Sept. 15, 1970 M. A. GARRISON 3,528,515

ROTARY PERFORATING TOOL AND SYSTEM FOR WELL PERFORATION

Filed Oct. 2, 1968 3 Sheets-Sheet 1

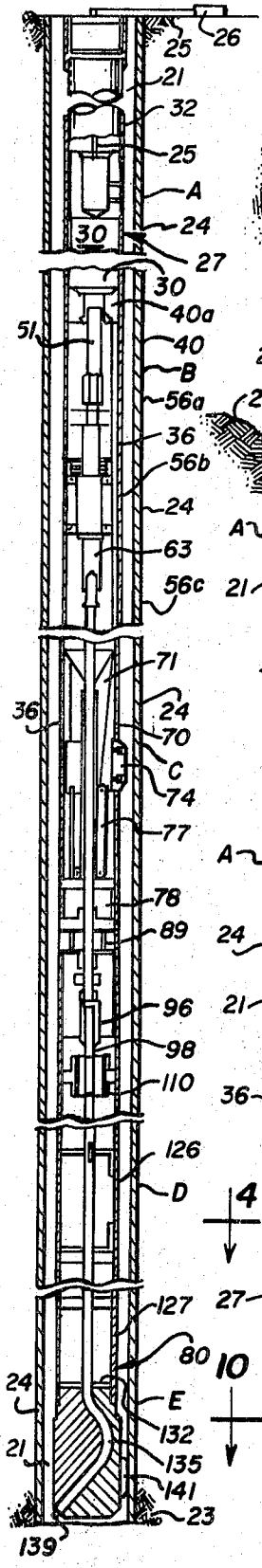


FIG. 1

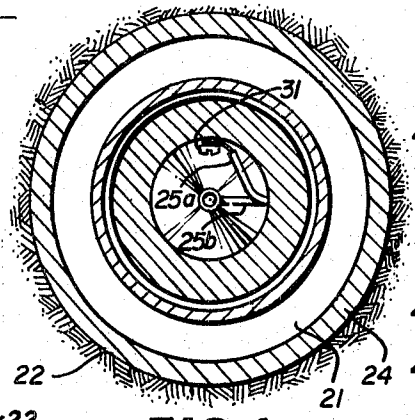


FIG. 4

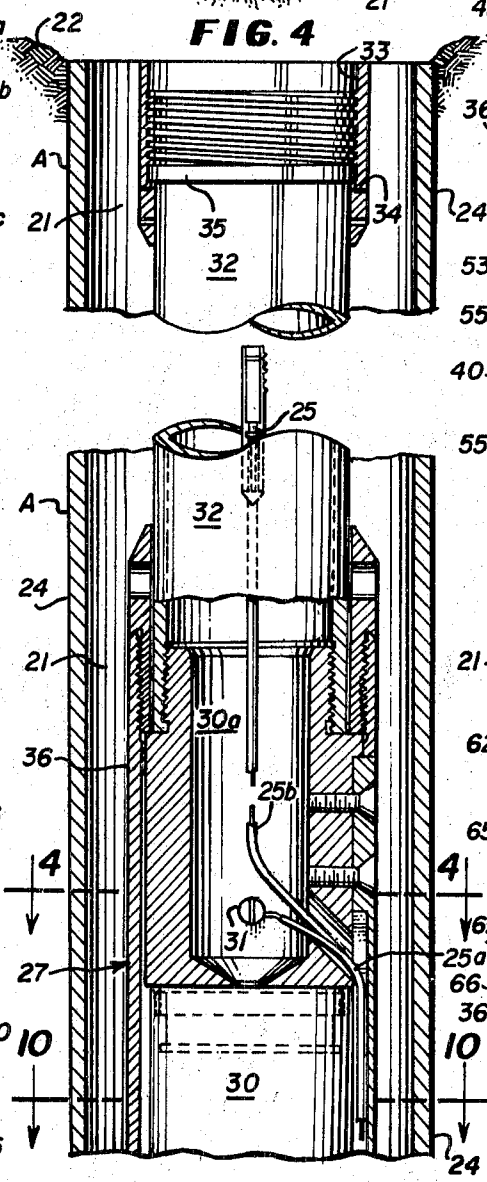


FIG. 2

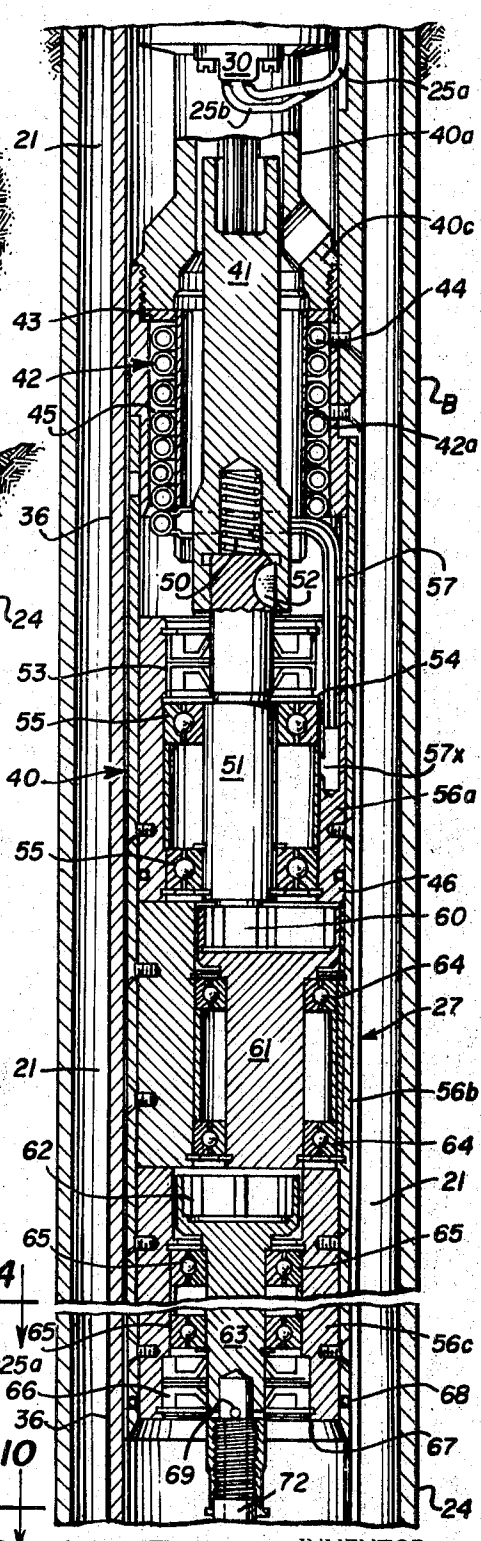


FIG. 3

INVENTOR.
Marion A. Garrison
BY
Garrison and Edwards
ATTORNEYS

Sept. 15, 1970 M. A. GARRISON 3,528,515

ROTARY PERFORATING TOOL AND SYSTEM FOR WELL PERFORATION

Filed Oct. 2, 1968 3 Sheets-Sheet 2

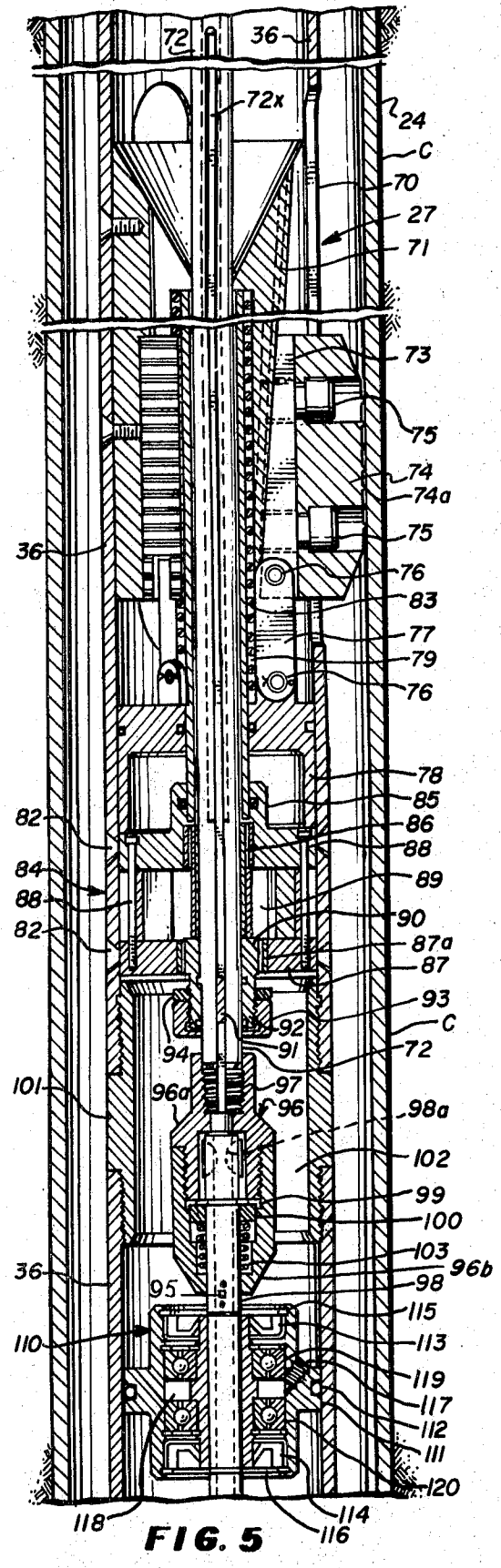


FIG. 5

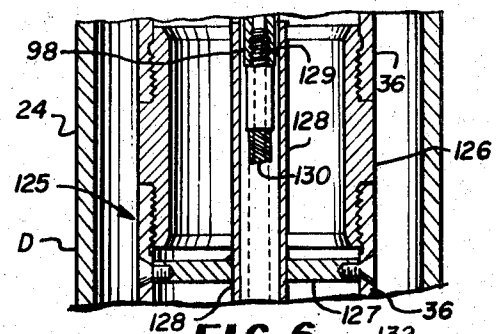


FIG. 6

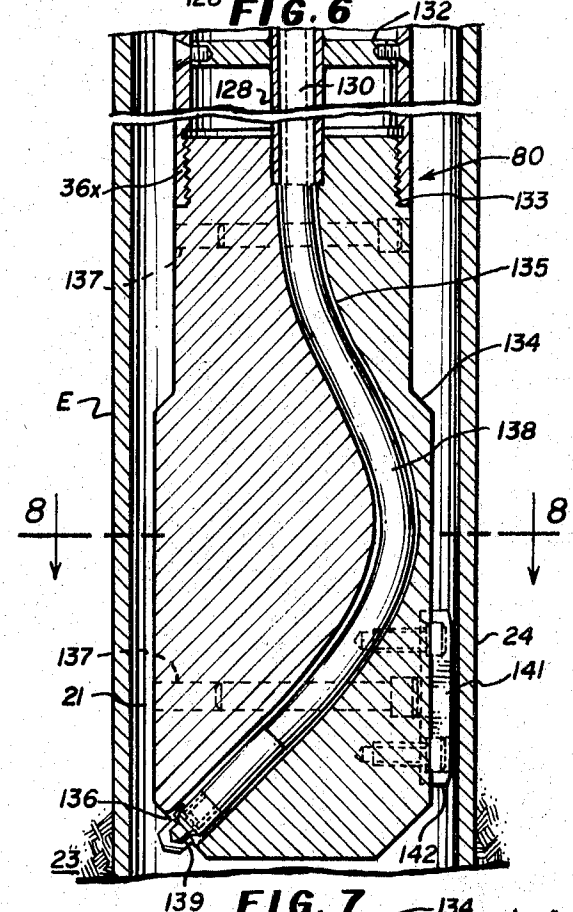


FIG. 7

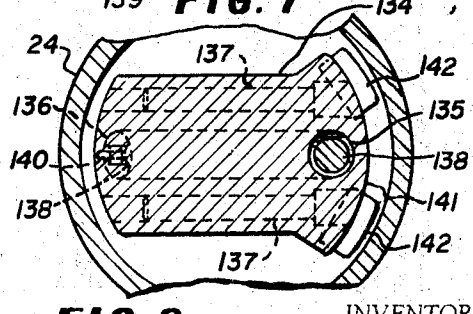


FIG. 8

INVENTOR.
Marion A. Garrison

BY

Gunn & Edwards
ATTORNEYS

Sept. 15, 1970 M. A. GARRISON 3,528,515

ROTARY PERFORATING TOOL AND SYSTEM FOR WELL PERFORATION

Filed Oct. 2, 1968 3 Sheets-Sheet 3

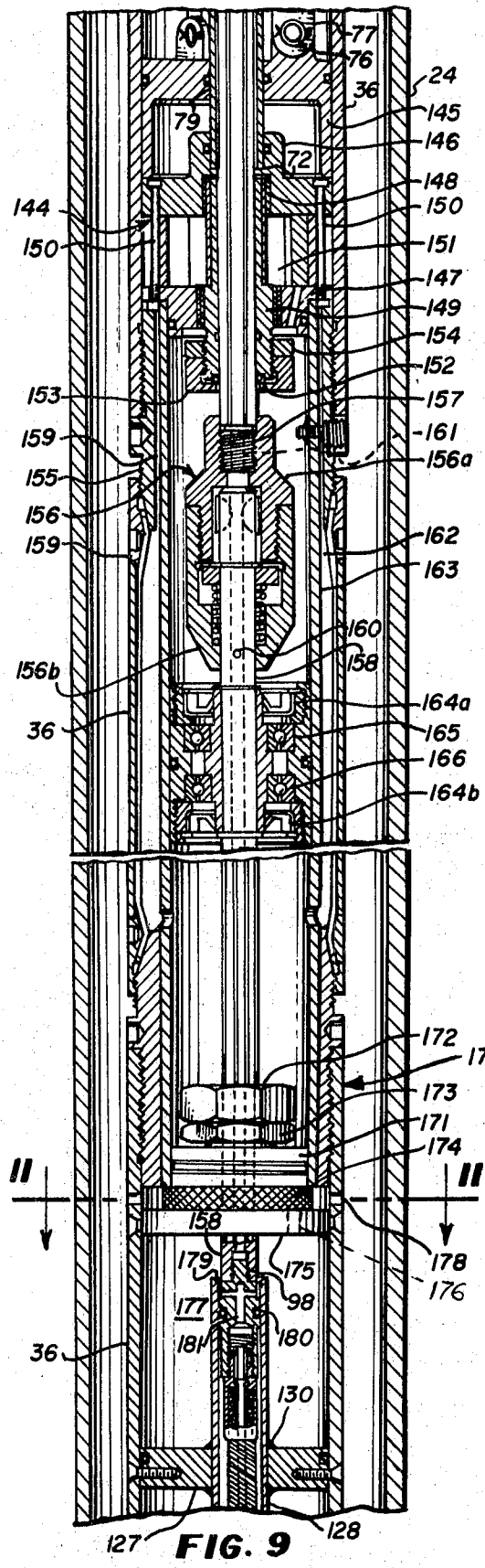


FIG. 9

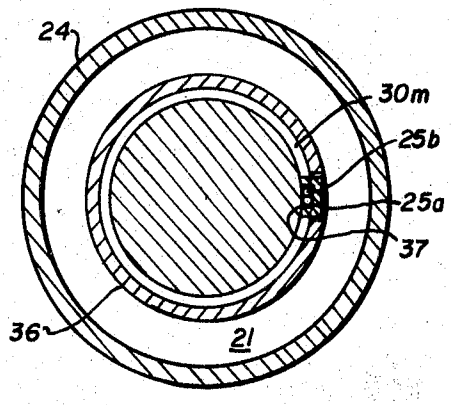


FIG. 10

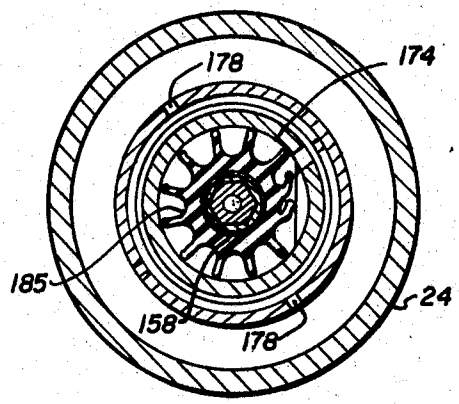


FIG. 11

INVENTOR.
Marion A. Garrison

BY

McDaniel and Edwards

ATTORNEYS

United States Patent Office 3,528,515 Patented Sept. 15, 1970

3,528,515

ROTARY PERFORATING TOOL AND SYSTEM FOR WELL PERFORATION

Marion A. Garrison, Denver, Colo., assignor to Empire Oil Tool Company, Denver, Colo., a corporation of Colorado

Filed Oct. 2, 1968, Ser. No. 764,544
Int. Cl. E21b 7/04, 49/06
U.S. Cl. 175—78 10 Claims

ABSTRACT OF THE DISCLOSURE

Rotary perforating tool and system for wells having electrically powered drilling assembly lowered with elongated tube into well by flexible cable having insulated electrical conductors, tube holds said assembly against independent rotation, expanding means extending through openings in tube for securing and releasing tube at selected locations in well, pump means supplying fluid to the expanding means for directing said actions and lubricating a drill bit, a flexible shaft connecting drill bit with the upper drill assembly, guide means for the flexible shaft, means for applying controlled pressure against bit while it is rotated, and means for maintaining said tube in a fixed position in well until bit is withdrawn from perforation.

This invention relates to a system of perforating well casings and adjoining structure by use of a perforating tool and to a perforating tool utilized in the performance of said system.

Wells frequently are drilled into various types of formation to obtain oil, gas and water, for example. It is the usual practice to line or encase the well bore with casing after the drilling has reached the total depth and this involves setting the casing, cementing and then perforating at one or more locations, which may be on the order of thirty to forty feet off bottom.

Sometimes after wells have produced for a period of time, the formation adjoining the well bottom becomes clogged or lacking in sufficient porosity to deliver a desired volume of flow into the well. Another condition which requires correction of well bottom features is the failure of the formation to produce fluid in sufficient quantity at the selected level where there has been an indication of capability to produce the desired quantity at a somewhat higher or lower elevation. Under these circumstances, a length of the casing at the bottom of the well will be sealed and it then becomes necessary to perforate the casing and usually some of the adjoining structural formation to obtain desired flow of fluid into the well at the newly established level above or below the point of sealing.

It has been a custom in the past to provide electric conductor cable extending into the well and gun-type or explosive-type perforators are carried on the lower end of such cable to the level where perforating is to be undertaken and the circuit controlling means at the surface is then operated to fire the explosive charges and thereby perforate the casing and adjoining formation. In many instances, the formations are seriously damaged by the high explosive charges used in such perforating operations. The present perforating system has been designed to utilize the conductive cable heretofore in use and to substitute a new type of perforating means for the explosive-type perforators and thereby attain the desired perforating of the lower end of the casing and associated formation without shattering effect or other damage to the structure.

The present invention includes both a novel system concept and a novel perforator tool concept which represents distinct departures from prior practices and utilize

a number of innovations in attaining the casing and formation perforation. One of these comprises a novel type of perforating tool inclusive of a drill bit carried on a flexible shaft with provision for continuous rotation of the bit through a predetermined range of drilling movement followed by a withdrawal movement of the same degree as the extent of the penetration.

Another innovation involves the provision of an elongated tubular body which is supported by conductor cable and lowered into the well to dispose its lower end at a predetermined elevation with the elongated tube suspended in spaced relation to the well casing throughout its entire length and having at least one internal component arranged to extend through openings in the tubular body and engage a surface of the well casing so as to prevent rotation of the tubular body when the casing is so engaged. This arrangement leaves the internal components of the tubular body free to rotate within its enclosure and thus provide a drive for a bit mounted on a flexible shaft carried at a lower end of the string of such internal components.

It is an object of my invention to provide a simple, economical and efficient system for perforating a well casing and adjoining producing formation to increase flow of formation fluids into the well.

Another object of my invention is to provide a drilling assembly of a novel character contained within an elongated tubular body adapted to be lowered into a well by conductor cable so as to dispose the bottom of the assembly at a level of a producing formation and to provide the electric power requirements for the perforating operations by an electric motor contained within the tubular body and having the operation thereof actuating a drill bit directed by control means at the surface.

A further object of my invention is to provide a novel type of pump in a drilling assembly contained within a tubular body lowered into a well which is capable of circulating well fluid or other fluid to expand a contained locking device preventing rotation of the tubular body within the well bore and supplying fluid to a rotating drill bit for the purpose of lubricating same and washing away cuttings produced by the bit.

Other objects reside in novel details of construction and novel combinations and arrangements of parts, all of which will be set forth fully in the course of the following description.

The practice of my invention will be described with reference to the accompanying drawings illustrating typical structural embodiments adapted for performing the novel system of perforating well casings and adjoining structure. In the drawings, in the several views of which like parts bear similar reference numerals,

FIG. 1 is a vertical section broken at different elevations to illustrate a typical installation in which a drilling assembly is suspended within a well and has its lower end disposed at the level of a producing formation. The well is shown as having casing extending throughout its lengthwise extent and the portions of the drilling assembly disposed between breaks shown in the casing are designated A, B, C, D and E, respectively;

FIG. 2 is an enlarged fragmentary vertical section of the A portion of the drilling assembly which as shown in FIG. 1 is the uppermost portion;

FIG. 3 is another fragmentary vertical section to the same scale as FIG. 2 and illustrating the structural features in the B section of the assembly;

FIG. 4 is a section taken along the line 4—4 of FIG. 2;

FIG. 5 is a fragmentary vertical section of the C portion of the drilling assembly shown in FIG. 1;

FIG. 6 is another fragmentary vertical section of the portion of the drilling assembly shown at D in FIG. 1;

FIG. 7 is a fragmentary vertical section of the portion shown at E in FIG. 1 which is the lowermost portion disposed at the level of a producing formation;

FIG. 8 is a section taken along the line **8—8** of FIG. 7;

FIG. 9 is a fragmentary partially broken vertical section to the same scale as FIGS. 2 through 8 and illustrates a closed circuit hydraulic system which is used in the drilling assembly of the type depicted in FIG. 1 as an alternative for the open circuit hydraulic system of that assembly;

FIG. 10 is a section taken along the line **10—10** of FIG. 2; and

FIG. 11 is a section taken along the line **11—11** of FIG. 9.

The practice of my invention will be described first with relation to the form of drilling assembly illustrated in FIGS. 1 through 8 and 10 in which an open circuit hydraulic system is provided for use of well fluid only. As shown in FIG. 1, a well **21** has been shown as extending from the surface **22** to a lower producing formation **23** with the well bore encased by casing **24**, and electric conductor cable **25** connected with means **26** at the surface controlling a circuit through said cable suspends a drilling assembly designated generally by the reference numeral **27** interiorly of the well casing in spaced relation thereto with a string of components comprising the drilling assembly being shown in the portions A, B, C, D and E of FIG. 1 in outline form and in complete detail in other figures of the drawings as will be specifically set forth in the following description. The conductor cable **25** carries electric current to the electric motor **30** driving a lower perforating tool **80** to provide the required drive therefor. This motor is a single phase motor and the circuit is completed by grounding the motor **30** to the drilling assembly **27** as shown at **31** in FIG. 2. This ground **31** is connected to the outer steel portion of the conductor cable **25** and therefore completes the electrical circuit. When the conductor cable has sufficient insulated conductors to handle three phases, a multi-phase motor may be used.

The structural arrangement shown in FIG. 2 includes an elongated body portion **32** secured by a top cover member **33** which is shouldered as shown at **34** and provides a seat for an internal threaded portion terminating in an annular flange **35** which seats against the shoulder **34** and suspends body portion **32** and a depending tubular portion **36** in the well bore. The electric conductor cable **25** is connected to and extends through the submerged top portion and forms a casing for the connector motor leads **25***a* and **25***b* which extend through the hollow portion of the tubular enclosure **36** and into the threaded neck and bore **30***a* of a motor **30**. As will be best understood by reference to FIG. 10, a channel **37** is formed in the exterior wall of the motor assembly **30***m* and permits the leads to descend to the bottom of said motor as shown at the top of FIG. 3.

As shown in FIG. 3, a collar portion **40***a* extends downwardly from the base of motor **30** and an internal coupling **41** extends downwardly from the throat **40***c* within a compensating tube **42** having a protector **43** at its top and a plug **44** adjoining the protector. An elongated flexible tube portion **42***a* of tube **42** is contained within an annular bore **45** below the plug **44** and is filled with oil, its lower end connecting to the interior of a sealed housing of the adjoining gear reduction unit **40** while its opposite end is plugged. A spring coupling **50** connects the extended portion of coupling **41** with the input shaft **51** of the reduction gear assembly **40** and a Woodruff key **52** holds the coupled members against an unwinding action. The gear reduction unit **40** has a double oil seal assembly **53** at its upper end and a retaining ring **54** under the seal assembly **53** which is disposed at the upper end of a double ball bearing assembly **55** interiorly of the upper section **56***a* of the gear reduction housing **40**. A compression tube **57** conducts oil from the compensating tube **42** to an outlet **57***x* lubricating the bearing assembly **55** and input shaft **51**.

A pinion gear **60** is mounted on the lower end of input shaft **51** and drives an intermediate shaft **61** of the gear assembly which is connected at its lower end with an internal gear **62** which drives the output shaft **63** of the gear reduction assembly. In this arrangement, the shafts **51** and **63** are centered on the longitudinal axis of gear **62**. Intermediate shaft **61** and output shaft **63** are each supported for rotation by ball bearing assemblies **64** and **65** and oil seals **66** are disposed below the lower ball bearing assembly **65** and secured by retaining rings **67** while an O-ring **68** is disposed in a recess in the outer wall of the lower section **56***c* of the reduction gear housing to confine lubricant flow in a manner to be subsequently described.

As shown in FIG. 5, the elongated tubular body **36** of drilling assembly **27** has a slotted portion **70** adjoining expanding means in tube **36** having an exterior portion arranged for movement through the slot **70** into frictional engagement with casing **24** to prevent rotation of tube **36** relative to casing **24**. The expanding means shown in FIG. 5 comprises a slip body **71** of tapering cross section supported by a screw attachment with an adjoining portion of tubular body **36** and bearing against a slip carrier **73** on which a slip **74** is secured by cap screws **75**. Slip pins **76** secure links **77** to a piston **78** mounted on a sleeve **79** on drive shaft **72**. The sleeve **79** confines an elongated spring **83** in biasing relation to piston **78**. Slip **74** as shown in FIG. 5 includes a plurality of jaws with teeth **74***a* on their exterior surface which are disposed at a common oblique angle to the longitudinal axis of slip **74** causing an expansion of said jaws when moved in one direction and a contraction by opposite movement. Because of the taper of body **71**, slacking of cable **25** induces retraction of the slip jaws and spring pressure against piston **78** holds the jaws in retracted position until the next drilling cycle.

Piston **78** is hollow and confines the top plate **85** of a low pressure pump assembly **84** carried on driven shaft **72** and a top bearing **86** is provided for plate **85** which is connected to a lower plate **87** having a bearing **87***a* by screws **88** and the pump impeller **89** is disposed between said plates for rotation directed by a pump shaft **90** which is secured on driven shaft **72** by a key **91**. Packing **92** is held against shaft **90** by a nut member **93** which is secured against unfastening by a lock nut **94**. This provides a sealed arrangement for the internal bearing means permitting the hub of the piston to rotate independently of its outer portion.

Pump assembly **84** will by-pass fluid within itself if the pressure reaches approximately 35 lbs. per square inch above the normal hydrostatic pressure within the well **21**. The pump is driven by means of the sliding keys **91** in the keyway **72***x* of driven shaft **72**. As pump assembly **84** is fastened fixedly with the tubular portion **36**, as shown at **82**, it does not move up and down with the motor reduction gear unit **40**.

A fluid relief valve **96** comprising an upper hollow section **96***a* and a lower hollow section **96***b* has a threaded connection **97** with the lower end of shaft **72** which terminates at said connection. A keyed shaft **98** is fastened to the interior surface of upper section **96***a* by keys **98***a* and is held in driven relation by relief valve **96**. A retaining ring **99** and washer **100** separate the hollow interior of section **96***a* from the hollow interior of section **96***b* which confines a spring **103**, permitting elongation of the valve when the conductor cable raises, thereby exposing port **95** to permit fluid flow out of the cylinder above piston **78**. Tubular portion **36** makes a threaded connection **101** with an exterior wall portion of a hollow chamber **102** in which the relief valve **96** is located.

A thrust type ball bearing assembly **110** is mounted on shaft **98** below valve **96** and has an enlarged intermediate portion **111** of its exterior surface in close fitting engagement with tubular portion **36** and an O-ring **112** therein

prevents fluid flow along the interior of said tube **36** past enlarged portion **111**. Assembly **110** includes an upper oil seal unit **113** and a lower oil seal unit **114**, secured by retaining rings **115** and **116**, respectively. A plug **117** normally closes an opening by which a lubricant can be introduced into an interior space **118** for supplying the lubricant requirement of an upper ball bearing unit **119** and a lower ball bearing unit **120**.

FIG. 6 illustrates an assembly **125** having a threaded connector **126** inserted between spaced threaded portions of tubular member **36**, the lowermost of said sections having a plate **127** closing its hollow interior and supporting a hollow guide tube **128** which extends upwardly in enclosing relation to the lower end of keyed shaft **98** which has an internal coupling **129** with a flexible shaft **130**.

FIG. 7 illustrates the perforating assembly of perforating tool **80** which includes an extension of guide **128** being supported within tubular portion **36** by another plate **132** supported from its inner wall surfaces and having a welded connection with guide **128**. The lower end **36***x* of tubular portion terminates in a threaded connection **133** with an elongated body **134** having an internal bore **135** extending from the lower end of shaft **130** at its top to a bottom side outlet **136** in a curved path. Preferably, the body **134** is formed by two castings providing the required shaping and held as an integral body by screws **137**.

The lower end of flexible shaft **130** is part of a stretch of flexible shaft shown at **138** extending through curved bore **135** which acts as a guide therefor. A drill bit **139** is carried at the lower end of flexible shaft and extends outwardly beyond outlet **136** to perforate the well casing **24** and associated producing formation **23**. Flexible shaft **138** has an internal passage **140** (FIG. 8) preferably lined by plastic tubing which delivers a lubricant to the drill bit while operating and also provides a sufficient flow to wash cuttings from the perforation being formed. A casing shoe **141** secures the headed ends of lower screws **137** against damage during drilling and is held on body **134** by cap screws **142**.

For some operating requirements, it will be advantageous to provide a closed circuit lubricating system in the drilling assembly and a closed circuit system of this type has been illustrated in FIGS. 9 and 11. The lubricant circulation and pumping and distributing features include different structural arrangements than those shown in FIGS. 5 and 6 and described hereinbefore and have been given different reference numerals. Structure shown above and below the closed circuit hydraulic system of FIG. 9 is identical with that shown in FIG. 5 and has been given the same reference numerals as in FIG. 5.

The closed circuit hydraulic system **144** illustrated in FIG. 9 has a piston **145** mounted on a lower portion of shaft **72** and the piston encases the top plate **146** of a pump assembly and a bottom plate **147** is spaced therefrom. A top bearing **148** is provided for plate **146** and a lower bearing **149** is supported adjacent plate **147**. The plates are secured by screws **150** and an impeller **151** on shaft **72** rotates in the space between plates **146** and **147**. Packing **152** is secured in a nut **153** at the lower end of bearing **149** and a lock nut **154** seats on nut **153** to maintain its established locked position.

A threaded connector **155** is disposed between spaced sections of tubular portion **36** and has an internal passage **159** through which lubricant is elevated into the hollow interior of impeller **151** and thence into piston **145**. In this system, it is necessary to conserve oil and it is bypassed through a passage **161** in the shaft **158** and out of a port **160** when the conductor cable or wire line **25** lifts the tool, thereby uncovering port **160** and flows into the piston relieving pressure above the piston, allowing the piston to be raised to the top of its stroke when a lifting force is exerted by cable **25**.

System **144** has a flexible reservoir **162** of soft, resilient oil-proof material which is exposed to the hydrostatic pressure in the well **21** by being located outside the housing **163** of system **144**. Reservoir **162** will expand and contract sufficiently to accommodate the displacement flow of the piston which actuates the slip **74**, and also permits a moderate amount of leakage. As the piston which drives the bit into drilling contact moves down, the oil below same is displaced into the reservoir **162** through ports **159** located in the cylinder near the lower end of same. When the assembly is lifted by wire line **25**, the valve **156** opens to allow the oil above the piston to be displaced as stated above. A ball bearing assembly is mounted on shaft **158** below the pump assembly **84** and comprises upper and lower oil seals **164***a* and **164***b*, respectively, and upper and lower bearings **165** and **166**, respectively.

A lower pump assembly **170** is provided to circulate well fluid to the bit and is of small volumetric output. This pump has an upper plate **171** secured on shaft **158** by a nut **172** and lock nut **173** and a screen member **174** is disposed between upper plate **171** and lower plate **175** having a passage **176** for delivery of screened well fluid into a lower distributing chamber **177** of the pump. Screen member **174** and associated lower plate **175** extend across the entire interior of tubular portion **36** with openings **178** or ports in portion **36** permitting intake of well fluid through screen member **174**, thence through passage **176** into the interior portion of chamber **177** under the pumping action of rotor **185** (FIG. 11).

The arrangement of the bottom closure of chamber **177** is the same structural arrangement as shown in FIG. 6 and connects in turn with a perforating tool of the type shown in FIG. 7. Consequently, reference numerals shown in FIG. 6 have been applied to the bottom plate **127** and guide structure **128** shown in FIG. 9. A slight gap **179** is provided between the top of guide member **128** and the lower end of shaft **158** which permits the well fluid within chamber **177** to pass into an internal passage **181** in the pump rotor **180** and thence into keyed shaft **130** to which the flexible shaft **138** of the perforating tool is connected.

It will be apparent that the well fluid after screening to eliminate solids which might block internal passages through which the fluid is conducted is delivered to the drill bit of the perforating tool in sufficient volume to provide the desired lubricating effect and to remove cuttings from the bit, while the lubricant circulation through the remainder of the closed circuit hydraulic system **144** is a clean lubricant which is confined and circulated through the closed circuit without contamination by well fluid.

Again referring to FIG. 1 in which the entire drilling assembly is shown as being in an operative position within an oil well **21**, said assembly is shown in portion A and the related view, FIG. 2, as having an upper member providing connection with electric conductor cable extending into the well from a surface location outside of same and with control means at the surface for controlling the operation of an electric circuit through and inclusive of said conductor cable. An electric motor is disposed in the upper body portion **32** within an elongated tubular body **36** which extends throughout substantially the entire length of drilling assembly **27**, the lower portion of which is disposed in a perforating position at the bottom of well **21**. Motor **30** is connected in driving relation to an input shaft **51** which as shown in FIG. 3 extends into a gear reduction unit **40** and another output shaft **63** extends downwardly from the lower end of the gear reduction unit in coupled relation to a driven shaft **72**. The tubular body **36** is apertured or slotted as shown at **70** in FIG. 5 and an expanding locking device has a slip portion **74** and associated carrier and linkage which assist the expansion and contraction movements of the slip body through the slot **70** into gripping engagement with the well casing **24**.

A sleeve **79** surrounds shaft **72** in supporting relation to the slip assembly which is fastened to tubular portion **36** by screws or other suitable fastening means. A low

pressure pump assembly **84** is mounted on shaft **72** below the slip assembly and has an upper piston which is driven by the electric motor-reduction gear unit. The piston is subjected to pump pressure and well fluid pressure and is the means which controls the expanding and closing movements of the slip assembly. When the slip is expanded into contacting relation with the well casing, rotation of the elongated tube member within the well is prevented but the internal components of such assembly are rotated to accommodate the perforating tool in a manner which will be described hereinafter.

A pump unit is carried on shaft **72** immediately below piston **78** and directs the flow of well fluid admitted into the interior of tubular member **36** by the slotted openings **70** and circulates such flow downwardly through a hollow portion of the shaft and into the bore of a connecting flexible shaft is a part of the perforating tool assembly. In the operation of the drilling assembly, provision is made for lowering the internal components a predetermined distance during one perforating cycle and after completion of which, the assembly is again raised by actuation of the conductor cable to dispose it in the operative position to resume the next drilling cycle.

The perforating tool assembly **80** as shown in FIG. 7 incldes a tubular body extending downwardly from plate **132** in encompassing relation to keyed shaft **130** which is connected to the flexible shaft **138** extending through a curved internal bore in the elongated body **134** and which carries a drill bit **139** at its lower end extending through a bottom side outlet **136**. The guide **128** prevents excessive bending or twisting of flexible shaft **138** within it and within the bore **135** while the bit **139** is being rotated and drilling a perforation through the well casing or adjoining formation. It also is essential that the bit and flexible cable be held against twisting during the following retraction stage of the cycle and the pumping pressure exerted against piston **78** and associated components is continued in the same degree until the bit is completely retracted and resumes the position shown in FIG. 7. At that stage of the operation, the conductor cable is pulled, allowing the relief valve **96** to move upwardly on shaft **72**, exposing the opening **95** which it normally covers, thereby allowing confined well fluid to pass out of shaft **72** relieving pressure on the top of piston **78** and the resulting upward movement retracts slip **74**, allowing it to return within the enclosure of tubular body **36** so that the entire assembly is elevated a distance equivalent to the maximum extension of bit **136** in the drilling action to establish a new position for operating in the next drilling cycle.

I claim:

1. A system for drilling perforation holes in a bordering surface of a well bore at a producing formation level, comprising an electric conductor cable supported at the surface and maintained in a depending position within the well bore, means at the surface for controlling an electric circuit through said cable, an elongated tube suspended by said cable in the well bore at a selected elevation below the surface, an electrically powered drilling assembly means for drilling the perforation holes, the electrically powered drilling assembly means being suspended by said cable interiorly of the tube and secured by the tube against independent rotation, pressure responsive expanding means extending through openings in the tube for selectively securing and releasing the tube at selected locations in said well bore, and a pump means for supplying fluid pressure to the expanding means whereby to direct its securing and releasing actions.

2. A system as defined in claim **1**, having means for limiting the output pressure of the pump means.

3. A system for drilling perforation holes in a bordering surface of a well bore at a producing formation level, comprising an electrical conductor cable supported at the surface and maintained in a depending position within the well bore, means at the surface for controlling an electric circuit through said cable, a drilling assembly supported by the conductor cable for rotation in a depending position in the well bore and including an elongated tubular enclosure for a drive assembly, and a perforating tool connected with the drive assembly, said perforating tool being directed in a laterally directed drilling operation by rotation imparted by the drive assembly responsive to the control means at the surface, said drive assembly including an electric motor, pressure responsive means for selectively locking the tubular enclosure to the well casing at selected depths within the well, piston means connected to the perforating tool for applying pressure to the bit thereof during the drilling operation, and pumping means operable to selectively supply fluid pressure to the locking means and the piston means whereby to selectively lock the tubular enclosure to the well casing and apply pressure to the bit of the perforating tool.

4. A system as defined in claim **3**, including second pumping means within the tubular enclosure for supplying fluid to the drill bit to lubricate it and wash away cuttings from the perforation, and means for supplying said second pumping means with a fluid withdrawn from the well bore.

5. A system as defined in claim **3**, having an open circuit hydraulic system including second pumping means within the tubular enclosure supplying liquid to the drill bit to lubricate it and wash cuttings away from the perforation, and means for supplying fluid from the well bore to said hydraulic system.

6. A system as defined in claim **3**, having a closed circuit hydraulic system including said first pumping means for circulating clean lubricant through the system, and a second pumping means within the tubular enclosure for supplying fluid from the well bore to lubricate the drill bit and wash cuttings away from the perforation.

7. A system for drilling perforation holes in a bordering surface of a well bore at a producing formation level, comprising an electric conductor cable supported at the surface and maintained in a depending position within the well bore, means at the surface for controlling an electric circuit through said cable, a drilling assembly in the well bore supported by the conductor cable and including an elongated tubular member containing an upper drive assembly inclusive of an electric motor, a gear reduction unit associated with the motor having concentric input and output shafts, pressure responsive expanding means extending through openings in the tubular member for selectively securing and releasing the tubular member at selected locations in the well bore, pump means operable by said motor for supplying fluid pressure to the expanding means whereby to secure the elongated tubular member at seletced elevations within the well bore, and said pump means being also operable to circulate a lubricant fluid interiorly of said drive assembly, and a lower perforating tool having a flexible shaft connection with the output shaft of the upper drive assembly, said perforating tool having a drill bit directed in a laterally directed drilling operation by rotation of the output shaft responsive to the control means at the surface, a guiding mechanism for said flexible shaft, said drilling assembly including means for measuring the travel of the conductor cable while the perforation is being cut by said bit, said expanding means being operable to continue to hold the guiding mechanism of the perforating tool against movement while the bit is withdrawn from the perforation, means delivering a lubricant fluid in induced flow through the flexible shaft to said bit, piston means responsive to said pump means and connetced to said perforating tool for applying a controlled pressure against the bit while it is rotated, and means for returning the conductor cable to the same starting position at the beginning of each cutting cycle.

8. In combination with a system for drilling perforation holes in the bodering surface of a well bore wherein a drilling assembly depends in said well bore from an

electric conductor cable supported at the surface, said drilling assembly including an elongated tubular member containing a drive assembly and a perforating tool, the improvement which comprises:

pressure responsive expanding means mounted on said tubular member for engaging said well bore whereby to secure said tubular member at selected depths in the well; and

selectively operable pump means for supplying fluid pressure to said expanding means whereby to selectively operate said expanding means.

9. The invention recited in claim **8**, wherein:

said tubular member has at least one slot therein for receiving said expanding means; and

said expanding means comprises:

jaw means slidably mounted in said slot to be selectively movable away or towards the axis of said tubular member, said jaw means being for engaging said well bore; and

a tapered actuating mechanism mounted along the axis of said tubular member in sliding contact with said jaw means, said actuating mechanism being operable in response to the fluid pressure of said pump means to move said jaw means into engagement with said well bore.

10. The invention recited in claim **8**, including pressure responsive means connected to said perforating tool for applying pressure to the bit thereof during the drilling operation, said pressure responsive means being responsive to the fluid pressure of said pump means.

References Cited

UNITED STATES PATENTS

2,516,421	7/1950	Robertson	175—78
2,539,047	1/1951	Arutunoff	175—78 X
2,558,452	6/1951	Mennecier	175—78
2,631,821	3/1953	Caldwell	175—78

ERNEST R. PURSER, Primary Examiner

U.S. Cl. X.R.

175—99