

Feb. 6, 1951

O. T. BROYLES

2,540,184

FIRING MECHANISM FOR GUN PERFORATING

Filed May 12, 1945

2 Sheets-Sheet 1

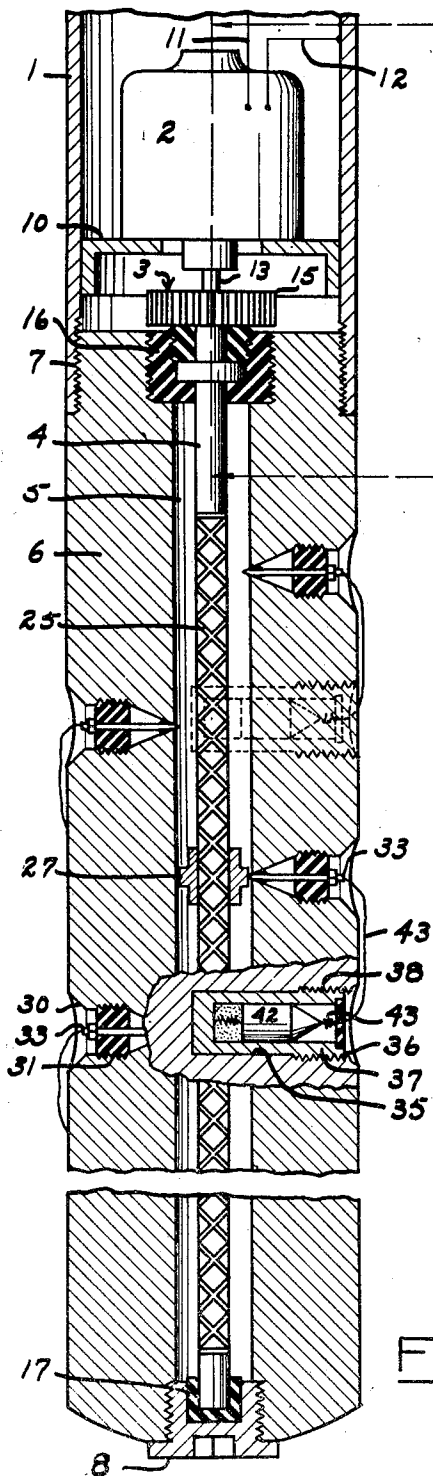


Fig. 1

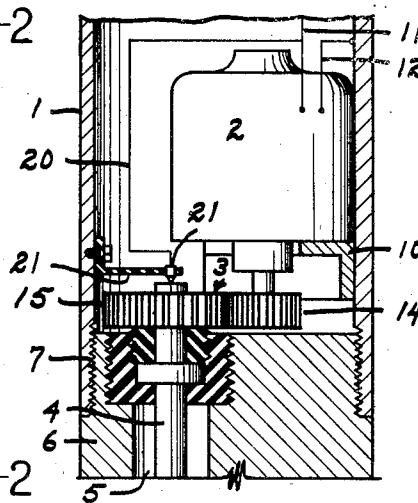


Fig. 2

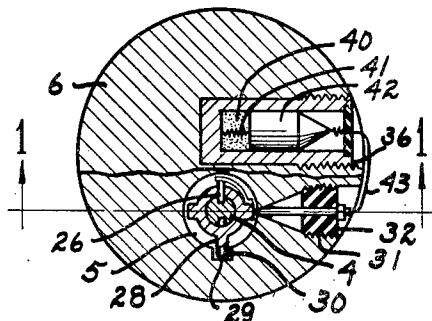


Fig. 3

OTIS T. BROYLES

INVENTOR.

BY *Lester B. Clark*
Ray L. Smith
 Attorneys.

Feb. 6, 1951

O. T. BROYLES

2,540,184

FIRING MECHANISM FOR GUN PERFORATING

Filed May 12, 1945

2 Sheets-Sheet 2

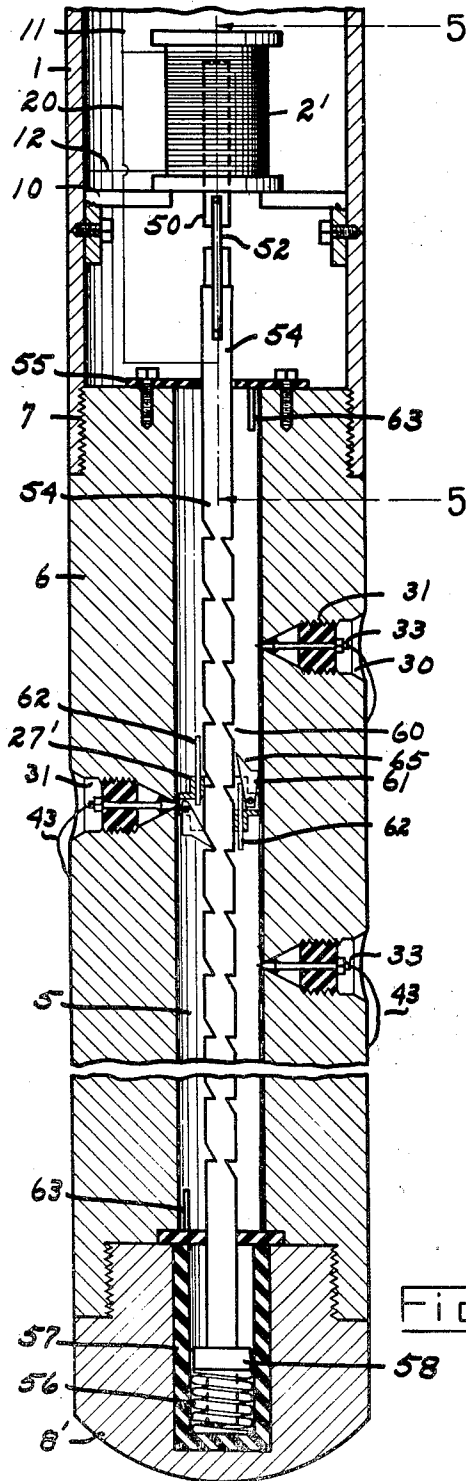


Fig. 4

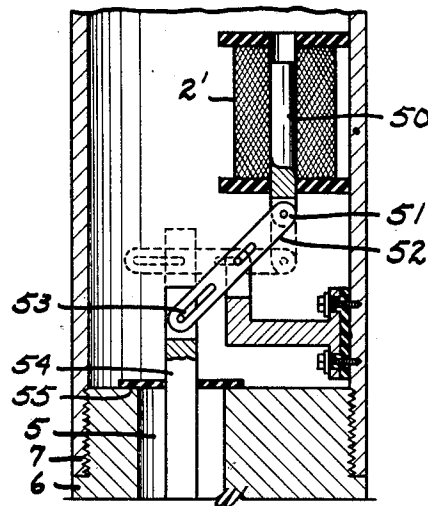


Fig. 5

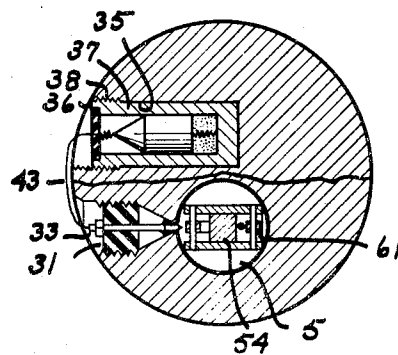


Fig. 6

OTIS T. BROYLES

INVENTOR.

Lester B. Clark

BY

Ray L. Smith

Attorneys.

UNITED STATES PATENT OFFICE

2,540,184

FIRING MECHANISM FOR GUN PERFORATING

Otis T. Broyles, Houston, Tex.

Application May 12, 1945, Serial No. 593,445

5 Claims. (Cl. 164—0.5)

1

This invention relates to new and useful improvements in gun perforators adapted to be lowered within a well bore, and controllably actuated to perforate casings set within the bore.

Gun perforators must be of rugged construction to withstand extreme pressures at depths where used within wells, and also to withstand the reaction incident to perforating operations. At the same time such devices must be readily controllable and positive in action so that perforating will take place with a high degree of certainty, and premature explosions which endanger both life and property will be avoided. It is also important that the construction and operation of a perforator be as simple as possible to minimize cost and upkeep, and also to enhance the ruggedness that is necessary for satisfactory and safe operation.

The primary object of the present invention is to provide an improved gun perforator that is simple and inexpensive to construct and maintain, and also that is positive in operation where-by the hazards incident to its use are minimized.

Another object is to provide a gun perforator in which an electric current is utilized to fire the explosive charges, but in which the electrical wiring for this purpose is extremely simple.

Still another object is to provide a gun perforator which may be constructed in any desired length without affecting its operating characteristics and efficiency.

A further object is to provide a device of the class described that is easily dismantled and repaired or recharged for further operations.

It is also an object to provide a device which may be rapidly operated so that shooting time is minimized.

Still another object is to provide a perforator in which a stationary contact is provided for each gun assembly mounted within the body of the device.

The invention contemplates the use of a traveling contactor to successively engage the stationary contacts to close an electric circuit and thereby set off the respective charges.

Another object is to provide a mechanism whereby the traveling contactor is operable to repeatedly traverse its path to engage the stationary contacts.

Another and more specific object of the invention is to provide a gun perforator having a longitudinal passage in which the traveling contactor moves, and means within the gun for moving the contactor within such passage.

The foregoing together with other objects and

2

advantages will be more fully apparent from the following description considered in connection with the accompanying drawings in which:

Fig. 1 is a vertical sectional view through one embodiment of the invention, such view being taken on line 1—1 in Fig. 3;

Fig. 2 is a sectional view taken on line 2—2 in Fig. 1;

Fig. 3 is a horizontal sectional view, the upper and lower portions thereof being taken respectively through a gun assembly and a contactor assembly of the device;

Fig. 4 is a view similar to that shown in Fig. 1, but illustrating an alternative embodiment of the actuating mechanism;

Fig. 5 is a sectional view taken on line 5—5 in Fig. 4;

Fig. 6 is a horizontal sectional view similar to that of Fig. 3 but showing structural details of the alternate embodiment, the upper and lower portions of the view being taken respectively through a gun assembly and the contactor assembly of such embodiment.

The embodiment shown in Figs. 1, 2 and 3 of the drawings comprises a housing 1 within which is located a power or driving unit 2 operably connected through gears 3 to a spindle 4 within the passage 5 which extends longitudinally of the body 6 and at one side of the axis of the body as best seen in Fig. 3. The body 6 is threadedly connected to the housing 1 at 7, and the bore 8 therein extends throughout the length of the body, and is closed at its lower end by plug 9. It is contemplated that the body 6 shall be of any desired length and that the device will operate with equal facility whether the body be short or long, and whether few or numerous shots are to be fired from within the body in a manner that will more fully appear.

The motor 2 is mounted upon a bracket 10 within the housing 1, and is supplied with electrical energy through a plurality of conductors or through a single conductor 11 and a grounded conductor 12 when the body is used as a return line. The armature shaft 13 is attached to pinion 14 meshing with gear 15 fixed upon the upper end of the spindle 4. This spindle is journaled in an insulating bushing 16 at the upper end of the passage 5, and is similarly journaled at its lower end in an insulating bushing 17 fitted within a recess in the inner end of the plug 9.

The spindle 4 comprises an element of an electric circuit which includes the conductor 20, interconnecting conductor 11, and the contact 21 mounted upon bracket 22 to engage the upper

3

end of the spindle 4. The gear 15 is insulated from the spindle 4 in a suitable manner or, if desired, the entire gear may be made of an insulating material.

Reversing threads 25 are provided upon a portion of the surface of the spindle 4, and such threads receive the follower 26 which comprises an element of the contactor 27. An ear 28 on the contactor extends into a groove 29 in the wall of the passage 5 to restrain the contactor from rotation. It is to be understood that suitable means such as insulation 30 on the ear 28 will be provided to prevent electrical engagement of the contactor with the body 6.

At selected points along the body 6 there are provided openings 30 which extend inwardly to the passage 5, and which are of a size and shape to receive the contact assembly 31. This assembly includes an insulating plug 32 into which the contact pin 33 is secured. This pin extends inwardly, and the tip thereof protrudes into the passage 5 a sufficient distance that contact is made with the contactor 27 as the latter moves axially of the passage.

Radial bores 35 are provided in the body 6 to receive the gun assembly 36 which includes the barrel 37 secured within the body 6 by means of the threads 38 to provide removability of the assembly.

The gun is loaded by positioning a quantity of explosive 40 in the bottom of the barrel 37 together with a filament 41 which has electrical contact with the barrel and also with the projectile 42 superposed upon the charge. An electrical connection 43 is also made between the projectile 42 and the contact pin 33 so that an electric circuit will be completed from the spindle 4 throughout the contactor 27, the pin 33 and the conductor 43 to the gun 36 and thence to the body 6 which serves as a ground.

In describing the operation of the device it will be assumed that each of the gun assemblies 36 is provided with a suitable projectile 42, and that the electrical connection 43 between the projectile and the pin 33 of the associated contact assembly is completed. It is to be understood that suitable passages or grooves will be provided so that the conductors 43 will not extend beyond the surface of the body 6.

When the perforator is lowered to a desired level within a casing to be perforated, electrical energy is supplied to the motor 2 to drive the spindle 4 whereupon the contactor 27 is caused to move axially of the passage 5. During such movement the contactor successively engages the inwardly projecting ends of the pins 33 whereby an electric circuit is completed through the filament 41 in the respective charges of explosive 40. In this manner the gun assemblies will be fired and the projectiles 42 will be successively driven outwardly through the surrounding casing and hence the desired perforations in the casing are formed.

If for any reason one or more of the gun assemblies fails to respond to the current supplied thereto, or there should be failure of contact between the contactor 27 and the pin 33, the motor 2 will be operated a sufficient time that the contactor reaches its limit of travel whereupon its direction of travel is reversed, and the contactor moves to again make contact in succession with the inner ends of the pins 33.

The embodiment of the invention as shown in Figs. 4, 5 and 6 operates in a manner similar to the preceding description, and similar parts of

4

this embodiment are identified by like reference characters.

The motor 2 of the previously described embodiment is replaced by a solenoid 2' which is supplied by impulses of current through the conductor 11 having the terminal 12 thereof grounded to the housing 1. A plunger 50 is mounted to move within the solenoid 2', and has its lower end pivotally connected at 51 to a lever 52 of which the opposite end is attached through a pin and slot connection 53 to the rod or bar 54 which extends axially of the passage 5 within the body 6. This rod is guided at its upper end by means of an insulating guide plate 55 overlying the upper end of the passage 5.

The rod 54 is constantly urged upwardly by means of a spring 56 which engages a collar 58 on the rod 54 located within insulating cup 57 in a recess in the plug 8' at the lower end of the body 6.

The rod 54 is of rectangular cross section and has a plurality of notches 60 upon its side surfaces. Such notches are engageable by dogs 61 pivotally mounted within the movable contactor 27'. This contactor also carries a pair of movable pins 62 which, together with stationary pins 63 at the upper and lower ends of the bore 5, cooperate and effect a reversal in the direction of travel of the contactor.

As the rod 54 is moved upwardly by the compression spring 56, the respective parts of the actuating mechanism normally assume the position indicated in dotted outline in Fig. 5. If, however, an impulse of electrical current is supplied through the conductor 11 to the solenoid 2', the plunger 50 moves upwardly while the rod 54 is forced downwardly against the compression of the spring 56. During such movement of the bar 54 the operating dog 61 on the contactor 27' rides upon the surface of the rod and enters the next adjacent notch 60 in the rod. When the solenoid 2' is de-energized the rod 54 then moves upwardly under the influence of the spring 56. It seems apparent that by successive operations of the mechanism as just described, the contactor 27' moves to engage the respective contact pins 33 whereby the associated guns are operated.

As the moving contactor approaches its upper limit of travel the upper pin 63 engages the tapered surface 65 of the inactive dog 61 and forces such dog inwardly. This causes the associated pin 62 to move downwardly so that this dog is in operating position. At the same time the pin 62 engages the guide plate 55 and moves the other dog 61 to inoperative position. For this reason the upward movement of the contactor 27' is terminated and succeeding movements of the rod 54 cause the contactor to travel in the opposite direction. Such reversed movement serves to send electrical impulses through those guns which were not fired during upward movement of the contactor.

Broadly the invention comprehends a gun perforator which is inexpensive to construct and maintain, and which is positive in action so that premature explosion of any of the gun elements thereof is avoided.

What is claimed is:

1. A gun perforator comprising a body, a plurality of radially and longitudinally displaced gun barrels therein, an electric firing device in said body for each of said barrels, a motor, a spindle connected thereto for movement thereby, and means operable by said spindle to energize said devices in sequence, the movement of said means

being automatically reversible on said spindle, as said energizing means reaches the end of travel along the spindle, to re-energize such of said firing devices which have not been fired.

2. A gun perforator comprising a body, a plurality of radially and longitudinally displaced gun barrels therein, an electric firing device in said body for each of said barrels, a motor, a spindle connected thereto for movement thereby, and means operable by said spindle to energize said devices in sequence, said spindle having reversing threads thereon, and means on said first mentioned means for engagement with said threads whereby said first means is movable repeatedly along the spindle by unidirectional rotation thereof.

3. A gun perforator comprising a body, a plurality of radially and longitudinally displaced gun barrels therein, an electric firing device in said body for each of said barrels, a motor, a spindle connected thereto for movement thereby, and means operable by said spindle to energize said devices in sequence, said spindle and means having a stepped ratchet engagement.

4. A gun perforator comprising a body, a plurality of radially and longitudinally displaced gun barrels therein, an electric firing device in said body for each of said barrels, a motor, a spindle

connected thereto for movement thereby, and means operable by said spindle to energize said devices in sequence, said spindle and means having a stepped ratchet engagement which is reversible to reenergize each firing device which has not been fired.

5. A gun perforator including, a body, a plurality of radially and longitudinally displaced gun assemblies therein, a bore in said body, a contactor mounted to move axially of the bore, contacts electrically connected to said assemblies each having a terminal engageable by said contactor, means for driving said contactor within the bore, and means automatically operable by a spindle at the ends of travel of said first means to reverse the direction of movement of the contactor within the bore.

OTIS T. BROYLES.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,125,487	Church	Aug. 2, 1938
2,296,318	Thompson	Sept. 22, 1942
2,317,238	Mennecler	Apr. 20, 1943