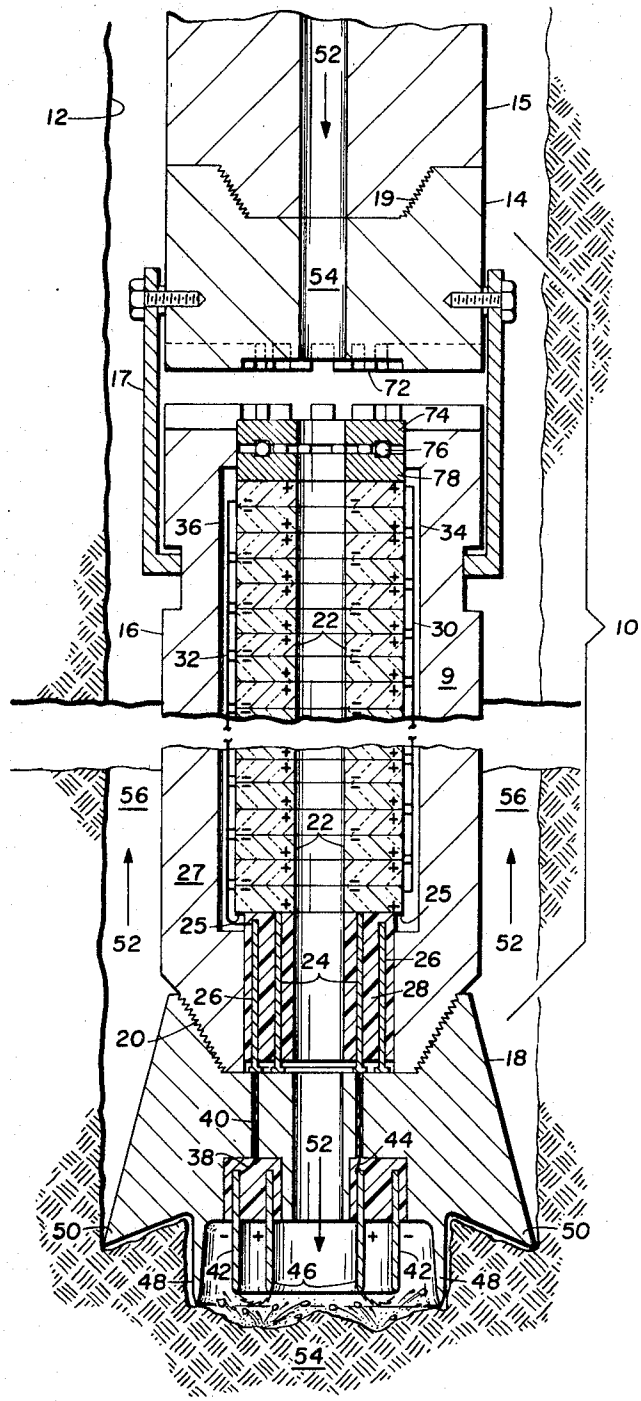
April 14, 1970 F. A. ANGONA 3,506,076

WELLBORE DRILLING WITH SHOCK WAVES

Filed Dec. 12, 1967 2 Sheets-Sheet 1

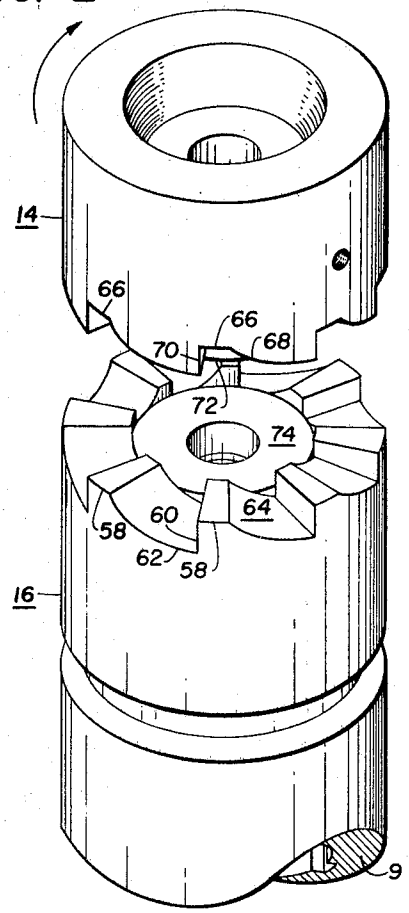
FIG. 1



WELLBORE DRILLING WITH SHOCK WAVES

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FIG. 2



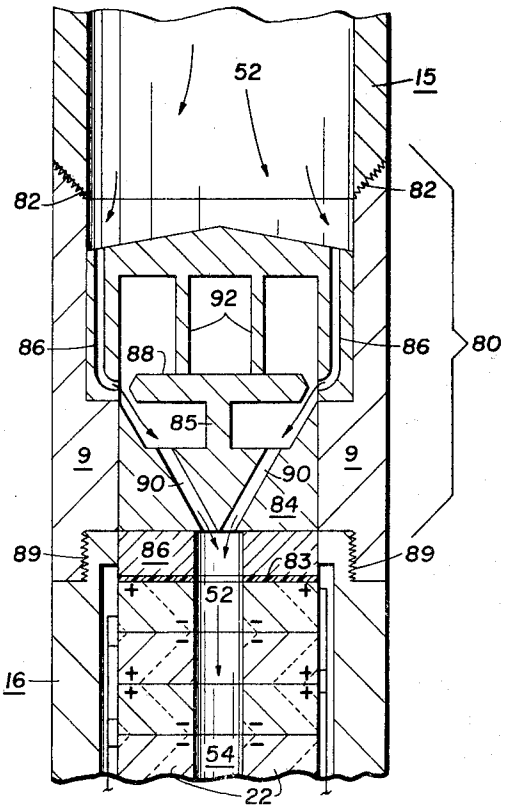


FIG. 3

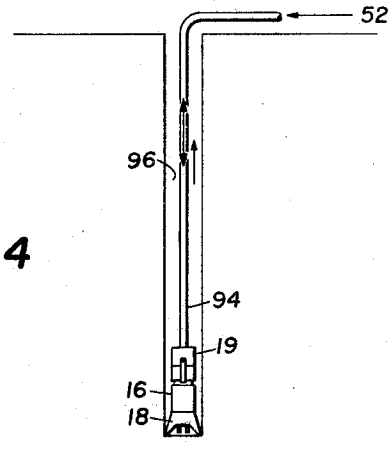


FIG. 4

United States Patent Office 3,506,076
Patented Apr. 14, 1970

3,506,076

WELLBORE DRILLING WITH SHOCK WAVES

Frank A. Angona, Dallas, Tex., assignor to Mobil Oil Corporation, a corporation of New York

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Int. Cl. E21b 1/06, 3/10
U.S. Cl. 175—57 15 Claims

ABSTRACT OF THE DISCLOSURE

This specification discloses a method and apparatus for utlizing shock waves in drilling a wellbore. The shock waves are created by arcing electrical energy between electrodes located in a drill bit. The electrical energy is generated downhole by converting mechanical energy into electrical energy with piezoelectric means.

BACKGROUND OF THE INVENTION

Field of the invention

The invention relates to methods and apparatus for drilling wellbores utilizing shock waves produced by arcing electrical energy between electrodes. The electrical energy is generated downhole by spark pumps comprised of piezoelectric means. The spark pumps convert mechanical energy into electrical energy which is thereafter arced or sparked between two or more electrodes to produce shock waves which fracture the formation.

Description of the prior art

Rotary drilling is the most commonly used method of drilling wellbores. In rotary drilling a drill bit is attached to one end of a drill string, the other end of which extends to the surface. The drill string has a passageway through which drilling fluids are passed. In carrying out rotary drilling operations, mechanical power in the form of rotational torque is applied at the surface to the drill string. This causes rotation of the drill string and of the drill bit at the bottom of the wellbore. Weight is applied on the drill bit by a specialized part of the drill string called drill collars which are of heavier weight than the other portion of the drill string called drill pipe. As the bit is rotated in contact with the wellbore bottom, the teeth of the bit break, fracture, and dig the formation. Drilling fluid is circulated from the surface of the earth to the bottom of the wellbore and back to the surface again. This circulating drilling fluid removes the formation debris from the wellbore and allows the bit to contact fresh formation. The drilling fluid may be, for example, drilling mud, gas or air. Pumps are used to circulate the drilling fluid between the surface and the wellbore bottom.

Though rotary drilling has proved to be in general the most practical method of drilling wellbores, it has many disadvantages. One of these disadvantages is the reduced power available at the drill bit compared to the power applied to the drill string. This power reduction results from such things as frictional losses in transferring mechanical energy in the form of rotational torque from the surface to the drill bit. Another disadvantage is that the drill pipe fails at times under this torsional stress causing expensive work in removing the parted section of the drill string remaining in the wellbore.

Other methods of drilling have been tried in order to alleviate these problems. One such method is electric arc drilling. In electric arc drilling two or more electrodes are positioned at the bottom of a wellbore and are connected through conductor cables to electrical generating equipment at the surface. Electrical power is transmitted downhole through the conductor cables and caused to continually arc between the electrodes to produce high temperatures which cause structural failure of the formation being drilled. Electric arc drilling has several principle problems. One of these involves the necessity of shielding the electrodes from liquid drilling fluid and surrounding them in a gas environment. This problem has been partially solved by providing a gas filled chamber surrounding the electrodes. A source of high pressure gas is used for pressurizing the electrode chamber. Another problem involves conducting electrical power downhole. This problem has not been successfuly solved for deep wellbores. Still another problem which has not been successfully solved involves the replacement of consumed electrodes.

Shock wave drilling is another method of drilling wellbores. By this method a drill bit having multiple electrodes depending therefrom and a fluid passageway extending therethrough is attached to the lower end of a drill string. Liquid drilling fluid is circulated between the surface of the earth and the bottom of the wellbore by passing the drilling liquid through the drill string and drill bit to the wellbore bottom and returning it to the surface by way of the annulus between the drill string and wellbore walls. In this manner the electrodes are surrounded by liquid drilling fluid. The multiple electrodes are comprised of cathodes and anodes which are intermittently energized by electrical energy thereby producing a spark by arcing the electrical energy between adjacent cathodes and anodes. This spark or electrical arc initiates a shock wave in the drilling liquid which propagates through the liquid and fractures the earth formation. Drilling liquid is circulated between the surface and the wellbore bottom and cleans the wellbore of formation debris. This method of drilling shares with electric arc drilling the problem of conducting electrical energy downhole to the drill bit.

SUMMARY OF THE INVENTION

This invention concerns a method and apparatus for shock wave drilling. By this invention electrical energy is generated downhole by a spark pump comprised of piezoelectric means. The spark pump converts mechanical or compressive energy into electrical energy which is arced or sparked between electrodes to produce shock waves in drilling liquid surrounding the electrodes. These shock waves propagate through the drilling liquid and break or crush the formation. Drilling liquid is circulated in the usual manner to remove formation debris from the wellbore.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a cross-sectional view of one embodiment of a downhole drill tool showing a lifting sub, spark pump sub, and drill bit.

FIGURE 2 is a perspective view of a portion of FIGURE 1 showing an apparatus for transferring mechanical energy from the drill string to the spark pump.

FIGURE 3 is a cross-sectional view of another embodiment showing a jet edge generator in combination with a spark pump sub.

FIGURE 4 is a diagrammatic view of yet another embodiment showing a cable drill tool employing a spark pump.

DESCRIPTION OF THE PREFERRED EMBODIMENT

This invention is comprised of a method and apparatus for drilling a wellbore utilizing acoustical shock wave energy. Mechanical and hydraulic energy is converted downhole into electrical energy by a spark pump which is comprised of a plurality of piezoelectric means electrically connected one with the other. This electrical energy is arced or sparked between electrodes immersed in a drilling liquid and associated with a drill bit. This arc pro-

duces shock waves in the drilling liquid which propagate to the formation being drilled and effect fracturing and failure of the formation.

In one embodiment of this invention, a drill tool comprising a means for generating electrical energy and a drill bit having cutting edges and electrodes is positioned in a wellbore such that the means for generating electrical energy is spaced from but closely adjacent the wellbore bottom. The drill bit is rotated and the cutting edges from an annular cut in the earth formation. The means for generating electrical energy which may be, for example, a spark pump is actuated to produce said electrical energy which is arced between the electrodes to generate shock waves in the drilling liquid which break the earth formation which otherwise would be encompassed by the annular cut. The means for generating electrical energy is moved at a rate commensurate with the drilling of the wellbore to maintain it at a substantially uniform distance from the wellbore end being drilled.

In another embodiment of this invention, a drill tool comprising a spark pump and a drill bit having cutting edges and electrodes is alternately raised from and dropped to the wellbore bottom thereby actuating the spark pump and producing electrical energy which is arced between the electrodes to generate shock waves which effect failure of the formation. Simultaneously the earth is fractured by contact of the cutting edges of the drill bit with the wellbore bottom. The cutting edges may be, for example, blades as are used in conventional cable, drag or rotary bits.

This invention is described in more detail by reference to the drawings. Referring specifically to FIGURE 1 there is seen a drilling tool **10** in a borehole **12**. This drilling tool **10** is comprised of a lifting sub **14**, spark pump sub **16**, and drill bit **18**. Drill bit **18** is attached to spark pump sub **16** by threads **20**. Spark pump sub **16** is attached to lifting sub **14** by connecting means **17** which permit vertical motion and differential rotation between lifting sub **14** and spark pump sub **16**. Spark pump sub **16** is comprised partly of a case **9** having a chamber therein. The interior surfaces of the chamber are coated with an insulating material, e.g., ceramic. Piezoelectric means **22** are stacked in this chamber. Appropriate piezoelectric means for use in this embodiment may typically be discs, cylinders, or rings made of lead zirconate-lead titanate ceramic. These piezoelectric means have the interior portion removed to form approximately a cylindrical passageway having the central axis of the passageway coinciding with the central axis of the piezoelectric means. The faces of the piezoelectric means **22** are silvered.

When piezoelectric means **22** are compressed, an electrical potential develops between opposite silvered faces that is proportional to the applied pressure. This potential appears essentially instantaneously. Thus, a condition is developed where one silvered face of piezoelectric means **22** has a positive potential as compared to its opposite face. Piezoelectric means **22** are stacked in the chamber of spark pump sub **16** by a method of alternately inverting each during stacking so that positive faces contact one another and negative faces contact one another. The lower end of the column of piezoelectric means **22** is supported partially by a shoulder **25** of case **9** and partially by a support structure **27**. Support structure **27** is comprised of concentric electrically conducting cylinders **24** and **26** potted in an insulating material **28**, e.g., plastic having structural strength. Channels **34** and **36** are recessed in case **9** and opened into the chamber therein. Channels **34** and **36** house electrical conductors **30** and **32** which are used to connect in parallel piezoelectric means **22**. Conductors **30** and **32** are electrically insulated from case **9**. This insulation may be provided about conductors **30** and **32** themselves or may be provided by coating the surfaces of channels **34** and **36** with an insulating material, e.g., ceramic.

Conductor **32** is connected to the ground terminals of piezoelectric means **22** and thence is connected to the upper end of cylinder **26**. The lower end of cylinder **26** is connected to one end of an electrical conductor **38** which passes through passageway **40** in bit **18** and connects to electrode **42** which may be, for example, an electrically conductive cylinder. Likewise the positive terminals of piezoelectric means **22** are connected to conductor **30** and thence cylinder **24** and conductor **44** to electrode **46**. Thus, the plurality of piezoelectric means **22** contained in the chamber of spark pump sub **16** are connected in parallel to electrodes **42** and **46**. By the preferred arrangement, electrodes **42**, which are located nearest metal teeth **48** of bit **18**, are connected to the ground terminals of piezoelectric means **22** to avoid electrical arcing between electrodes **42** and teeth **48**. However, if it is desired to reverse the electrical connections then electrodes **42** may be spaced sufficiently far from teeth **48** so that arcing does not take place therebetween.

Drill bit **18** is a modified drill bit having teeth **48** for drilling a pilot hole and electrodes **42** and **46** for arcing of electrical energy there between. Cutting edge **50** serves the purpose of keeping the borehole in gage as well as removing formation **54** from the outer portion of the borehole during rotation of the drill bit. It is to be understood that teeth **48** and cutting edge **50** as shown are for illustration purposes and may be any suitable cutting apparatus such as are used in cable or rotary bits. These cutting edges are generally adapted for cutting an annular ring in the earth formation. The arcing of electrical energy in the drilling liquid between the electrodes produces shock waves which fracture the earth formation encompassed by the annular cut.

Piezoelectric means **22** are intermittently compressed to produce electrical energy which is connected through electrical conductors **30** and **32** conducting cylinders **24** and **26** and conductors **38** and **44** to electrodes **42** and **46**. Electrodes **42** and **46** are so spaced that arcing takes place only after substantial electrical potential is developed between them. This electrical potential at which arcing takes place may be, for example, about 30,000 volts. This arcing produces shock waves in drilling liquid **52** which propagate to uncut formation **54** and fracture and break it. Drilling liquid **52** is circulated from the surface to the bottom of the wellbore and back to the surface thereby removing debris from the wellbore.

Next is described one embodiment for applying mechanial energy to the column of piezoelectric means **22**. For this description FIGURES 1 and 2 are referred to. Lifting sub **14** is supported at the lower end of drill string **15** and connected thereto by threads **19**. Connector means **17** attaches lifting sub **14** to spark pump sub **16** whereby vertical movement and differential rotation between said subs is allowed. The connecting interfaces formed at the ends of the cases of lifting sub **14** and spark pump sub **16** are shaped to produce a cammed motion. For purposes of description the lifting sub is considered the cam follower and the spark pump sub is considered the cam. In operation rotational torque is applied at the surface to drill string **15**. This rotational torque is transferred from the surface through drill string **15** to cam follower **14**. This torque is transferred from cam follower **14** to cam **16**. Bit **18** encounters resistance in rotating against formation **54** and provides a counter force which reduces the rotation rate of cam **16** with respect to the cam follower **14**. Cam **16** and cam follower **14** may have any configuration necessary to simultaneously produce the desired vertical movement and differential rotation. In the configuration shown in FIGURE 2, the interfaces of the cam follower **14** and cam **16** have a series of shoulders, sloping faces, and vertical faces. These interfaces are shaped to produce a vibration motion between cam follower **14** and cam **16** when cam follower **14** is rotated with respect to cam **16**. The amplitude of the vibrations induced in cam follower **14** is controlled by the vertical

distance from the shoulders to the bottom of the vertical faces of cam follower **14** and cam **16**. The frequency of the vibrations is related to both the differential rotation rate between the cam follower and cam and the number of shoulders and troughs employed. For example, if there are 10 shoulders and 10 troughs in the cam surfaces of both the cam follower and cam and the differential rotation rate is 60 revolutions per minute or 1 revolution per second, the cam follower will be vibrated 10 times per second and thus the vibration frequency is 10 cycles per second.

Lifting sub **14** is provided with center extension **72** of approximately the same size and shape as plate **74** of spark pump sub **16**. Center extension **72** extends to a position intermediate trough **66** and shoulder **68**. Metal plate **74** extends to a position intermediate trough **62** and shoulder **58**. On each downward vibration of lifting sub **14**, center extension **72** contacts metal plate **74** thereby transferring the weight of drill string **15** from case **9** to center extension **72**, through plate **74**, bearing **76**, and metal plate **78** to the column of piezoelectric means **22**. In this manner piezoelectric means **22** are compressed and produce electrical energy which is arced between electrodes **42** and **46** to produce shock waves.

Another embodiment of this invention is illustrated by FIGURE 3. In this embodiment a jet-edge generator of the type, for example, as described in U.S. 3,315,755 to Warren B. Brooks is used instead of the cam previously described to compress piezoelectric means **22**. Jet-edge generator **80** is attached by threads **82** to drill string **15** and by threads **89** to spark pump sub **16**. Drilling liquid **52** is forced through jet-edge generator **80** which converts the hydraulic energy of the moving drilling liquid **52** into mechanical energy of vibrating piston **84**. Piston **84** contacts or very nearly contacts metal plate **86** which is electrically insulated from the column of piezoelectric means **22** by, for example, an insulating washer **83**. The vibrating piston **84** intermittently transfers mechanical energy through metal plate **86** and washer **83** to the column of piezoelectric means **22** and thereby intermittently compresses the piezoelectric means to generate electrical energy. The vibrational frequency produced by the jet-edge generator is dependent upon the velocity of the drilling liquid. A frequency of 100 cycles per second is both obtainable and operational. However, this frequency is by no means critical.

Still another embodiment of this invention is illustrated by FIGURE 4. This embodiment uses the spark pump sub in cable tool operations. The drill tool is intermittently raised and dropped to the bottom of the wellbore. The energy of the impact of the drilling tool with the wellbore bottom is used to compress the piezoelectric means and thereby produce electrical energy which is arced between the electrodes to produce shock waves. In carrying out this operation, jet-edge generator **80** of FIGURE 3 is removed and in its stead a collar **19** is attached to spark pump sub **16**. The upper end of collar **19** connects to flexible drilling conduit **94** which extends to the surface. Collar **19** fits firmly down upon metal plate **86** thus firmly fixing the upper end of the column of piezoelectric means **22**. The flexible conduit may be, for example, reinforced cable and is used both for the purpose of supporting the drill tool and for passing drilling liquid therethrough to the bottom of the wellbore.

A spark pump sub of approximately 10 feet in length develops sufficient electrical energy for drilling a wellbore by all embodiments of this invention. The piezoelectric means employed are approximately four inch ceramic rings one inch high and having a one inch diameter central hole therethrough for passage of circulating drilling liquids. One hundred such ceramic rings are used in a typical 10 foot sub. A suitable ceramic for making these rings is lead zirconate-lead titanate.

The determination of the total electrical energy which is developed by a typical 10 foot spark pump sub is calculated as follows.

The capacitance of each piezoelectric element is .0035 microfarad calculated as follows:

$$C_0=\frac{\epsilon_0 KA}{L}\text{ farads}=.0035\text{ microfarad}$$

where

C_0=capacitance of each ceramic element;

$\epsilon_0=8.85\times10^{-12}$ farads/meter;

K=1300 (for PZT–4 ceramic spark pump as manufactured by Clevite);

$$A=\frac{\pi}{4}(4^2-1)\times6.45\times10^{-4}\text{ m}^2$$

$L=1\times2.54\times10^{-2}$ m.

The total capacitance of 100 elements wired in parallel is:

$$C=100\ C_0=0.35\text{ microfarad}$$

The electro-mechanical constant g_{33} for PZT–4 ceramics is 4.2 volts/inch/p.s.i. By loading a column of ceramics with a drill string weighing approximately 85,000 pounds the applied stress will be of the order of 7200 p.s.i. and the electrical field generated by the stress will be

$$E_v=Sg_{33}=\frac{85{,}000}{\text{Area}}\times4.2=30{,}000\text{ volt/inch}$$

where

$$A=\frac{\pi}{4}(4^2-1)$$

The ceramic elements are connected in parallel and are connected to a pair of electrodes so spaced that the electric charge will cause a spark discharge as the voltage approaches 30,000 volts. The quantity of electrical energy stored in the spark pump column and discharged to form the shock wave is $E=\frac{1}{2}CV^2=158$ joules.

What is claimed is:

1. In a method of drilling a wellbore in an earth formation, the steps which comprise:

positioning means for generating electrical energy spaced from but closely adjacent to the wellbore end being drilled,

circulating a drilling liquid in said borehole,

periodically actuating said electrical generating means to periodically generate electrical energy,

periodically discharging said energy in said drilling liquid to generate shock waves such that drilling is obtained,

moving said means for generating electrical energy at a rate commensurate with the rate of drilling of said wellbore to maintain said means for generating electrical energy at a substantially uniform distance from said wellbore end being drilled.

2. A method of drilling a wellbore into subsurface formations employing a drill string having a liquid passageway therethrough and a drill bit having electrodes for arcing electrical energy therebetween the method which comprises:

periodically generating electrical energy downhole, circulating drilling liquid between the surface of the earth and the bottom of the wellbore,

discharging said electrical energy in said liquid between said electrodes to produce shock waves for fracturing said formation in advance of said electrodes, and

removing the formation debris to the surface of the earth by said circulating drilling liquid.

3. The method of claim **2** wherein the electrical energy is periodically downhole by positioning a spark pump adjacent the wellbore bottom and periodically applying mechchanical energy to the spark pump.

4. The method of claim **3** wherein the mechanical energy applied to the spark pump is generated by alternately raising and lowering the lower end of the drill

string with respect to the spark pump to alternately apply to and remove from the spark pump a compressive force.

5. The method of claim 3 wherein the mechanical energy applied to the spark pump is generated by converting hydraulic energy of circulating drilling liquid into mechanical energy of a vibrating mass and applying said mechanical energy to said spark pump.

6. The method of claim 3 wherein the mechanical energy applied to the spark pump is generated by alternately raising and dropping a drill bit to the wellbore bottom.

7. In a combination rotary and shock wave method for drilling a liquid-filled wellbore employing a drill bit the steps which comprise:

rotating a drill bit to cut an annular ring through an earth formation,

generating shock waves in said liquid at a position spaced above but in the vicinity of the bottom of said wellbore, said shock waves being transmittted through said liquid to fracture an earth core encompassed by said annular ring, and

removing the earth fractures from the wellbore by circulating drilling liquid.

8. A combination rotary and shock wave drill bit for forming a wellbore in earth formations comprising:

a bit body having a longitudinal axis,

cutting edges on said bit body spaced laterally from said longitudinal axis of said body and terminating in a lower extension below said body, and

electrodes on said bit body spaced laterally between said cutting edges and said longitudinal axis, said electrodes extending below said bit body to a position intermediate said bit body and said lower extension of said cutting edges.

9. A combination rotary and shock wave drill bit for forming a wellbore in earth formations comprising:

a body having a longitudinal axis and a liquid passageway therethrough,

cutting edges on said body spaced laterally from said longitudinal axis, said cutting edges terminating in a lower extension whereby an annular cut is made in said earth formation upon rotation of said bit in contact with said earth formation, and

electrodes on said bit body spaced laterally intermediate said cutting edges and said longitudinal axis, said electrodes extending below said bit body and said lower extension of said cutting edges.

10. The drill bit of claim 9 wherein the electrodes are comprised of concentric electrically conductive cylinders.

11. A shock wave drill tool for drilling a wellbore into subsurface formations comprising in combination:

a jet-edge generator including a moveable piston for converting hydraulic energy of flowing drilling liquid into mechanical energy,

a spark pump sub comprising a column of piezoelectric means which when compressed converts mechanical energy into electrical energy,

means for connecting said piston to said piezoelectric means to alternately compress said means,

a drill bit having cutting edges and at least two electrodes in close proximity to the bit face, said electrodes being spaced so that arcing of electrical energy takes place therebetween upon said electrical energy attaining a predetermined potential, and

means for electrically connecting said piezoelectric means to said electrodes.

12. In a combination rotary and shock wave method for drilling a wellbore into an earth formation employing a drill bit the steps which comprise:

circulating drilling liquid between the surface of the earth and the wellbore bottom,

rotating said drill bit in contact with said earth formation to fracture the perimeter of said wellbore bottom,

periodically generating electrical energy downhole adjacent said drill bit,

intermittently discharging said energy within said periphery to generate shock waves in said liquid, said shock waves being transmitted through said liquid to fracture the wellbore bottom inside the periphery, and

removing the fractured formation to the surface by the circulating drilling liquid.

13. A combination rotary and shock wave drilling system which comprises:

means for circulating drilling liquid between the surface of the earth and the wellbore bottom,

bit means supported at the lower end portion of said means for circulating drilling liquid, said bit means comprised of a bit body having a longitudinal axis, cutting edges on said bit body spaced laterally from said longitudinal axis of said body and terminating in a lower extension below said body, and electrodes on said bit body spaced laterally between said cutting edges and said longitudinal axis, said electrodes extending below said bit body to a position intermediate said bit body and said lower extension of said cutting edges,

means positioned near said bit means for generating electrical energy downhole,

spaced electrodes mounted on said bit means having portions exposed to said drilling liquid,

means interconnecting said generating means and said electrodes to conduct the electrical energy to said electrodes for discharge therebetween to create shock waves which propagate through said drilling liquid to the formation and fracture it, and

means for rotating said drill bit in contact with the formation to fracture it, said fractured formation being removed to the surface by the circulating drilling liquid.

14. A combination rotary and shock wave drilling system which comprises:

means for circulating drilling liquid between the surface of the earth and the wellbore bottom,

bit means supported at the lower end portion of said means for circulating drilling liquid,

spark pump means positioned near said bit means for generating electrical energy downhole, said spark pump means being comprised of a column of piezoelectric means utilized for converting mechanical energy into electrical energy,

spaced electrodes mounted on said bit means having portions exposed to said drilling liquid,

means interconnecting said generating means and said electrodes to conduct the electrical energy to said electrodes for discharge therebetween to create shock waves which propagate through said drilling liquid to the formation and fracture it, and

means for rotating said drill bit in contact with the formation to fracture it, said fractured formation being removed to the surface by the circulating drilling liquid.

15. A combination rotary and shock wave drilling system which comprises:

means for circulating drilling liquid between the surface of the earth and the wellbore bottom,

bit means supported at the lower end portion of said means for circulating drilling liquid,

means positioned near said bit means for generating electrical energy downhole,

spaced electrodes comprised of concentric electrically conductive cylinders mounted on said bit means and having portions exposed to said drilling liquid,

means interconnecting said generating means and said electrodes to conduct the electrical energy to said electrodes for discharge therebetween to create shock

waves which propagate through said drilling liquid to the formation and fracture it, and

means for rotating said drill bit in contact with the formation to fracture it, said fractured formation being removed to the surface by the circulating drilling liquid.

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CHARLES E. O'CONNELL, Primary Examiner

R. E. FAVREAU, Assistant Examiner

U.S. Cl. X.R.

175—93, 104

PO-1050
(5/69)

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,506,076 Dated April 14, 1970

Inventor(s) Frank A. Angona

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 12, "utlizing" should read --utilizing--.

Column 2, line 9, "successfuly" should read --successfully--.

Column 3, line 9, "from" should read --form--.

Column 6, line 61, after "downhole," start a new paragraph with --circulating.....--;

Column 6, line 70, "periodically downhole" should read --periodically generated downhole--.

SIGNED AND
SEALED
AUG 25 1970

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents