L. H. BROADWATER.

APPARATUS FOR FIRING EXPLOSIVES IN WELLS.

APPLICATION FILED DEC. 30, 1908.

941,852. Patented Nov. 30, 1909.

2 SHEETS—SHEET 1.

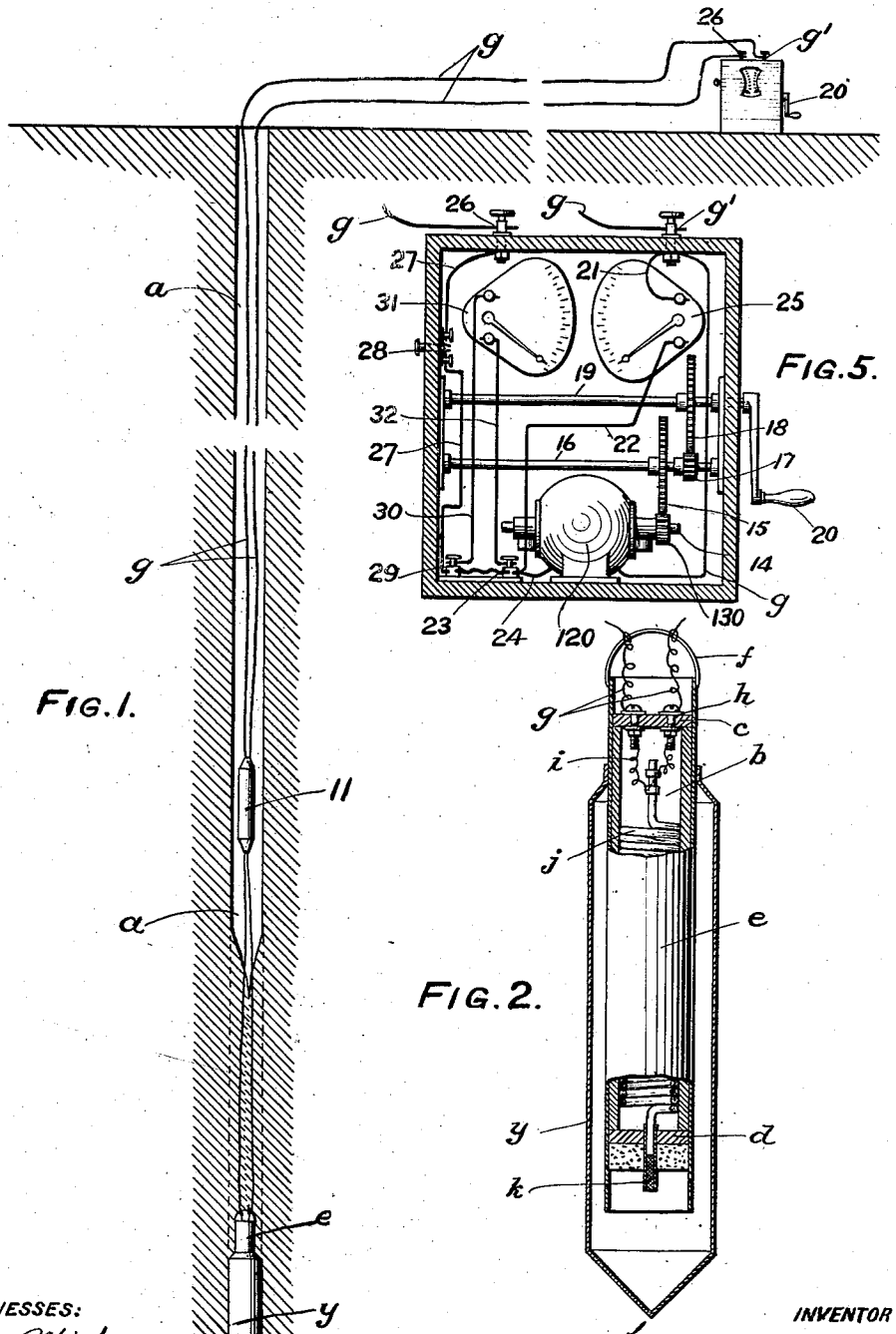

FIG. 1.

FIG. 5.

FIG. 2.

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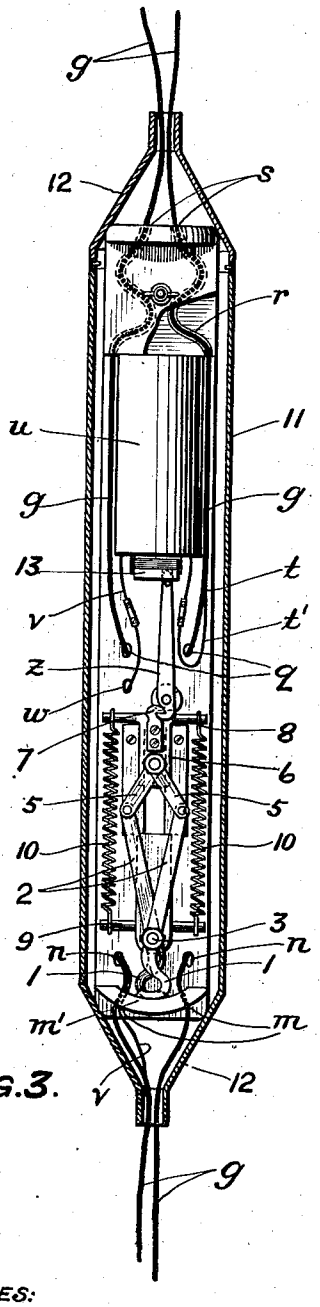

FIG. 3.

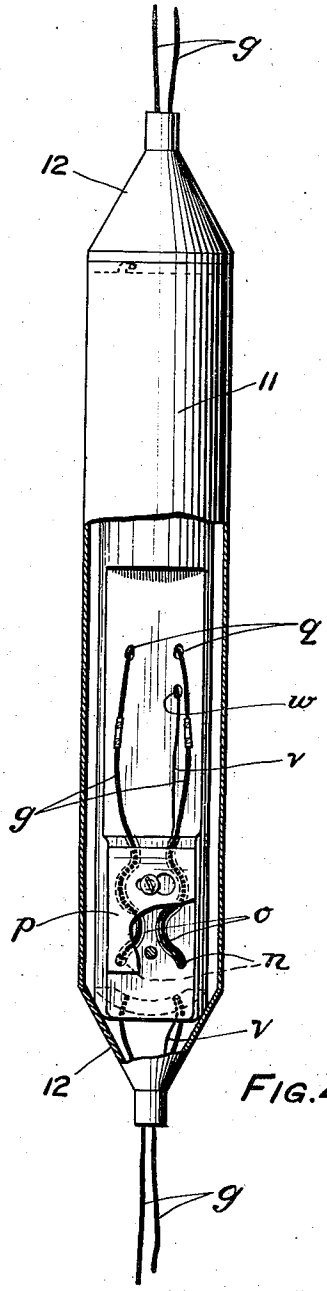

FIG. 4.

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UNITED STATES PATENT OFFICE.

LUKE H. BROADWATER, OF FINDLAY, OHIO, ASSIGNOR TO THE E. I. DU PONT DE NEMOURS POWDER COMPANY, OF WILMINGTON, DELAWARE, A CORPORATION OF NEW JERSEY.

APPARATUS FOR FIRING EXPLOSIVES IN WELLS.

941,852. Specification of Letters Patent. Patented Nov. 30, 1909.

Application filed December 30, 1908. Serial No. 470,099.

To all whom it may concern:

Be it known that I, LUKE H. BROADWATER, a citizen of the United States, residing at Findlay, county of Hancock, and State of Ohio, have invented a new and useful Improvement in Apparatus for Firing Explosives in Wells, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, which form a part of this specification.

My invention is applicable to those cases in which the explosive in the well is of the ordinary construction, and generally speaking, fired in the ordinary manner. It is also applicable, and particularly applicable, to those cases such as are shown in Letters Patent Nos. 855,224 and 866,838 issued to me, and an application filed by me, December 30, 1908, Serial No. 470,098 in which provision is made not only for firing the well, but for severing the wires to save a portion of the wire, and, as in the construction shown in my aforesaid application for severing the wires below the severing apparatus, or at the lower end thereof, to save a large proportion of the firing wire and the severing apparatus.

In all the aforesaid apparatuses it is quite essential that the operator controlling the apparatus should be in a position initially to know that the current is of sufficient strength to insure the firing, and also to make certain of the severing connection, and, after the switch has been operated to cause the firing and the severing, to determine that such has been accomplished.

In all the aforesaid cases herein spoken of, the severing apparatus is placed in shunt circuit with the main firing wires, which shunt circuit controls the severing of the wires. In the two patents before spoken of, this is accomplished by means of an explosive fired from the shunt circuit, which explosive severs the line wires at that point. In the application spoken of, the shunt circuit includes an electro magnet which controls devices for mechanically severing the electrical connection of the shunt circuit and the line wires.

Speaking generally, my invention consists in using a normally open circuit for the line wires between the generator and the primer (which therefore includes the severing device) and a switch for controlling that circuit, and an ammeter in said circuit, and a normally closed circuit from the generator in which is placed a volt meter. By this arrangement, the operator can, by means of the closed circuit, including the volt meter, determine the voltage, and therefore will only close the switch when the voltage is sufficient to produce the desired result of firing the fuse or primer, and operating the severing device. Moreover, the moment the switch is operated, the ammeter is at once in circuit, and when it indicates that no current is passing, the operator can tell with certainty that the detonation has taken place and the wires have been severed by the severing device.

I will now describe my invention in connection with the apparatus illustrated and described in the aforesaid application, although as before stated, this invention includes the case in which no severing apparatus is used and is independent of any specific detonating construction or any specific severing construction.

In the drawings: Figure 1 is a view of my invention in a well. Fig. 2 is a detail view of my apparatus, the firing portion being shown in section. Fig. 3 is a front sectional elevational view of the severing apparatus. Fig. 4 is a rear view of same. Fig. 5 is a view of the electric firing apparatus.

a represents the well to be fired, in the bottom of which and close to the explosive charge is placed the fuse chamber *b*. The fuse chamber has the top and bottom caps *c* and *d* and the outer casing *e* extends above and below the caps *c* and *d*. To the casing *e* is connected the bail *f* around which the firing or line wires *g* are wound, and then pass to the binding posts *h* on cap *c*, from which wires *i* pass to the resistance in the main fuse *j*. This fuse *j* is in the fuse chamber *b* and its lower end is connected with the detonator *k* in the priming charge, which is contained in the vessel *y*. The wires *g* extend upward to the severing apparatus which is a distance far enough above the bottom of the well not to be affected by the caving in of the well by the explosion. The wires *g* extend through

orifices m in the ledge or flange m' on the lower end of the severing apparatus, and pass through orifices n to the back thereof where they are guided in the sinuous grooves o covered by the plate p. They then pass along the back of the severing apparatus to the orifices q where they pass to the front thereof, and from thence along the front or top of this apparatus to the sinuous grooves r at the upper end, from which they pass through orifices s, and thence to the top of the well where they lead to the source of current supply including a switch, for closing the current. From one end of these wires g at the point t, a wire t' leads to the electro magnet u. From the other side of said magnet a wire v extends, which wire passes from the face to the back through the orifice w, it also passes from back to face through one of the orifices n and also through one of the orifices m beyond which it is connected to the opposite wire g from that which the wire t' led and connects at a point which is below where the severing of the line wires takes place.

13 is the armature of the magnet u. A pivoted hook z is normally held in an orifice in the armature 13. 1—1 are two knives connected to the arms 2—2 pivoted at 3 so that said arms move in the arc of a circle along the face of the ledge or flange m' through which the orifices m extend. The ends of these arms 2—2 are pivotally connected by links 5 with a slide 6 carrying the hook 7. Upon this slide is the fixed rod or bar 8. 9 is a fixed bar or rod. The rods or bars 8 and 9 are connected by springs 10. By pulling the bar 8 forward, the hook 7 may be brought into engagement with the hook z, and the knives 1 brought to their central position and the springs 10 thrown into tension (as shown Fig. 3).

When the circuit is closed through the wires g, a shunt circuit passes to the magnet u energizing the same and causing its armature to move upward, releasing the hook z which in turn releases the hook 11, and, the action of the springs 10, causes the knives to move outward passing over the orifices m and thus severing the line wires g and the shunt wire w to the electro magnet. By means of the sinuous grooved passages for the wires g and the passage of the wires from front to back, the severing apparatus and the wires g between the top of the well and the lower end of the severing device may be lifted out of the well and used again.

The severing mechanism is placed within the casing 11. This casing is made of some light metal, as for instance, aluminum. It has the cylindrical body and the conical ends 12—12. This enables this device to be readily lowered into the well and lifted therefrom after firing.

120 is the generator having the small gear 130 on the shaft 14 thereof meshing with the large gear 15 on the shaft 16. On the shaft 16 is the small gear 17 meshing with the large gear 18 on the shaft 19, which shaft is rotated by the crank 20. By this means, the generator is rapidly rotated.

From one pole of the generator one of the main line wires g extends. From this wire g at binding post g' extends the wire 21 to the volt meter 25. From this volt meter a wire 22 extends to the binding post 23 on the shunt, and from this binding post 23 a wire 24 extends to the other pole of the generator. Thus the volt meter is always in a closed circuit with the generator, and whenever the generator is active, receives current. The other wire g extends from the outside line wiring to the binding post 26 on the box, and from this binding post a wire 27 upon which is the switch 28, extends to the binding post 29 of the shunt. From this binding post 29 a wire 30 extends to the ammeter 31, and from the ammeter a wire 32 extends to the binding post 23. It may be seen from this that with the switch 28 normally open, the line is open and the ammeter is in a normally open circuit. However, when this switch is closed, the current which passes to the fuse in the well and to the severing device, also passes through the ammeter. Therefore, when the switch is closed if the arrangement is intact and correct, the ammeter will momentarily indicate current, but will, practically at once, return to zero if the firing and the action of the severing device have properly taken place. Thus the operator may determine initially whether the voltage is proper for his purpose and ultimately determine whether the firing and the severing have properly taken place.

In practice with the use of the hand generator, the shaft is revolved until a voltage of about 140 volts is reached. The crank is then continued to be turned and the switch closed, when the current passes to the priming fuse, and to the severing device, if one be used. At once there will be temporarily an indication at the ammeter, and if the operation is satisfactorily carried out, it will at once be indicated by the return of the ammeter to zero.

I do not intend to limit myself to the specific generator shown, as other generators may be used. I have simply used the specific generator for the purpose of illustrating an operative embodiment of my invention.

Having now fully described my invention, what I claim and desire to protect by Letters Patent is:

1. The combination with a generator and a primer, of firing wires leading from the generator to the primer, a switch for controlling said circuit, and an ammeter in said

circuit, an electrically controlled severing device in circuit with the firing wires beyond the ammeter.

2. The combination with a generator and a primer, of firing wires leading from the generator to the primer, a switch for controlling said circuit, an ammeter in said circuit, an electrically controlled severing device in circuit with the firing wires beyond the ammeter, a normally closed circuit from the generator, and a volt meter in said normally closed circuit.

In testimony of which invention, I have hereunto set my hand, at Findlay, Ohio, on this 26th day of December, 1908.

LUKE H. BROADWATER.

Witnesses:
J. FRANK AXLINE,
JOHN E. BETTS.