Nov. 23, 1943. J. JOHNSON 2,334,931

GUN PERFORATOR AND FIRING DEVICE THEREFOR

Filed March 17, 1941 2 Sheets-Sheet 1

FIG. 1.

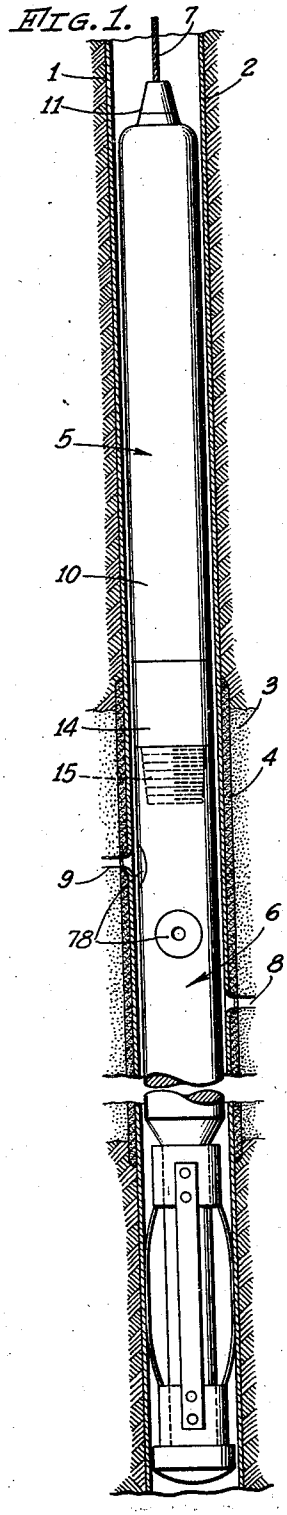


FIG. 2.

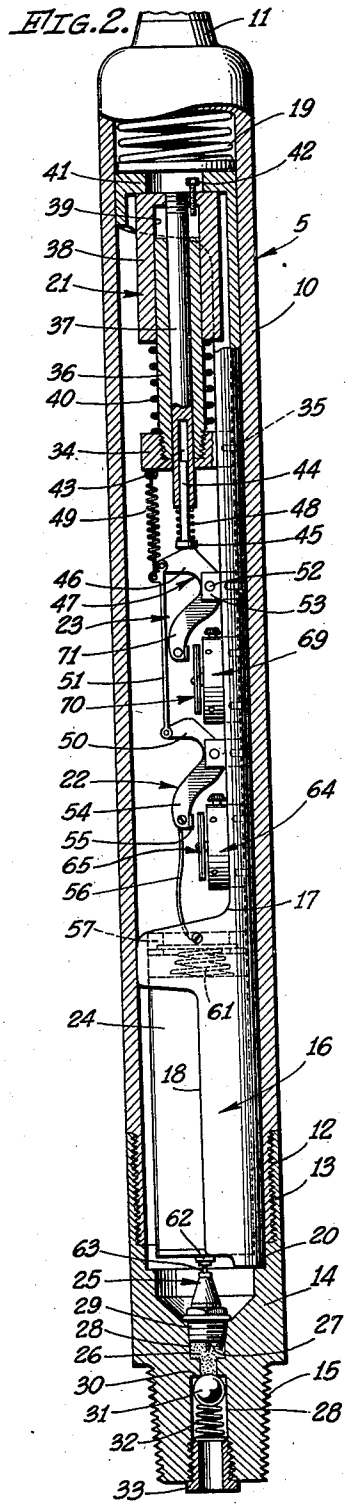


FIG. 3.

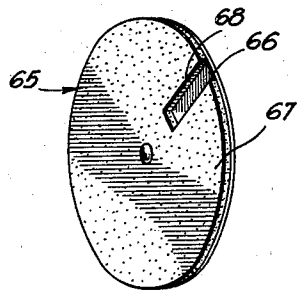
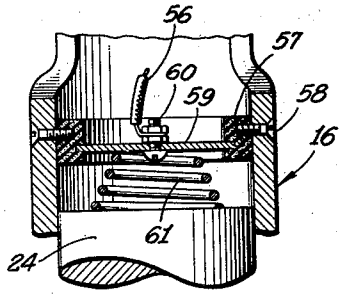


FIG. 4.



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Nov. 23, 1943. J. JOHNSON 2,334,931

GUN PERFORATOR AND FIRING DEVICE THEREFOR

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FIG. 5.

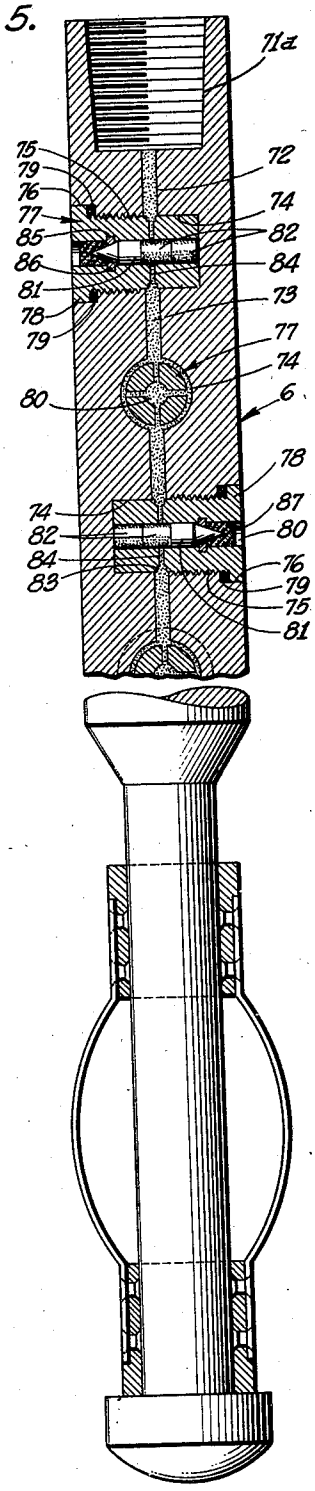


FIG. 6.

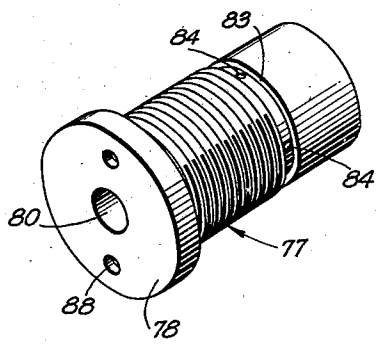


FIG. 7.

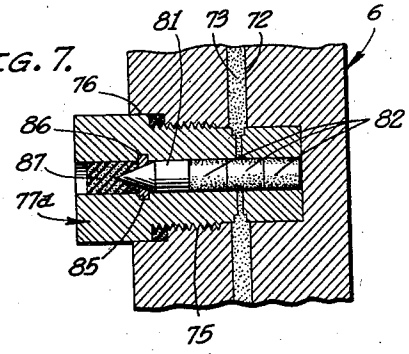
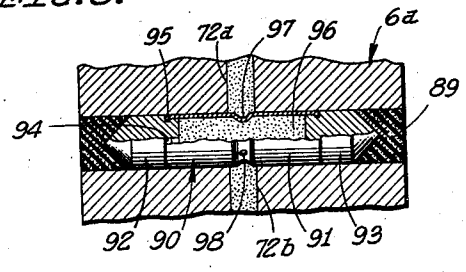


FIG. 8.



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UNITED STATES PATENT OFFICE

2,334,931

GUN PERFORATOR AND FIRING DEVICE THEREFOR

Jack Johnson, Compton, Calif., assignor to Methox Well Cleaning Corp., Long Beach, Calif., a corporation of California

Application March 17, 1941, Serial No. 383,727

20 Claims. (Cl. 164—0.5)

My invention relates to explosive operated tools for use in oil wells and also to a firing mechanism therefor and has particular reference to an explosive operated casing perforator and a firing device for controlling the operation of the same.

Certain of the tools used in the oil producing industry in connection with the drilling of deep wells and the production of oil and gas therefrom are arranged to be operated by the energy developed through the firing of an explosive charge. Such tools include gun perforators for perforating casing in the event it is desired to produce oil and gas from a previously sealed off productive zone, torpedoes such as are used for cleaning screens and for the jarring of the formation for the purpose of expediting the flow of oil and gas therefrom, and certain packer setting devices such as are used for the setting of packers in connection with oil well cementing operations and the setting of flow tubing. Most of these tools are equipped with firing devices, and two well known types of firing devices are in general commercial use. One such type of firing device is connected to certain control mechanism at the ground surface by means of one or more electrical conductors built into the supporting cable which is used to lower the tool into the well bore.

This type of cable is very expensive and due to the reeling and unreeling of the cable and the passing of the cable over relatively short radius blocks and pulleys, is subject to the breaking of one or more of the electrical conductors. The breaking of the conductors renders the firing device inoperative and necessitates the expenditure of considerable time and money in determining the location of the break and in the subsequent repairing of the break. Furthermore, this type of cable is extremely heavy so that special equipment must be employed for its handling, and cables of this type require special and careful handling in order to avoid injury to the electrical conductors included therein.

The other commonly employed type of firing device comprises a trigger mechanism so arranged that a weight or "go-devil" surrounding the cable used to lower the tool into the oil well may be dropped from the ground surface after the tool has been positioned as desired in the well, the cable serving to guide the go-devil in its fall through the well bore and the impact of the go-devil with the trigger serving to actuate the firing mechanism.

This type of firing device is unsatisfactory for the reason that the well bores are never straight and the go-devil may be arrested in its fall before it reaches the device due to the bearing of the supporting cable against the sides of the well bore. Furthermore, the travel of the go-devil down the supporting cable subjects the cable to undue wear and abrasion, with the occasional result that the cable will break while the tool is lowered into the well bore, with the result that the tool and a portion of the cable are lost in the bore, necessitating an expensive fishing operation in order to retrieve the lost equipment.

It is, therefore, an object of my invention to provide a firing device for explosive operated oil well tools which overcomes the above noted disadvantages by including a means operable from the ground surface to actuate the explosive operated tool without the use of go-devils or electrical conductors extending to the ground surface.

It is also an object of my invention to provide a firing device of the character set forth in the preceding paragraph in which an inertia device, responsive to abrupt vertical movement, is employed for igniting an explosive charge.

It is an additional object of my invention to provide a firing device of the character set forth in the preceding paragraphs in which a timing means is employed for rendering the inertia device inoperative until after the elapse of a predetermined time.

It is a still further object of my invention to provide a firing device of the character set forth hereinbefore in which an electrically operated igniter is connected in series with an inertia switch actuatable to complete a firing circuit by an abrupt vertical movement of the device and in which a timing means is employed for maintaining the firing circuit open irrespective of actuation of said inertia switch until after the elapse of a predetermined time.

It is additionally an object of my invention to provide a firing device of the character set forth in the foregoing in which a second timing means is employed for also preventing actuation of said inertia switch until after the elapse of a predetermined time.

It is a still further object of my invention to provide a firing device of the character set forth in the preceding paragraphs which includes a timing mechanism for preventing actuation of the firing device if the device is not actuated within a predetermined time period.

Among the various explosive operated oil well tools above referred to is included the class of casing perforating devices known as gun perfora-

tors. During the drilling of an oil well it frequently happens that a potential oil producing zone is passed up and sealed off for the purpose of extending the well bore into a deep oil bearing stratum. Subsequent conditions, such as the exhausting of the lower strata, make it desirable to start production from the previously sealed off strata. Casing perforators are employed for punching a number of holes through the casing at the location of the sealed off zone, and for this purpose gun or explosive operated perforators have been found to be particularly advantageous.

Gun perforators of the character at present employed do, however, include the disadvantage of the lack of adjustability as regards the diameter of casing which they are adapted to perforate; that is to say, it is the present practice to employ a different instrument or tool for each of the various sizes of casings to be perforated. It occasionally happens also that mud, water or other fluids will seep past the bullet in the barrel and wet the powder or explosive deposited behind the bullet and so prevent the same from exploding when an attempt is made to fire the perforator.

It is, therefore, an additional object of my invention to provide a gun perforator which includes a plurality of removable gun barrel units whereby units of various lengths may be installed, depending upon the diameter of the casing to be perforated.

It is also an object of my invention to provide a gun perforator of the character set forth in the preceding paragraph in which a novel construction is employed for resisting the expulsion of the bullet until considerable pressure is built up in the firing chamber and for also preventing the ingress of water and the like to the explosive material.

Other objects and advantages of my invention will be apparent from a study of the following specifications, read in connection with the accompanying drawings, wherein:

Fig. 1 is an elevational view illustrating the firing device of my invention as being arranged to actuate a gun perforator, the firing device and gun perforator being illustrated as having been lowered to a desired position in a well bore;

Fig. 2 is a longitudinal section illustrating the details of construction of the firing device shown in Fig. 1;

Fig. 3 is a perspective view illustrating the appearance and construction of a part of a timing means employed in the firing device shown in Fig. 2;

Fig. 4 is a fragmentary sectional view illustrating the manner in which an electrical connection is obtained to the case or negative terminal of a battery used in the firing device;

Fig. 5 is a longitudinal section illustrating the details of construction of the gun perforator shown in Fig. 1;

Fig. 6 is a perspective view illustrating the construction and appearance of a removable gun barrel unit incorporated in the perforator of Fig. 5;

Fig. 7 is an enlarged sectional view illustrating the manner in which a longer gun barrel unit may be substituted for the purpose of adapting the perforator for use with large diameter casings; and

Fig. 8 is a fragmentary sectional view similar to Fig. 7 but illustrating a modified form of my invention employing a unitary cartridge and projectile assembly adapted to simultaneously perforate opposite sides of a well casing.

Referring to the drawings, I have illustrated in Fig. 1 a section of a well bore 1 as being lined with casing 2, the casing being extended through a potentially productive zone 3 and such zone being sealed off as by means of cement or concrete 4.

Fig. 1 illustrates a firing device 5 carrying a gun perforator 6 as having been lowered by means of a sand line 7 to a position to perforate the casing 2 and the concrete 4 as indicated at 8 and 9 for the purpose of producing from the potentially productive zone 3.

The firing device is illustrated in detail in Fig. 2 as comprising an outer tubular housing or shell 10 fitted at its upper end with a suitable adapter or cable socket 11 for attaching the supporting cable 7 thereto. The lower end of the housing 10 is preferably provided with male threads 12 adapted to be received within corresponding female threads 13 formed on the upper end of a collar or connector 14, which connector is provided at its lower end with a pin 15 permitting threaded attachment of the firing device 5 to the perforator 6 or other explosive operated oil well tool.

The connection afforded by the threads 12 and 13 provides for the removal of the adapter 14 which in turn permits the insertion into or removal from the housing 10 of a support 16. The support 16 is preferably formed from a section of tubing having an outside diameter adjusted to be closely received within the inside of the housing 10, the tube being cut away as indicated at 17 and 18 to permit ready access to various instrumentalities carried by the support 16 when the support is removed from the housing 10. When installed within the housing 10, the support 16 is urged downwardly as by means of a compression spring 19 into engagement with a shoulder 20 formed on the interior of the connector 14.

Upon the support 16 I mount an inertia responsive mechanism 21 adapted to be actuated in response to a sudden vertical movement of the housing 10 and close an electrical switch 22, the closing of which is controlled by means of an interlocking lever 23. The electrical switch 22 is included in a series circuit comprising the switch 22, one or more dry cells or batteries 24, and an igniter 25 so that closing of the switch 22 will energize the igniter 25 and explode a small quantity of explosive 26 disposed in contact with the igniter.

The igniter 25 may conveniently comprise a spark plug of substantially standard construction, between the electrodes of which is connected a piece of small wire 27 adapted to be heated to incandescence when the aforementioned electrical circuit is closed. The igniter 25 is preferably secured into a bore 28 formed in the connector 14 as by means of screw threads 29 and the bore 28 preferably extends completely through the connector 14 in an axial direction. The bore 28 is preferably constricted as indicated at 30 to provide a seat for a ball check valve 31 normally urged against the seat by means of a compression spring 32 which is confined between the ball 31 and a bushing 33 threaded into the lower end of the bore 28.

The explosive charge 26 is confined between the check valve 31 and the igniter 25. Thus, when the charge 26 is fired by energization of the igniter 25, burning gases, the products of the combustion of the explosive 26, are projected past the valve 31 and downwardly through the bore 28 so as to set fire, ignite or explode the explosive material carried by the explosive operated tool

6 to which the firing device 5 is attached. Whenever the pressure developed by the explosion of the explosive contained within the tool 6 rises to a value substantially equal to the pressure developed by the ignition of the charge 26, the check valve 31 will close and so prevent the full force and effect of the resulting explosion from being impressed upon the igniter 25. This serves to avoid the risk of the igniter being loosened or dislodged from its attachment to the connector 14.

The inertia actuated device 21 above referred to preferably includes a laterally extending supporting member 34 which may be secured to the support 16 as by means of screws 35 and from which rises an upwardly extending tubular stem 36. The tubular stem 36 slidably guides a pin 37 which is secured at its upper end to a weight or cap 38 which is in turn provided with a cylindrical recess 39 adapted to receive the upstanding end of the tubular guide 36. The weight 38 and pin 37 are thus slidably supported by the stem 36 for vertical movement relative to the housing 10. The weight of these members is preferably normally supported by means of a compression spring 40 interposed between the laterally extending support 34 and the lower end of the weight 38. The weight 38 will, therefore, normally remain stationary relative to the housing 10 but will be responsive to acceleration or deceleration of the housing, at which time the weight 38 will be urged either upwardly or downwardly.

Undesired upward movement of the weight 38 is preferably arrested as by means of an inwardly turned flange 41 formed on the upper end of the support 16 and downward movement of the weight 38 may be limited and adjusted as by means of an adjusting screw 42.

The lower end of the pin 37 is preferably bored as indicated at 43 to slidably receive an actuator 44 which is in turn formed with a foot 45 bearing upon a substantially laterally extending arm 46 of a bell crank 47. A small compression spring 48 is preferably interposed between the foot 45 and the lower end of the pin 37 so that when the weight 38 is moved downwardly as a result of an upward jerk on the cable 6, a downward force is exerted on the arm 46 through the compression spring 48, the spring 48 serving as a cushion to prevent unduly abrupt application of force to the bell crank 47.

The bell crank 47 is preferably urged to a position such as that illustrated in Fig. 2 by means of a tension spring 49 interconnecting the arm 46 with the laterally extending support 34. The bell crank 47 is preferably drivably connected to the switch member 22, this latter member comprising a bell crank having a horizontally extending arm 50 which is interconnected with the arm 46 of the bell crank 47 as by means of a link 51. The bell crank 47 is supported for pivotal movement as by means of a pivot pin 52 carried by a supporting bracket 53 which is in turn secured to the support 16 and a similar construction is employed for mounting the switch member 22 for pivotal movement.

The switch member 22 carries on a downwardly extending arm portion 54 thereof an electrical contact 55 which is preferably insulated from the arm 54 and connected as by means of an electrical conductor 56 to the negative terminal or case of the dry battery 24. This connection may be accomplished by means of a construction such as that illustrated in Fig. 4 wherein an insulating supporting ring 57 is illustrated as being secured as by means of screws 58 to the sides of the support 16. The ring 57 supports a metal plate 59 carrying a binding post 60 to which the conductor 56 is attached. The under side of the plate 59 supports a compression spring 61 which may be secured thereto as by spot welding, soldering or other suitable means, the compression spring 61 being adapted to engage the bottom or case of the dry batteries 24.

The ring 57 and plate 59 are preferably disposed in such location that the center pole or positive terminal 62 of the battery 24 will rest upon the upper end or contact terminal 63 of the igniter 25 when the mechanism is assembled in the manner illustrated in Fig. 2.

Since one electrode of the igniter 25 is grounded to the housing 10 through the connector 14, it will be seen that an electrical circuit will be completed through the ignition member 27 whenever the electrical contact member 55 is connected to ground or to a metallic member which is in turn connected to the casing 10. Since the casing 10 might be subjected to jerks and jars sufficient to actuate the inertia device 21 during the lowering of the tool to the desired location in the well bore, it is considered necessary to provide some means for preventing the completion of the aforementioned electrical circuit until after the elapse of a definite time interval. For this purpose I employ a timing device 64 which may conveniently comprise an inexpensive spring driven time keeping mechanism, such as an inexpensive watch or a device such as is illustrated in Fig. 2 of the Phipps Patent No. 2,156,228, the timing mechanism 64 being suitably secured to and supported by the support 16.

The shaft of the watch 64 which normally drives the minute hand of the watch is connected to a contact plate 65 and may be constructed along the lines illustrated in Fig. 3. The plate 65 consists of a circular disk 66 of metal or other electrically conductive material, upon the upper surface of which is secured a relatively thick disk 67 of insulating material. The disk 67 is preferably provided with a notch 68 of a width substantially equal to the width of the contact member 55 so that the contact member 55 cannot be engaged with the plate 65 until the disk 66 has been rotated to a position aligning the notch 68 with the contact member 55. Thus, inadvertent operations of the inertia device 21 will serve only to bring the contact member 55 into engagement with the insulated disk 67 and will thus fail to complete the electrical circuit which is necessary for the actuation of the igniter 25.

Upon assembling the device preparatory to lowering it into a well bore, the disk 65 is positioned so as to require the elapse of a predetermined time period before the firing circuit can be completed. The device with the tool attached is then lowered into the well bore to the desired location and as soon as the time period has elapsed, the cable 7 is given a jerk, whereupon the inertia device serves to cause the contact member 55 to penetrate the notch 68 and complete the electrical circuit, with the result that the explosive 26 is ignited and the explosive operated tool 6 is thus operated.

It may be desirable to provide a mechanical inter-lock for additionally protecting the equipment against inadvertent operation. This may be accomplished by providing a second timing mechanism 69 identical in construction with the

timing mechanism 64 previously described and carrying an inter-locking disk 70 identical in construction with the disk 65 previously described.

The bell crank 47 is provided with a downwardly extending arm 71 adapted to arrest pivotal movement of the bell crank 47 before the switch arm 22 is moved to circuit closing position by engagement of the arm 71 with the surface of the insulating material 67. It will thus be seen that in order for a jerk on the cable 7 to energize the igniter, it is necessary for the notches 68 in each of the disks 70 and 65 to be, respectively, aligned with the bell crank arm 71 and the contact member 55. This mechanism, therefore, serves to insure that the device will not be actuated by inadvertent jerks or accelerations or decelerations of the cable during the time the tool is being lowered into the well bore.

Attention is furthermore directed to the fact that if, for any reason, the tool fails to fire at the intended time, the tool may be hoisted to the ground surface in complete safety since once the notches 68 have moved past their respective bell crank arms, the firing circuit cannot be completed by subsequent actuation of the inertia device 21.

I have illustrated in Fig. 5 a preferred form of construction of a casing perforator which is particularly adapted for use with a firing device above described. The perforator 6 comprises a long cylindrical piece of metal which is recessed and threaded at its upper end to provide a boss 71*a* permitting threaded attachment of the perforator 6 to the pin end 15 of the firing device 5.

From the lower center of the boss 71*a* a powder or firing channel 72 is extended vertically for substantially the full length of the perforator, the channel 72 being packed with powder or other suitable explosive material 73 and the channel 72 being intersected at suitably frequent intervals by gun barrel receiving bores 74. These bores are each threaded as indicated at 75 and counter-bored at their outer ends as indicated at 76 to permit the insertion into the bore 74 of a gun barrel unit 77, the unit 77 being threaded externally so as to engage the threads 75 and being preferably also headed as indicated at 78 to permit the clamping of a sealing ring or washer of gasket material 79 between the head 78 and the bottom of the counterbore 76.

Each of the barrel units 77 is preferably bored as indicated at 80 to receive a steel bullet or projectile 81, the space behind the bullet 81 being filled or packed with powder or other suitable explosive material 82. The wall thickness of each of the barrel units 77 is made sufficient to withstand the bursting forces developed by the ignition of the explosive 82. The circumference of the unit 77 is preferably grooved as indicated at 83 in Fig. 6 and a number of radially extending bores or ports 84 communicate between the groove 83 and the central bore 80 so as to carry the burning of the powder 73 into the chamber behind the bullet 81 and so fire the explosive 82 carried thereby.

The bore 80 is preferably internally recessed as indicated at 85 so as to permit a retaining ring 86 of relatively soft material such as copper to be swaged into the recess. This serves to prevent expulsion of the projectile 81 upon the firing of the explosive 82 until a considerable pressure has been developed by the explosive, at which time the ring 86 shears off and the projectile is discharged with great force from the barrel 80.

Fluid leakage past the bullet 81 is preferably prevented by the insertion into the bore 80 of a rubber or cork plug 87. Ready removal of the gun barrel unit 77 from the body member 6 may be permitted by providing a recess 88 adapted to receive a spanner permitting the unscrewing of the unit 77 so as to disengage its threaded connection with the body member 6.

In case the perforator is to be used with casing having an interior diameter considerably larger than the exterior diameter of the unit 6 which is illustrated in Fig. 5, I prefer to remove the relatively short gun barrel units 77 illustrated in Fig. 5 and substitute therefor relatively long gun barrel units 77*a* of the character illustrated in Fig. 7 so as to provide a longer length of barrel through which the projectile 81 may be accelerated and also to bring the mouth of the barrel more closely adjacent the wall of such large diameter casing. Thus, it will be seen that by providing a selection of lengths of gun barrel units 77, the perforator 76 may be adapted for use with casing of substantially any desired size, and that it is unnecessary to provide a complete gun perforator for each size of casing.

I have illustrated in Fig. 8 a modified form of my invention wherein a gun perforator body 6*a* is provided with a longitudinally extending firing channel 72*a* which intersects a transversely extending projectile guiding bore 89. The bore 89 is extended laterally through the body 6*a* from one side to the other thereof and within the bore 89 is positioned a unitary cartridge and projectile assembly 90.

The assembly 90 comprises a cylindrical sleeve 91 adapted to be inserted into the bore 89. Opposite ends of the sleeve 91 are closed by projectiles 92 and 93 each of which is formed near its rearward end with a horizontally extending groove 94 into which the end of the sleeve 91 is swaged or clamped as is illustrated at 95. This serves to secure the projectiles 92 and 93 to the sleeve 91 and at the same time close the ends thereof so as to define within the interior of the sleeve 91 a supply of gun powder or other explosive material 96.

The central portion of the sleeve 91 is deformed or exteriorly machined to provide an externally circumferentially extending groove 97 disposed in such location longitudinally of the sleeve 91 as to be positioned adjacent the firing channel 72*a* when the cartridge 90 is inserted within the bore 89 in the manner illustrated in Fig. 8. The groove 97 thus serves to provide a communication between the firing channel 72*a* and the continuation 72*b* thereof. The sleeve 91 is provided with one or more perforations 98 positioned in the bottom of the recess 97 and providing a communication between the recess and the interior of the cartridge so that the charge 96 of gun powder contained within the cartridge may be fired when the flame producing material 73*a* with which the channel 72*a* is filled is ignited as previously described.

When the charge 96 is fired, the projectiles 92 and 93 are forcibly ejected in opposite directions from the bore 89 so as to simultaneously perforate the casing on opposite sides of the perforator body.

From the foregoing it will be observed that I have shown and described a novel gun perforator which includes novel features of construction providing for the building up of a considerable pressure behind the projectile before the projectile is discharged from the barrel and that

provision is made for preventing the ingress of moisture into the mechanism which would prevent the firing of the explosive.

It will also be observed that I have provided a firing mechanism for use with a gun perforator or other explosive operated oil well tool and that the firing mechanism above described is so arranged as to require the elapse of a predetermined time period before the same can be actuated and such that if the explosive in the tool is not fired during such predetermined time period, the same can be safely withdrawn from the well bore without danger of an inadvertent explosion.

It will also be observed that the firing mechanism above described provides for the actuation of an explosive operated oil well tool without requiring the use of either electrical conductors extending from the ground surface or the use of go-devils adapted to be slid down the cable used to support such tools.

While I have shown and described the preferred embodiment of my invention, I do not desire to be limited to any of the details of construction shown or described herein, except as defined in the appended claims.

I claim:

1. In a firing device, a housing having means on one end for attachment to a cable for lowering said housing through a well bore to a desired location therein and having means on the other end for attachment to an explosive operated oil well tool, said housing containing the following instrumentalities: an igniter actuatable to cause operation of said tool; inertia means operable to operate said igniter in response to accelerating movement of said housing freely in said well bore; and timing means for preventing actuation of said igniter until the elapse of a predetermined time period of sufficient length to permit lowering of said housing to said desired location during said period.

2. In a firing device, a housing having means on one end for attachment to a cable for lowering said housing through a well bore to a desired location therein and having means on the other end for attachment to an explosive operated oil well tool, said housing containing the following instrumentalities: an igniter actuatable to cause operation of said tool; a weight mounted for vertical movement relative to said housing; a spring interposed between said weight and said housing for normally supporting said weight while permitting vertical movement thereof relative to said housing in response to accelerating movement of said housing freely in said well bore; control means connected to said weight and operable in response to movement thereof relative to said housing to actuate said igniter; and timing means for preventing operation of said control means until the elapse of a predetermined time period of sufficient length to permit lowering of said housing to said desired location during said period.

3. In a firing device, a housing having means on one end for attachment to a cable for lowering said housing into a well bore and having means on the other end for attachment to an explosive operated oil well tool, said housing containing the following instrumentalities: an igniter actuatable to cause operation of said tool; a weight mounted for vertical movement relative to said housing; a spring interposed between said weight and said housing for supporting said weight; control means connected to said weight and operable in response to movement thereof to actuate said igniter; timing means for preventing operation of said control means until the elapse of a predetermined times; and another timing means for preventing actuation of said igniter until the elapse of said predetermined time.

4. In a firing device, a housing having means on one end for attachment to a cable for lowering said housing into a well bore and having means on the other end for attachment to an explosive operated oil well tool, said housing containing the following instrumentalities: an igniter energizable to cause operation of said tool; a battery for energizing said igniter connected in circuit therewith; and a normally open inertia switch means in said circuit closable to energize said igniter in response to an abrupt movement of said housing.

5. In a firing device, a housing having means on one end for attachment to a cable for lowering said housing into a well bore and having means on the other end for attachment to an explosive operated oil well tool, said housing containing the following instrumentalities: an igniter energizable to cause operation of said tool; a battery for energizing said igniter connected in circuit therewith; normally open switch means in said circuit including a member movable to a position completing said circuit and energizing said igniter; inertia means movable relative to said housing in response to an abrupt movement of said housing; and means interconnecting said switch means and said inertia means for moving said member to circuit closing position in response to movement of said inertia means.

6. In a firing device, a housing having means on one end for attachment to a cable for lowering said housing into a well bore and having means on the other end for attachment to an explosive operated oil well tool, said housing containing the following instrumentalities: an igniter energizable to cause operation of said tool; a battery for energizing said igniter connected in circuit therewith; normally open switch means in said circuit including a member movable to a position completing said circuit and energizing said igniter; inertia means movable relative to said housing in response to an abrupt movement of said housing; means interconnecting said switch means and said inertia means for moving said member to circuit closing position in response to movement of said inertia means; a movable stop normally disposed in a position to arrest movement of said inertia means before said member is moved to circuit closing position; and timing means for moving said stop to a position permitting free movement of said inertia means upon the elapse of a predetermined time.

7. In a firing device, a housing having means on one end for attachment to a cable for lowering said housing into a well bore and having means on the other end for attachment to an explosive operated oil well tool, said housing containing the following instrumentalities: an igniter energizable to cause operation of said tool; a battery for energizing said igniter connected in circuit therewith; normally open switch means in said circuit including a member movable to a position completing said circuit and energizing said igniter; inertia means movable relative to said housing in response to an abrupt movement of said housing; means interconnecting said switch means and said inertia means for moving said member to circuit closing position in response to movement of said inertia means; a

movable stop normally disposed in the path of movement of said member for engaging and arresting said member before it is moved to circuit closing position; and timing means for moving said stop out of the path of movement of said member upon the elapse of a predetermined time.

8. In a firing device, a housing having means on one end for attachment to a cable for lowering said housing into a well bore and having means on the other end for attachment to an explosive operated oil well tool, said housing containing the following instrumentalities: an igniter energizable to cause operation of said tool; a battery for energizing said igniter connected in circuit therewith; normally open switch means in said circuit including a member movable to a position completing said circuit and energizing said igniter; inertia means movable relative to said housing in response to an abrupt movement of said housing; means interconnecting said switch means and said inertia means for moving said member to circuit closing position in response to movement of said inertia means; a movable stop normally disposed in a position to arrest movement of said inertia means before said member is moved to circuit closing position; timing means for moving said stop to a position permitting free movement of said inertia means upon the elapse of a predetermined time; a second movable stop normally disposed in the path of movement of said member for engaging and arresting said member before it is moved to circuit closing position; and a second timing means for moving said second stop out of the path of movement of said member upon the elapse of said predetermined time.

9. In a firing device, a housing having means on one end for attachment to a cable for lowering said housing into a well bore and having means on the other end for attachment to an explosive operated oil well tool, said housing containing the following instrumentalities: an igniter actuatable to cause operation of said tool; inertia means operable to actuate said igniter in response to an abrupt movement of said housing; and timing means for permitting actuation of said igniter only during a predetermined time period.

10. In a firing device, a housing having means on one end for attachment to a cable for lowering said housing into a well bore and having means on the other end for attachment to an explosive operated oil well tool, said housing containing the following instrumentalities: an igniter energizable to cause operation of said tool; a battery for energizing said igniter connected in circuit therewith; normally open switch means in said circuit including a member movable to a position completing said circuit and energizing said igniter; inertia means movable relative to said housing in response to an abrupt movement of said housing; means interconnecting said switch means and said inertia means for moving said member to circuit closing position in response to movement of said inertia means; a movable stop normally disposed in a position to arrest movement of said inertia means before said member is moved to circuit closing position; and timing means for moving said stop to a position permitting free movement of said inertia means upon the elapse of a predetermined time and for moving said stop to said normal position upon the elapse of another predetermined time.

11. In a gun perforator, the combination of: an elongated body member adapted to be lowered into a well bore and having a longitudinally extending firing channel for receiving a material capable of burning with great rapidity; a plurality of gun barrel units carried by said body member, each defining a transversely extending projectile guiding bore, each of said units including a chamber for receiving an explosive and a plurality of ports extending transversely of and intersecting said projectile guiding bore and communicating with said channel; and means detachably securing each of said units in said body member, whereby said units may be removed and other units of different length substituted therefor to adapt the perforator for the perforation of a different size of oil well casing.

12. A gun barrel unit for use with a gun perforator including a body member adapted to be lowered into a well bore and having a longitudinally extending firing chamber for receiving a material capable of burning with great rapidity and having a plurality of laterally extending gun barrel receiving recesses intersecting said channel, said unit comprising: a thick walled barrel member insertable in said recess and defining a projectile guiding bore, said bore being intersected by a plurality of transversely extending ports disposed in a position to also intersect said channel when said member is inserted in said recess.

13. A gun barrel unit for use with a gun perforator including a body member adapted to be lowered into a well bore and having a longitudinally extending firing chamber for receiving a material capable of burning with great rapidity and having a plurality of laterally extending gun barrel receiving recesses intersecting said channel, said unit comprising: a thick walled barrel member insertable in said recess and defining a projectile guiding bore, said bore being intersected by a plurality of transversely extending ports disposed in a position to also intersect said channel when said member is inserted in said recess, said barrel member having a circumferentially extending groove formed in its exterior surface communicating with all of said ports to provide communication between said ports and said channel when said barrel member is inserted in said recess with said ports disposed out of alignment with said channel.

14. In a gun perforator, the combination of: an elongated body member adapted to be lowered into a well bore and having a projectile guiding bore extended transversely through said body member from one side to the other thereof in a position to intersect a firing channel formed in said body; a projectile in each of the outer ends of said bore; and a cartridge extended between and secured to said projectiles, said cartridge being filled with an explosive material and having a port communicating between said firing channel and the interior of said cartridge.

15. For use with a gun perforator having a projectile guiding bore extended transversely through the body thereof and intersecting a firing channel formed therein, a cartridge construction comprising a cylindrical sleeve insertable in said bore for holding a supply of explosive material, said sleeve having a circumferentially extending groove formed in the outer surface thereof in a position to be disposed adjacent said firing channel and having a port communicating between said groove and the interior

of said sleeve; and a projectile fitted into each end of said sleeve, each of said projectiles having a circumferentially extending groove formed therein and the corresponding end of said sleeve being clamped into said groove to secure said projectile to said sleeve.

16. In a firing device, a housing having means on one end for attachment to a cable for lowering said housing into a well bore and having means on the other end for attachment to an explosive operated oil well tool, said housing containing the following instrumentalities: an igniter actuatable to cause operation of said tool; control means operable to actuate said igniter; timing means for preventing operation of said control means until the elapse of a predetermined time; and another timing means for preventing actuation of said igniter until the elapse of said predetermined time.

17. In a firing device, a housing having means on one end for attachment to a cable for lowering said housing into a well bore and having means on the other end for attachment to an explosive operated oil well tool, said housing containing the following instrumentalities: an igniter energizable to cause operation of said tool; a battery for energizing said igniter connected in circuit therewith; normally open switch means in said circuit including a member movable to a position completing said circuit and energizing said igniter; control means movable relative to said housing; means interconnecting said switch means and said control means for moving said member to circuit closing position in response to movement of said control means; a movable stop normally disposed in a position to arrest movement of said control means before said member is moved to circuit closing position; and timing means for moving said stop to a position permitting free movement of said control means upon the elapse of a predetermined time.

18. In a firing device, a housing having means on one end for attachment to a cable for lowering said housing into a well bore and having means on the other end for attachment to an explosive operated oil well tool, said housing containing the following instrumentalities: an igniter energizable to cause operation of said tool; a battery for energizing said igniter connected in circuit therewith; normally open switch means in said circuit including a member movable to a position completing said circuit and energizing said igniter; control means movable relative to said housing; means interconnecting said switch means and said control means for moving said member to circuit closing position in response to movement of said control means; a movable stop normally disposed in a position to arrest movement of said control means before said member is moved to circuit closing position; timing means for moving said stop to a position permitting free movement of said control means upon the elapse of a predetermined time; a second movable stop normally disposed in the path of movement of said member for engaging and arresting said member before it is moved to circuit closing position; and a second timing means for moving said second stop out of the path of movement of said member upon the elapse of said predetermined time.

19. In a firing device, a housing having means on one end for attachment to a cable for lowering said housing into a well bore and having means on the other end for attachment to an explosive operated oil well tool, said housing containing the following instrumentalities: an igniter actuatable to cause operation of said tool; control means operable to actuate said igniter in response to an abrupt movement of said housing; and timing means for permitting actuation of said igniter only during a predetermined time period.

20. In a firing device, a housing having means on one end for attachment to a cable for lowering said housing into a well bore and having means on the other end for attachment to an explosive operated oil well tool, said housing containing the following instrumentalities: an igniter energizable to cause operation of said tool; a battery for energizing said igniter connected in circuit therewith; normally open switch means in said circuit including a member movable to a position completing said circuit and energizing said igniter; control means movable relative to said housing; means interconnecting said switch means and said control means for moving said member to circuit closing position in response to movement of said control means; a movable stop normally disposed in a position to arrest movement of said control means before said member is moved to circuit closing position; and timing means for moving said stop to a position permitting free movement of said control means upon the elapse of a predetermined time and for moving said stop to said normal position upon the elapse of another predetermined time.

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