Nov. 12, 1935. H. M. GREENE 2,020,410

SAFETY DETONATING DEVICE FOR USE IN TORPEDOING OIL WELLS

Filed April 19, 1935

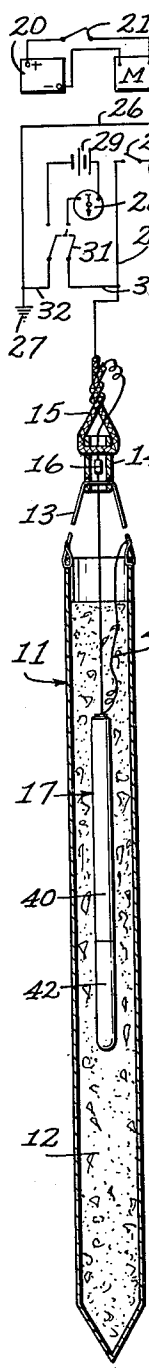


Fig. 1.

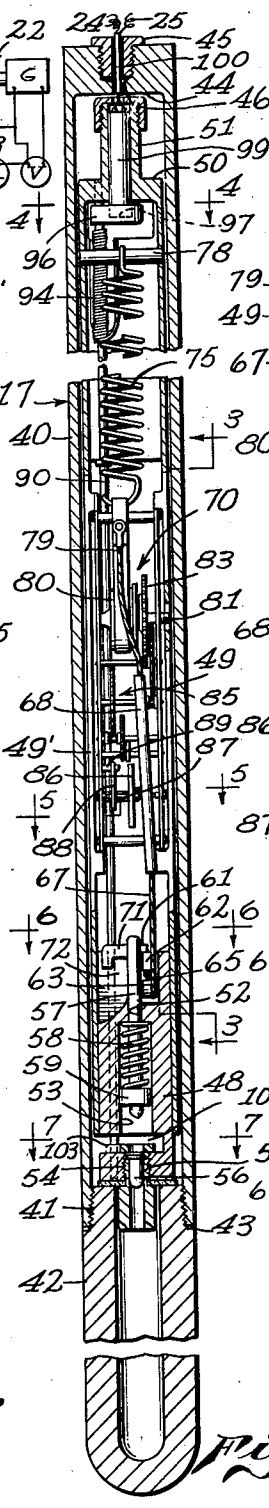


Fig. 2.

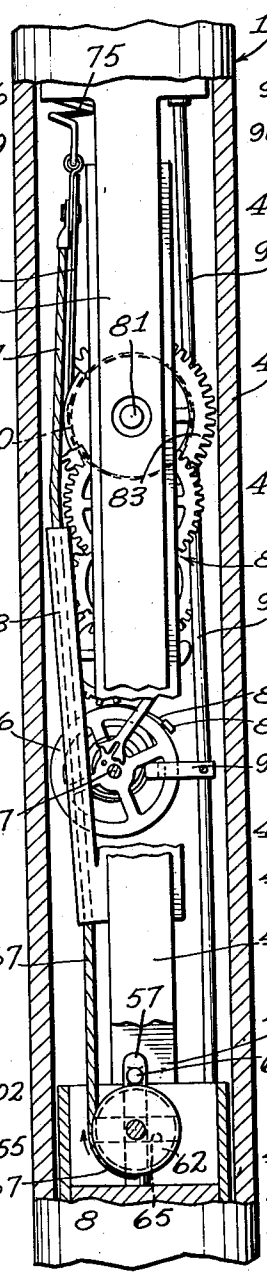


Fig. 3.

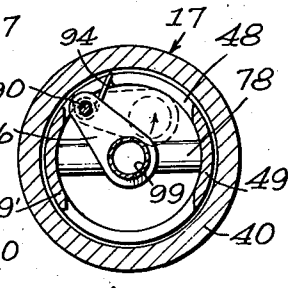


Fig. 4.

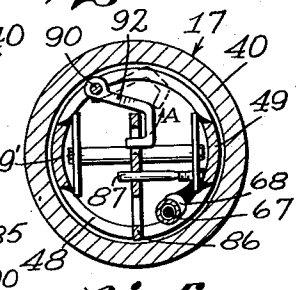


Fig. 5.

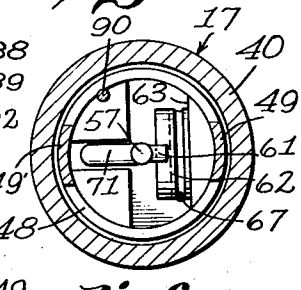


Fig. 6.

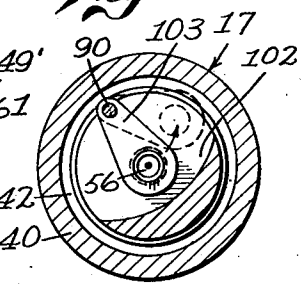


Fig. 7.

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SAFETY DETONATING DEVICE FOR USE IN TORPEDOING OIL WELLS

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Application April 19, 1935, Serial No. 17,227

17 Claims. (Cl. 102—4)

This invention has to do in a general way with subterranean and submarine blasting operations and is more particularly related to the art of torpedoing wells.

As is well known to those familiar with the art, it has long been the practice to increase the production of certain types of wells by discharging a heavy charge of high explosive in the well. This charge of explosive in the form of a torpedo is lowered into the well by means of a suitable line or cable and is provided with detonating means adapted to be set off instantaneously by the application of an electric current through a suitable conductor from the surface of the ground, or by means of a timing mechanism associated with the torpedo, and set in operation at the surface of the ground before the torpedo is lowered. In the latter case the timing mechanism is set so as to discharge the detonator after a predetermined interval of, say, six hours, which is presumed to give the torpedo ample time to reach the bottom of the well.

Numerous casualties have resulted from the use of both of these conventional types of detonators, and it therefore becomes a primary object of this invention to produce a detonating device which may be used with maximum safety to the operator. In line with this objective, my invention contemplates a detonating device adapted to be set off by a clockwork or timing mechanism which in turn is locked against operation by means which can be released only by the application of an electric current from the surface of the ground. In this way the time of the explosion is always under the direct control of the operator, and the clockwork or timing mechanism introduces adequate delay between the time at which the circuit is closed and the time at which the detonator is discharged to permit the removal of the detonator from the charge and its disassembly before it can be fired, in the event the circuit is inadvertently closed before the torpedo is lowered into the well.

It is the usual practice in torpedoing operations of the class described to lower the torpedo into the well by means of a line or cable which remains attached thereto at all times, and the explosion of the torpedo results in the loss of considerable of this line or cable. It is a further object of this invention to provide an improved type of connection between the cable and the torpedo which is designed so as to be broken when the electric circuit is closed, and the delay referred to above, which is obtained by virtue of the timing mechanism in the detonating device, permits the cable to be withdrawn from the well and thereby saved before the detonator actually explodes the charge.

It is a further object of this invention to provide the electric circuit, which is used in breaking the connection and starting the operation of the clockwork, with indicating means whereby the operator can determine whether or not the connection has been broken and the clockwork released before he starts the removal of the cable from the well.

This invention contemplates the use of a firing pin adapted to be released by the timing mechanism which fires a cap to explode the detonating material. It is a further feature of the invention that the device incorporates a safety finger which is normally positioned between the cap and the firing pin, such safety finger being interconnected with the mechanism which releases the clockwork, thereby providing a double safety which assures the protection of the cap from the firing pin until the clockwork is actually started.

It is a still further object of this invention to produce a device of the class described which is of simple and compact construction and can be economically manufactured and sold.

The details in the construction of a preferred form of my invention, together with other objects attending its production, will be best understood from the following description of the accompanying drawing, which are chosen for illustrative purposes only, and in which

Fig. 1 is an elevational view, partly in section, showing a torpedo assembly equipped with my invention, and illustrating the same in connection with a wiring diagram showing a preferred form of circuit adapted to be used in connection therewith.

Fig. 2 is a sectional elevation illustrating a preferred form of detonating mechanism contemplated by this invention.

Fig. 3 is an enlarged fragmentary sectional elevation taken in a plane represented by the line 3—3 of Fig. 2.

Fig. 4 is a plan section taken along the line 4—4 of Fig. 2.

Fig. 5 is a plan section taken along the line 5—5 of Fig. 2.

Fig. 6 is a plan section along the line 6—6 of Fig. 2; and

Fig. 7 is a plan section along the line 7—7 of Fig. 2.

More particularly describing the invention as herein illustrated, reference numeral 11 indicates a torpedo which is in the form of an elongated metal container filled with an explosive charge

12 which may be of nitroglycerine composition or any other suitable high explosive. The torpedo 11 is connected through a wire bail 13 with a frangible coupling collar 14, such collar in turn being connected through a loop with a lowering cable 15. The frangible collar 14 contains an electric blasting cap 16 of sufficient power to burst the frangible connection when it is energized and thereby release the lowering cable from the torpedo. Reference number 17 indicates a detonating device which is suspended or embedded in the explosive charge 12, and the details of the construction of this device will be described later in the specification.

In Fig. 1 I have shown a preferred form of electrical circuit which is especially designed for use with the combination of elements shown.

This circuit comprises a battery 20 which is connected through a switch 21 to a motor generator unit 22. The generator G of this unit is connected across a voltmeter V and one side of the generator is connected through an ammeter A and a switch 23 with a conductor 24 which passes through the lowering cable 15 in series with the electric blasting cap 16 and extends on down to the detonating device 17 to which it is connected in the manner which will be hereinafter described. Another conductor 25 leads from the detonating device 17 and is grounded to the wall of the torpedo 11, the circuit being completed through the conductor 26 of the generator G which is grounded as indicated at 27. Reference numeral 28 indicates a galvanometer which is connected to a very low voltage battery 29, the voltage of such battery being insufficient to either set off the cap 16 or start the operation of the timing mechanism in the detonating device 17. This battery and galvanometer circuit is adapted to be connected through the medium of a suitable switch 31 and conductors 32 and 32' across the two legs of the circuit through the explosive means 16 and the detonating device 17. Since the voltage of the battery 29 is insufficient to discharge the torpedo, as pointed out above, this galvanometer provides an effective means of, first, testing the circuit to see whether it is complete through the system and, second, of determining the resistance of the circuit so that the amount of voltage required to discharge the torpedo can be determined.

Referring now to Figs. 2 to 7, inclusive, for a more detailed description of the detonating device 17, reference numeral 40 indicate an elongated shell or casing which is provided with threads 41 at its lower end, adapted to receive a cup member 42 which in turn is filled with a suitable detonating material such as fulminate of mercury. A suitable gasket 43 is provided to seal the bottom portion of this container. The top of the container is closed, as indicated at 44, such closure being provided with a central passage the top of which is enlarged to receive a packing nut 45.

Mounted within the container, and resting upon the top of the cup member 42, is what I may term a frame structure which consists of a bottom block 48 to which side supports 49 and 49' are secured in any suitable manner. These side supports 49 and 49' terminate at their upper ends in a top plate 50 which has a vertically extending cylinder member 51 formed thereon.

The bottom block 48 is provided with an axial passage 52 having an enlarged chamber 53 therein, the bottom portion of this passage being internally threaded as indicated at 54 for the reception of a bushing member 55 which supports a small impact detonating cap 56. Extending through the top portion of the passage 52 is a firing pin 57 which is fired downwardly toward the cap by means of a compression spring 58 mounted in the enlarged chamber 53 and engaging a head or cross member 59 on the lower portion of the firing pin. The firing pin 57 is normally held in its upper or retracted position by means of a shoulder or projection 61 thereon which engages the upper surface of a rotatable member 62 mounted on an inner face 63 formed in the block 48 adjacent the firing pin. This rotatable member 62, in the form of my invention shown herein, is illustrated as being in the nature of a solid wheel which is provided with a slot 65 adapted to be rotated up into alignment with the projection or shoulder 61 by means of a tension member in the nature of a wire or cable 67. The tension member 67 extends upwardly through a guide tube 68 and has its upper end secured in any suitable way to a clockwork or timing mechanism which is generally indicated by reference numeral 70. In order that the projection 61 on the firing pin may always be held in position for proper alignment with the notch or slot 65 in the rotatable member 62, I provide the firing pin with a guide projection 71 which is slidably received in a guide slot 72 formed in the block 48.

The clockwork or timing mechanism 70, which is operative to actuate the tension member 67, is shown as comprising a tension spring 75 suspended from a cross bar 78 and connected at its lower end to a flexible metal strip 79 which is wound on a reel 80 mounted on the main shaft 81. It will be observed that the upper end of the tension member 67 is shown as being attached to the top of the strip 79, but it will be understood that this member may be attached in any suitable manner, such as by direct connection to the tension spring 75 which is, in effect, the main spring of the clockwork. The clockwork itself may be in general character a conventional clock structure and embodies a main gear 83 which is mounted on the main shaft 81, such gear operating through a train of clock reduction gears indicated at 85, to actuate the escapement wheel 86. The escapement wheel 86 is mounted upon a shaft 87 and is associated with an escapement spring 88, the outer end of which is secured to a projection 89 formed on the side standard 49'.

For the purpose of releasably locking the clockwork against operation, I provide a longitudinally extending shaft 90, the lower end of which is mounted in the bottom of the block 48, and the upper end of which has its bearing in the top plate or cover portion 50. Mounted on the shaft 90, adjacent the escapement wheel 86, is a locking finger 92, such finger being shaped as shown in Fig. 5 so as to be swung into the space between two of the escapement wheel spokes. The shaft 90 is provided with a torsion spring 94 (see Fig. 2) which normally biases the shaft toward the unlocking position. In other words the spring 94 normally applies a torque to the shaft in the direction of the arrow A of Figs. 4, 5, and 7, so that the spring 94 is effective to remove the finger 92 from engagement with the escapement wheel and start the clockwork in operation.

For the purpose of releasably holding the finger 92 in a clock-locking position, I provide the upper end of the shaft 90 with a second finger mem-

ber 96. This finger member is provided with a recess 97 adapted to fall into axial alignment with the chamber in cylinder 51 when the finger 92 is in the full line position shown in Fig. 5. For the purpose of locking the shaft 97 in this position, I provide the cylinder 51 with what I may term an inflammable squib, indicated by reference numeral 99. This squib 99 is shown as being in the nature of a celluloid capsule filled with powder and having a resistant conductor therein, the ends of which are connected to the lead conductors 24 and 25. These conductors 24 and 25 are shown as being contained in a suitable sheath 100 which passes through the passage of the packing nut 45' which with the packing material 46 seals the upper end of the container.

It was mentioned as one object of this invention to provide safety means for preventing the firing pin being released into engagement with the cap at any time except when the firing pin was released through the operation of the clockwork. This object is accomplished by providing in the block 48 a transverse slot or nut 102 (see Figs. 2 and 7) which extends from the side adjacent the shaft 90 across the block and beyond the axial passage which contains the firing pin. Within this slot I provide what I may term an obstruction finger 103 which is rigidly secured to the shaft 90 and is positioned so as to be interposed between the firing pin and the cap as long as the finger 97 and its associated parts are locked in position by the squib 99.

The operation of the detonating device as disclosed herein is as follows: assuming these parts to be arranged in the manner shown in full lines in Fig. 2, which is the position they occupy when the unit is sealed for delivery to the operator, the device is set off by applying an electric current to the conductors 24 and 25 of sufficient potential to ignite the squib 99. The ignition of this squib releases the finger 97 which in turn permits the rod 90 being swung by the action of the tension spring 94 so as to rotate the locking finger 92 and the obstruction plate 103 in the direction of the arrows A in Figs. 5 and 7. In this way the path between the firing pin and the shaft is clear, and the escapement wheel of the clock-work is released. It will be understood that, when the unit is assembled, the escapement wheel is rotated so as to wind up the escapement spring and, immediately upon the release of the escapement wheel, the clockwork is started in operation. The operation of the clockwork permits the tension spring 75 to gradually apply tension to the tension member 67 which, after a predetermined time, depending upon the setting of the clockwork assembly, is effective to rotate the member 62 into a position at which the slot 63 is in alignment with the projection 61. At this time the firing pin 57 is released to be forced downwardly into engagement with the cap under the action of the compression spring 58. The explosion of the cap 56 in this member fires the detonating material in the cup 42 which, in turn, is effective to fire the high explosive charge in the torpedo.

As to the operations carried on by the operator at the surface of the ground in firing the torpedo, the first step, as has been previously pointed out, is to test the circuit to see whether it is complete and measure the resistance thereof by means of the galvanometer 28. After this has been done the operator knows the voltage required to fire the charge and start the motor generator unit 22. When the voltmeter V indicates that sufficient voltage has been generated to fire the charge, the switch 23 is closed, thereby closing the circuit through the torpedo. As long as the circuit is closed through the torpedo, the ammeter will show a certain current value. As soon as the circuit is broken, however, by virtue of the explosion of the cap 56 and the squib 99, the current will either drop to zero or will drop back to another lower value. In other words, the operator watches the ammeter as he closes the switch, and, if the needle thereof first switches to a high current value and then drops back to zero or to a lower value, he knows that the charge has been exploded and it is safe to withdraw the shooting line from the well.

It is to be understood that, while I have herein described and illustrated one preferred form of my invention, the invention is not limited to the precise construction described herein but includes within its scope whatever changes fairly come within the spirit of the appended claims.

I claim as my invention:

1. A detonating device embodying: a cap; means for supporting said cap; a firing pin for said cap; means including a clockwork for releasably supporting said firing pin is a retracted position; means for locking said clockwork against operation; and means controlled by an electric current for releasing said clockwork locking means whereby said clockwork is effective to release said firing pin after a predetermined interval of time.

2. In a detonating device, the combination of: a firing pin; timing means for releasably holding said firing pin is a retracted position; and electrically controlled means for starting the operation of said timing means whereby said firing pin is released after a predetermined interval of time.

3. In a detonating device, the combination of: a firing pin; timing means for releasably holding said firing pin in a retracted position; means including an electric circuit for starting the operation of said timing means; and means in said circuit for indicating whether or not said timing means has been started.

4. In a detonating device, the combination of: a firing pin; timing means for releasably holding said firing pin in a retracted position; a lock for holding said timing means against operation; and means including an electric circuit for releasing said lock, thereby starting the operation of said timing means.

5. In a detonating device, the combination of: a firing pin; timing means for releasably holding said firing pin in a retracted position; a lock for holding said timing means against operation; means including an electric circuit for releasing said lock, thereby starting the operation of said timing means; and means in said circuit for indicating whether or not said lock has been released.

6. In a detonating device, the combination of: a cap; means for supporting said cap; a firing pin for said cap; means including a clockwork for releasably holding said firing pin in a retracted position; means for locking said clockwork against operation; an obstruction interposed between said firing pin and said cap; and means controlled by an electric current for simultaneously releasing said clockwork locking means and withdrawing said obstruction whereby said firing pin is released to fire said cap after a predetermined time.

7. In a detonating device, the combination of: a detonator; means including a clockwork for firing said detonator after a predetermined time in-

terval; and means controlled by an electric current for starting the operation of said clockwork.

8. For use in well blasting operations, the combination of: a torpedo; a suspending cable; frangible means connecting said cable to said torpedo; an explosive in said frangible connection; a detonator in said torpedo; timing means associated with said detonator and operative after a predetermined interval to discharge said detonator; and means operative by an electric current to simultaneously discharge the explosive in said frangible connection and start the operation of said timing means.

9. For use in well blasting operations, the combination of: a torpedo; a suspending cable for said torpedo; frangible means connecting said cable to said torpedo; explosive means associated with said frangible connecting means adapted to break the same and release said cable; a detonator in said torpedo; means including a clockwork for discharging said detonator after a predetermined time; means for locking said clockwork against operation; and means actuated by an electric current for simultaneously discharging said explosive means to break said frangible connection and releasing said clockwork locking means.

10. For use in well blasting operations, the combination of: a torpedo; a suspending cable for said torpedo; frangible means connecting said cable to said torpedo; explosive means associated with said frangible connecting means adapted to break the same and release said cable; a detonator in said torpedo; means including a clockwork for discharging said detonator after a predetermined time; means for locking said clockwork against operation; means actuated by an electric current for simultaneously discharging said explosive means to break said frangible connection and releasing said clockwork locking means; and means including a conductor in said cable for supplying current to said explosive means and said lock releasing means.

11. For use in well blasting operations, the combination of: a torpedo; a suspending cable for said torpedo; frangible means connecting said cable to said torpedo; explosive means associated with said frangible connecting means adapted to break the same and release said cable; a detonator in said torpedo; means including a clockwork for discharging said detonator after a predetermined time; means for locking said clockwork against operation; means actuated by an electric current for simultaneously discharging said explosive means to break said frangible connection and releasing said clockwork locking means; an electric circuit for supplying current to said explosive means and said lock releasing means; and indicating means in said circuit for indicating whether or not the circuit through said explosive means and said lock releasing means has been broken.

12. In a detonating device of the class described, the combination of: an elongated shell; a block member in the bottom of said shell, said block member having a passage provided with an enlarged chamber; a detonating cap mounted in the bottom of said chamber; a firing pin in said passage above said cap; yieldable means in said passage for forcing said firing pin against said cap; a rotatable member mounted on said block adjacent said firing pin; a shoulder on said firing pin adapted to engage said firing pin and hold the same in a retracted position; a clockwork in said shell; means actuated by said clockwork for turning said rotatable member, thereby disengaging said shoulder and releasing said firing pin; means for locking said clockwork against operation; and means actuated by an electric current for releasing said clockwork locking means.

13. In a detonating device of the class described, the combination of: an elongated shell; a detonating cap mounted in the bottom of said shell; a firing pin mounted in said shell above said cap; a rotatable member for releasably holding said firing pin in a retracted position; a clockwork in said shell; means actuated by said clockwork for turning said rotatable member to release said firing pin after a predetermined time; means for locking said clockwork against operation; and means controlled by an electric current for releasing said locking means.

14. In a detonating device of the class described, the combination of: an elongated shell; a detonating cap mounted in the bottom of said shell; a firing pin mounted in said shell above said cap; a rotatable member for releasably holding said firing pin in a retracted position; a clockwork having an escapement wheel in said shell; means actuated by said clockwork for turning said rotatable member to release said firing pin after a predetermined time; a longitudinally extending shaft rotatably mounted in said shell; a finger on said shaft adapted to engage said escapement wheel and lock said clockwork against operation; yieldable means for turning said shaft to disengage said finger and said escapement wheel; and means controlled by the action of an electric current for releasably holding said shaft and said finger in an escapement locking position.

15. In a detonating device of the class described, the combination of: an elongated shell; a detonating cap mounted in the bottom of said shell; a firing pin mounted in said shell above said cap; a rotatable member for releasably holding said firing pin in a retracted position; a clockwork having an escapement wheel in said shell; means actuated by said clockwork for turning said rotatable member to release said firing pin after a predetermined time; a longitudinally extending shaft rotatably mounted in said shell; a finger on said shaft adapted to engage said escapement wheel and lock said clockwork against operation; yieldable means for turning said shaft to disengage said finger and said escapement wheel; means controlled by the action of an electric current for releasably holding said shaft and said finger in an escapement locking position; and an obstruction finger rigidly mounted on said shaft in a plane between said cap and the retracted position of said firing pin, said obstruction finger being formed and positioned so as to lie between said firing pin and said cap when said shaft is in an escapement locking position.

16. In a detonating device of the class described, the combination of: an elongated shell; a detonating cap mounted in the bottom of said shell; a firing pin mounted in said shell above said cap; a rotatable member for releasably holding said firing pin in a retracted position; a clockwork in said shell; means actuated by said clockwork for turning said rotatable member to release said firing pin after a predetermined time; means for locking said clockwork against operation; and means including an electrically ignitable fuse for releasing said locking means.

17. In a detonating device of the class de-

scribed, the combination of: an elongated shell; a detonating cap mounted in the bottom of said shell; a firing pin mounted in said shell above said cap; a rotatable member for holding said firing pin in a retracted position; a clockwork in said shell, said clockwork including a tension spring secured at one end to the top portion of said shell for operating same; means including a tension member interposed between said spring and said rotatable member for turning said rotatable member to release said firing pin after a predetermined time interval; means for locking said clockwork against operation; and means controlled by an electric current for releasing said locking means.

HASKELL M. GREENE.