isolate the perforator circuit from stray currents which may be induced in the wire above the diodes. Above the diodes, the casing collar locator coil **80** (which is a conventional device) is connected to the wire **78** and responds to the presence of casing collars in the pipe string to indicate their location. The casing collar electrical signals are, however, isolated from the firing circuit by the diodes **79**. Wire **78** is connected at the surface to a switch (not shown) which connects the wire **78** to a recorder (not shown) for obtaining the indications of casing collars or a source of power for operating the perforator.

The wire **76** can be connected at the earth's surface by a switch (not shown) to a source of D.C. power (not shown). When the surface switch is properly connected, direct current (position potential) is passed through a diode to cause operation of a conventional pulse generator **83**, the pulse generator **83** producing spaced electrical pulse outputs. The output of the pulse generator **83** is connected via microswitch **31** to a coil of a solenoid **85** which operates motor **22** (such as a Ledex solenoid motor hereinafter explained more fully). Pulse generator **83** is also connected via the microswitch and a diode **83***a* to a coil of a solenoid switch **84** (hereinafter

more fully explained) which actuates the pump valve **24**. Pump valve **24** when so actuated connects pump outlet **28** to conduit **29**. The wire **76** is also connected via a resistance **84***a* to the solenoid **84**. The solenoid **84** requires the larger current output of the pulse generator **83** for actuation and a far lesser current supplied by the direct connection through resistance **84***a* to maintain the solenoid in an actuated condition. The current required to maintain the solenoid **84** actuated is less than the current required to actuate the pulse generator **83**. The output of the pulse generator supplied to the pump solenoid **85** is monitored by a resistance-diode combination **83***b* connected between the coil of the solenoid **85** and the wire **77** which will hereafter be more fully explained.

Motor **22**, as described heretofore, drives the pump **23** to provide a fluid under pressure via conduit **29** to move the annular piston **39** and thereby move the anchor pads **19** into engagement with the wall of the borehole. The pump **23** will continue operation until the pressure of the fluid in conduit **29** and **35** builds up sufficiently to actuate the pressure responsive switch means **25** thereby actuating microswitch **31**. Microswitch **31**, when actuated, disconnects the pump motor solenoid **85** from pulse gentrator **83** and connects the pulse generator **83** to a coil **86** of a solenoid motor in motor **50** (hereinafter more fully explained) in the rotation section which rotates the sections **11** and **10** relative to the attached anchor section. Motor **50** like motor **22** is preferably a Ledex solenoid motor. Other diodes (not numbered) are suitably provided throughout the circuitry for electrical protection purposes.

Also, in the indexing section, the rotation of the housing **54** causes the spring contactor member **71** to sequentially engage the fingers **74** and the slots **73***a* breaking the circuit, the fingers, slots, and contactor member therefore providing a switch means. The contactor member **71** is connected to the housing section at electrical ground potential while the conductor ring **72** (FIG. 5) is connected via resistor **87** to the wire **77**. Each time the spring contactor **71** passes a slot **73***a* between the contactor fingers **74**, an electrical indication is produced which is detected at the earth's surface. These indication signals consist of D.C. pulse type voltage signals which are readily distinguishable from the electrical signals generated by the radioactivity orientor section. The enlarged slot **73***b* and narrower finger **74***a* provide an electrical reference signal easily distinguishable from the remaining indication signals.

In the radioactivity orientor section **11**, a detector tube **88**, such as a scintillation counter is connected via an amplifier **89** to the wire **77** while a voltage supply **89***a*, provided to operate the amplifier and detector tube, is also supplied power from the surface via wire **77**. The use of a single wire such as wire **77** to provide downhole power and pass distinct signals up to the surface is well known in the art. Likewise, the surface equipment used in connection with wire **77** to record the radioactivity indications and the switch **71** indications is well known in the art.

It will be appreciated that the foregoing description concerns the operation of a valve and pump simultaneously and the pump and motor sequentially from a single wire with a ground return. A D.C. power supply is connected to a single conductor and the valve, motor and pump are all D.C. responsive. This unique system reduces the number of cable conductors required and, hence, cable costs. However, it will be appreciated that a multiconductor cable containing six or more conductors could be used and other than D.C. operated equipment could be employed. However this is not particularly preferable.

Wires **76–78** are passed through the apparatus in a normal fashion and the apparatus housing provides an electrical ground. In the lower part of FIG. 3, however, the electrical connections are arranged in a novel manner for insuring safety of operation. With reference to FIG. 3, wire **78** is connected to the central conductor **60**. The first coaxial conductor **61** is connected to an electrical ground and the outer coaxial conductor **62** is connected to the radioactivity conductor wire **77**. It will be appreciated that the coaxial assembly is such that the firing wire **60** is separated from the radioactivity wire **77** by an electrical ground wire. Hence, protection against accidental electrical connection between the current in the radiocativity conductor **62** and the firing conductor **60** in the rotation section is prevented since the electrical ground conductor **61** prevents such a direct connection. Hence, the firing line is electrically isolated from the radioactivity line in the rotator section.

Before turning to the details of apparatus illustrated in FIGS. 6A and 6B, the detailed operation of the electrical system will be outlined. When the assembled tool as shown in FIG. 1 is positioned in a tubing string (as shown in FIG. 2) to a depth at which perforations are desired, the surface control switch (not shown) is operated to connect the D.C. power supply to wire **76** and provide sufficient current to actuate pulse generator **83**, the pulse generator producing a pulse output to microswitch **31**. In the position of microswitch **31** shown, the pulse output is applied via a diode **83***a* to actuate the solenoid **84**, the solenoid **84** being held actuated by current passed via wire **76** through resistance **84***a*. The pulse output of the pulse generator **83** also actuates the solenoid **85** each time a pulse is applied to it. The pulse output from pulse generator **83** is also conveyed via a resistor-diode combination **83***b* to wire **77** and at the surface of the earth this indication is indicated on suitable instruments, such as a neon bulb. The purpose of obtaining this indication is to determine that the pump is being operated in the well bore.

The pump **23** provides a fluid under pressure to the pressure cylinder **38** and piston **39** to move piston **39** downwardly against the action of spring **42** and urge the anchor pads **19** outwardly into engagement with the tubing wall. As the pads **19** engage the wall the fluid pressure builds up and in so doing actuates the pressure responsive means **25** by moving the piston **32** and moving switch **31** to its other position. Switch **31**, when switched, connects the pulse generator **83** directly to the solenoid **86** of the motor **50** for the orientor and disconnects the pump motor **22** from operation. The valve solenoid **84** is, however, kept actuated by the holding current conveyed via resistance **84***a* which is prevented from reaching pump solenoid **85** by means of diode **83***a*. The resistor-diode combination **83***b* is disconnected from the wire **77**.

The motor solenoid **86** when actuated by each pulse operates to rotate the radioactivity section **11** and perforating section **10** relative to the anchored section. In the radioactivity section **11**, the source **17** emits gamma rays and gamma ray detections are made by the tube **88** in detector **18** in a lateral direction. Hence, during a full circular sweep about the tubing, the gamma ray indications will decisively alter at the points where the lateral gamma ray devices are directed toward the adjacent tubing string. A plot of the gamma ray measurements taken illustrates very clearly the alteration in the detected gamma ray intensity caused by virtue of the presence of the adjacent pipe. The precise readings of the radioactivity detections are correlated relative to the tubing string position(s) by virtue of the indications produced simultaneously therewith by the opening and closing of switch **71** at 10 degree angular intervals. The irregular slot **73***b* in the collector ring **72** of switch **71** provides a reference point.

After one or more complete circular sweeps and the radioactivity measurements are clearly plotted, the gun may be stopped relative to the reference point in a position to fire away from the adjacent tubing string by

stopping the rotor motor solenoid **86**. Motor solenoid **86** is stopped by reducing the current on wire **76** to a point below which the pulse generator **83** will not operate, this point, however, still being above the current value necessary to be sent via resistance **84***a* to maintain the valve solenoid **84** actuated. With the gun so oriented, a firing current is passed via wire **78** to the gun and which fires the gun in a well-known manner. To retrieve the apparatus the current on wire **76** is then shut off so that valve solenoid **84** is deactuated and conduit **29** is now connected to the outlet pipe **30** in the reservoir **21** so that the fluid pressure in the conduit is relieved. Spring **42** urges the piston **39** towards a retracted position and pushes the fluid above back into the reservoir and the pads **19** are retracted. Thereafter, the tool is retrieved from the tubing in a well-known manner.

In the foregoing description of the apparatus and operation thereof, a gamma-gamma radioactivity orienting system and a single tool was described. However, it should be obvious that if desired the source **17** could be completely removed from the tool before it is lowered into the well and instead an omnidirectional source of radioactivity lowered to a corresponding depth in the adjacent tubing string. Thus, the detector **18** also can be oriented relative to the source of radioactivity in adiacent tubing string.

Referring now to FIGS. 6A and 6B, a preferable embodiment of the schematically illustrated details of the anchor section in FIG. 3 will be described. Motor **22** is a well-known commercially available "Ledex" solenoid motor assembly which produces successive longitudinal and rotational motions of a shaft upon passing a current to a solenoid actuating coil (coil **85** illustrated in FIG. 4). The motor **22** is attached to a spool-like frame **100** and a universal coupling connection **101** is used to connect the motor **22** to the shaft **102** of the pump. Shaft **102** is slidably mounted in a bearing **103** in the core of the spool and is shown in its upper operating position. Shaft **102** at its lower end has an enlarged cylindrical portion forming a valve element **104** which has a hollow or blind bore **105** therein. Valve element **104** has a lengthwise extending, narrow width slot **106** which, in the upper position of the valve element shown, terminates with an inclined surface **107** located just above the inlet port **27** in the spool **100**. Inlet port **27**, like slot **106** is a lengthwise extending, narrow width slot. In operation, fluid contained in the chamber **21** about the spool **100** is free to enter port **27** and, in the position of the valve element shown, enter into the blind bore **105** of the valve element. When the motor **22** is actuated, the shaft **102** is moved downwardly and rotationally so that the slot **106** of the valve element **104** is taken out of register with the opening **27** and the fluid trapped in the blind bore **105** is therefore placed under pressure. The fluid under pressure is forced through a spring-type check valve **108** in a valve block **109** into the pump outlet passageway **28** in the valve block.

Flow control valve **24**, which is the first component of the tool to be operated when the apparatus is in position in a well bore, has a toroidal electrical coil **84** mounted on a non-magnetic tubular supporting member **111** and which is connected to the valve block **109**, the coil being held on the supporting member **111** by an attachment part **112** received in a case member **113**. The case member **113** with the valve block **109** provides a sealed, closed, fluid chamber enclosing therein the coil **84** and supporting member **111**. A tubular flow conduit **114** couples the lower part of the case **113** to a passageway **115** in a housing **116** which extends downwardly as shown in FIG. 6B to a point above the piston **39** so that fluid can enter into the annular piston space **38** via passageway **115**. The valve block **109** also has passageways **118, 119** which intersect at the bore forming cylinder **33** in the valve block. In the cylinder **33**, the piston **32** is urged downwardly by the spring **34**. The force of spring **34** on piston **32** can be controlled by an adjustment nut **120**, a rod **121** on the piston **32** is connected to the piston **32** and upward movement of rod **121** operates the microswitch **31**. Outlet passageway **28** is centrally disposed in the valve block **109** and a lower passageway **123** is provided in the supporting member **111** and connects to the discharge outlet **30** provided in the attachment member **112**.

As thus far described it should be appreciated that passageway **118, 119**, the interior of case **113**, conduit **114**, passageway **115** define the passageway **29** referred to in FIG. 3. Passageway **35** referred to in FIG. 3, is at the junction of passageways **118, 119** with cylinder **33** in FIG. 6A.

A valve element **123***a* constructed of magnetic material is slidably received in the valve support **111** and has upper and lower sealing elements **126, 124**. Valve element **123***a* is movable between the upper position shown (where sealing element **126** closes outlet **28**) and a lower position where sealing element **124** closes an opening in support **111** in communication with passageway **123**. When the solenoid **84** is actuated, the passageway **123** (and outlet **30**) is closed by the sealing element **124** on the valve element and pump outlet passageway **28** opens to passageway **119** in the valve block. When the solenoid **84** is de-energized, a spring **125** in the valve element **123***a* urges the valve element **123***a* upwardly so that an upper sealing element **126** closes the upper outlet passageway **28**. Valve element **123***a* is flutted so that fluid may pass between passageway **119** and the discharge passageway **123**.

The entire assembly can be mounted in a tubular shell **127** in the housing so that electrical conductors can be passed between the shell and the housing assembly.

Referring now to FIG. 6B, the parts as illustrated schematically in FIG. 3 are only more accurately detailed herein and further description is not necessary.

While particular embodiments of the present invention have been shown and described, it is apparent that changes and modifications may be made without departing from this invention in its broader aspects and, therefore, the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of this invention.

What is claimed is:

1. Well perforating apparatus adapted for suspension by an electric cable in a well bore having at least one string of pipe comprising:

perforating means having a prescribed direction of lateral firing,

selectively operable anchor means for selectively engaging the wall of a string of pipe including wall engaging members movable laterally between non-engaging and wall-engaging positions,

and hydraulic pump means operably connected to said anchor means for laterally moving said wall-engaging members, said pump means including solenoid means having a longitudinally reciprocal element,

a fluid receiving cylinder, said cylinder having inlet and outlet ports and a check valve in said outlet port,

a valve element in said cylinder having an access opening therein sized to register with said inlet port in one longitudinal position of said valve element in said cylinder and to be out of register with said inlet port in another longitudinal position,

means connecting said valve element to said reciprocal element,

and rotator means intermediate said anchor means and said perforating means operative for rotating said perforating means relative to said anchor means when said wall engaging members are in said wall engaging position.

2. The apparatus of claim **1** and further including:

selectively operable valve means with an inlet coupled to said outlet port,

said valve means having two outlets and said valve means being operable to connect its inlet to either of its outlets,

switch means normally connected in one position to said solenoid means for controlling the operation of said anchor means and connected in another position for controlling the operation of said rotator means,

pressure responsive means in one of said valve means outlets operable at a prescribed pressure to operate said switch means.

3. In a well perforating and orienting apparatus adapted for suspension by a cable in a well bore, the combination of wall-engaging members for anchoring sections of the apparatus in the well bore and power means for rotating other sections of the apparatus in the well bore, which comprises piston means positioned within a pressure cylinder and operably connected to said wall-engaging members, hydraulic pump means for supplying fluid to said piston means for operating said wall-engaging members, said pump means comprising a fluid receiving cylinder having inlet and outlet ports, a check valve in said outlet port, a valve element in said fluid receiving cylinder having an access opening therein sized to register with said inlet port in one longitudinal position of said valve element in said fluid receiving cylinder and to be out of register with said inlet port in another longitudinal position, solenoid means for reciprocating said valve element, and means providing fluid communication between said outlet port and said pressure cylinder.

4. In a well perforating and orienting apparatus adapted for suspension by a cable in a well bore, the combination of wall-engaging members for anchoring sections of the apparatus in the well bore and power means for rotating other sections of the apparatus in the well bore, which comprises piston means positioned within a pressure cylinder and operably connected to said wall-engaging members, hydraulic pump means comprising a fluid receiving cylinder, said cylinder having inlet and outlet ports, a check valve in said outlet port, a valve element in said fluid receiving cylinder having an access opening therein sized to register with said inlet port in one longitudinal position of said valve element in said fluid receiving cylinder and to be out of register with said inlet port in another longitudinal position, solenoid means for reciprocating said valve element, passageway means providing fluid communication between said outlet port and said pressure cylinder, means for selectively opening said passageway means to fluid communication between said outlet port and said pressure cylinder to control the application of fluid to said piston means and thereby provide for selective operation of said wall-engaging members, and switch means responsive to pressure in said passageway means for deenergizing said solenoid means and for energizing said power means to rotate sections of the apparatus.

5. A well perforating and orienting apparatus adapted for suspension by a cable in one string of pipe in a well bore having at least one other co-extending string of pipe comprising in combination; anchor means, rotating means, directional pipe locator means and directional perforating means, said anchor means including a support, wall-engaging members for anchoring to the wall of a string of pipe, and means for moving said wall-engaging members relative to said support; actuating means including a piston and cylinder means where one of said actuating means is operably connected to said wall-engaging members and the other of said actuating means is on said support; hydraulic pump means in said support comprising a fluid receiving cylinder with inlet and outlet ports; a check valve in said outlet port; a valve element in said fluid receiving cylinder having an access opening therein sized to register with said inlet port in one longitudinal position of said valve element in said fluid receiving cylinder and to be out of register with said inlet port in another longitudinal position; electrical means for reciprocating said valve element, and a passageway providing fluid communication between said outlet port and said actuating cylinder means; means for selectively opening said passageway to fluid communication between said outlet port and said actuating cylinder means to control the application of fluid to said actuating piston means and thereby provide for selective operation of said wall-engaging members; said rotating means being coupled between said support and said pipe locator means; switch means responsive to fluid pressure in said passageway for disconnecting said electrical means and for operating said rotating means; said perforating means having a presecribed alignment with and coupled to said pipe locator means; rotation responsive means for providing indications of the rotational position of said perforating means and pipe locator means relative to said wall-engaging member; and position responsive means connected to said wall-engaging members for providing electrical signals of the position of said wall-engaging members.

6. A well perforating and orienting apparatus adapted for suspendsion by a cable in one string of pipe in a well bore having a least one other co-extending string of pipe comprising in combination; anchor means, rotating means, directional pipe locator means and directional perforating means; said anchor means including a support member, piston and cylinder operating means where one of said operating means is part of said support member; longitudinally extending wall anchor means with upper and lower ends disposed along said support member; lower link means coupled to said lower end and to said support member, said lower link means extending downward from said lower end; upper link means coupled to said upper end and to the other of said operating means, said upper link means extending upward from said upper end, said upper and lower link means permitting lateral movement of said wall anchor means in response to actuation of said operating means; hydraulic pump means in said support comprising a fluid receiving cylinder, with inlet and outlet ports; a check valve in said outlet port; a valve element in said fluid receiving cylinder having an access opening therein sized to register with said inlet port in one longitudinal positon of said valve element in said fluid receiving cylinder and to be out of register with said inlet port in another longitudinal position; electrical means for reciprocating said valve element; a passageway providing fluid communication between said outlet port and said cylinder operating means; means for selectively opening said passageway to fluid communication between said outlet port and said pressure cylinder to control the application of fluid to said piston operating means and thereby provide for selective operation of said wall-anchor means; said rotating means being coupled between said support and said pipe locator means; switch means responsive to fluid pressure in said passageway for disconnecting said electrical means and for operating said rotating means; said perforating means having a prescribed ailgnment with and coupled to said pipe locator means; rotation responsive means for providing indications of the rotational position of said perforating means and pipe locator means relative to said wall-anchor means; and position responsive means connected to said wall-anchor means for providing electrical signals of the position of said wall-anchor means.

7. Well perforating apparatus adapted for suspension by an electric cable in a well bore having at least one string of pipe therein comprising: perforating means having a prescribed direction of lateral firing, selectively operable anchor means for selectively engaging the wall of a string of pipe including wall-engaging members movable laterally between non-engaging and wall-engaging positions, rotator means intermediate said anchor

means and said perforating means operative for rotating said perforating means relative to said anchor means when said wall-engaging members are in said wall-engaging position, rotation responsive means connected between said perforating and anchor means for providing electrical signals of the rotational position of said perforating means relative to said anchor means when said wall-engaging members are in said wall-engaging position, and position responsive means connected to said wall-engaging members for providing electrical signals of the position of said wall-engaging members.

8. Well perforating apparatus adapted for suspension by an electric cable in a well bore having at least one string of pipe therein comprising: perforating means having a prescribed direction of lateral firing, selectively operable anchor menas for selectively engaging the wall of a string of pipe including wall-engaging members movable laterally between non-engaging and wall-engaging positions, rotator means intermediate said anchor means and said perforating means operative for rotating said perforating means relative to said anchor means when said wall-engaging members are in said wall-engaging position, and position responsive means connected to said wall-engaging members for providing electrical signals of the position of said wall-engaging members.

9. Well perforating apparatus adapted for suspension by an electric cable in one string of pipe in a well bore having at least one other coextending string of pipe comprising: perforating means having a prescribed direction of lateral firing, pipe locator means operative for determining the location of one or more coextending strings of pipe from said one string of pipe, said perforating means and pipe locator means interconnected in a prescribed oriented manner, selectively operable anchor means for selectively engaging the wall of a string of pipe including wall-engaging members movable laterally between non-engaging and wall-engaging positions, and rotator means intermediate said anchor means and said interconnected perforating and pipe locator means operative for rotating said interconnected means relative to said anchor means when said wall-engaging members are in said wall-engaging position, said rotator means including electrical interconnecting means comprised of at least three coaxially arranged and electrically insulated conductors where alternate conductors are electrically grounded.

10. Well perforating apparatus adapted for suspension by an electric cable in a well bore having at least one string of pipe comprising: perforating means having a prescribed direction of lateral firing, selectively operable anchor means for selectively engaging the wall of a string of pipe including wall-engaging members movable laterally between non-engaging and wall-engaging positions, said anchor means further including hydraulic actuating means connected to said wall-engaging members for imparting lateral movement to said members and selectively operable control means for operating said hydraulic actuating means, and rotator means intermediate said anchor means and said perforating means operative for rotating said perforating means relative to said anchor means when said wall-engaging members are in said wall-engaging position, said control means including switch means responsive to a predetermined fluid pressure in said hydraulic actuating means for discontinuing operation thereof while conditioning said rotator means for operation.

11. Well perforating apparatus adapted for suspension by an electric cable in one string of pipe in a well bore having at least one other coextending string of pipe comprising: perforating means having a prescribed direction of lateral firing, pipe locator means operative for determining the location of one or more coextending strings of pipe from said one string of pipe, said perforating means and pipe locator means interconnected in a prescribed oriented manner, selectively operable anchor means for selectively engaging the wall of a string of pipe including wall-engaging members movable laterally between non-engaging and wall-engaging positions, rotator means intermediate said anchor means and said interconnected perforating and pipe locator means operative for rotating said interconnected means relative to said anchor means when said wall-engaging members are in said wall-engaging position, rotation responsive means for providing indications of the rotational position of said perforating means relative to said anchor, and position responsive means connected to said wall-engaging members for providing electrical signals of the position of said wall-engaging members.

12. Well perforating apparatus adapted for suspension by an electric cable in a well bore having at least one string of pipe therein comprising: perforating means, rotator means, anchor means, and pipe locator means coupled in a fixed longitudinal position relative to one another, said perforating means having a prescribed direction of lateral firing, said pipe locator means and said perforating means being fixedly interconnected in a prescribed oriented manner, said anchor means including wall-engaging members movable between non-engaging and wall-engaging positions relative to the wall of a string of pipe, said pipe locator means being capable of locating one or more coextending strings of pipe from said one string of pipe; and means for selectively moving said wall-engaging members between said positions, said rotator means including a rotational connection and electrical drive means for rotating said perforating means relative to said anchor means while maintaining said fixed longitudinal positions between said anchor means and perforating means.

13. Well perforating apparatus adapted for suspension by an electric cable in a well bore having at least one string of pipe therein comprising: perforating means, rotator means, anchor means, and pipe locator means coupled in a fixed longitudinal position relative to one another, said perforating means having a prescribed direction of lateral firing, said pipe locator means and said perforating means being fixedly interconnected in a prescribed oriented manner, said anchor means including wall-engaging members movable between non-engaging and wall-engaging positions relative to the wall of a string of pipe, said anchor means further including hydraulic actuating means connected to said wall-engaging members for imparting lateral movement to said members; and selectively operable control means for operating said hydraulic actuating means to move said wall-engaging members between said positions, said rotator means including a rotational connection and electrical drive means for rotating said perforating means relative to said anchor means while maintaining said fixed longitudinal positions between said anchor means and perforating means.

14. Well perforating apparatus adapted for suspension by an electric cable in a well bore having at east one string of pipe therein comprising: perforating means, rotator means, anchor means, and pipe locator means coupled in a fixed longitudinal position relative to one another, said perforating means having a prescribed direction of lateral firing, said pipe locator means and said perforating means being fixedly interconnected in a prescribed oriented manner, said anchor means including wall-engaging members movable between non-engaging and wall-engaging positions relative to the wall of a string of pipe, means for selectively moving said wall-engaging members between said positions, said rotator means including a rotational connection and electrical drive means for rotating said perforating means relative to said anchor means while maintaining said fixed longitudinal position between said anchor means and perforating means.

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