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PIPE PERFORATOR

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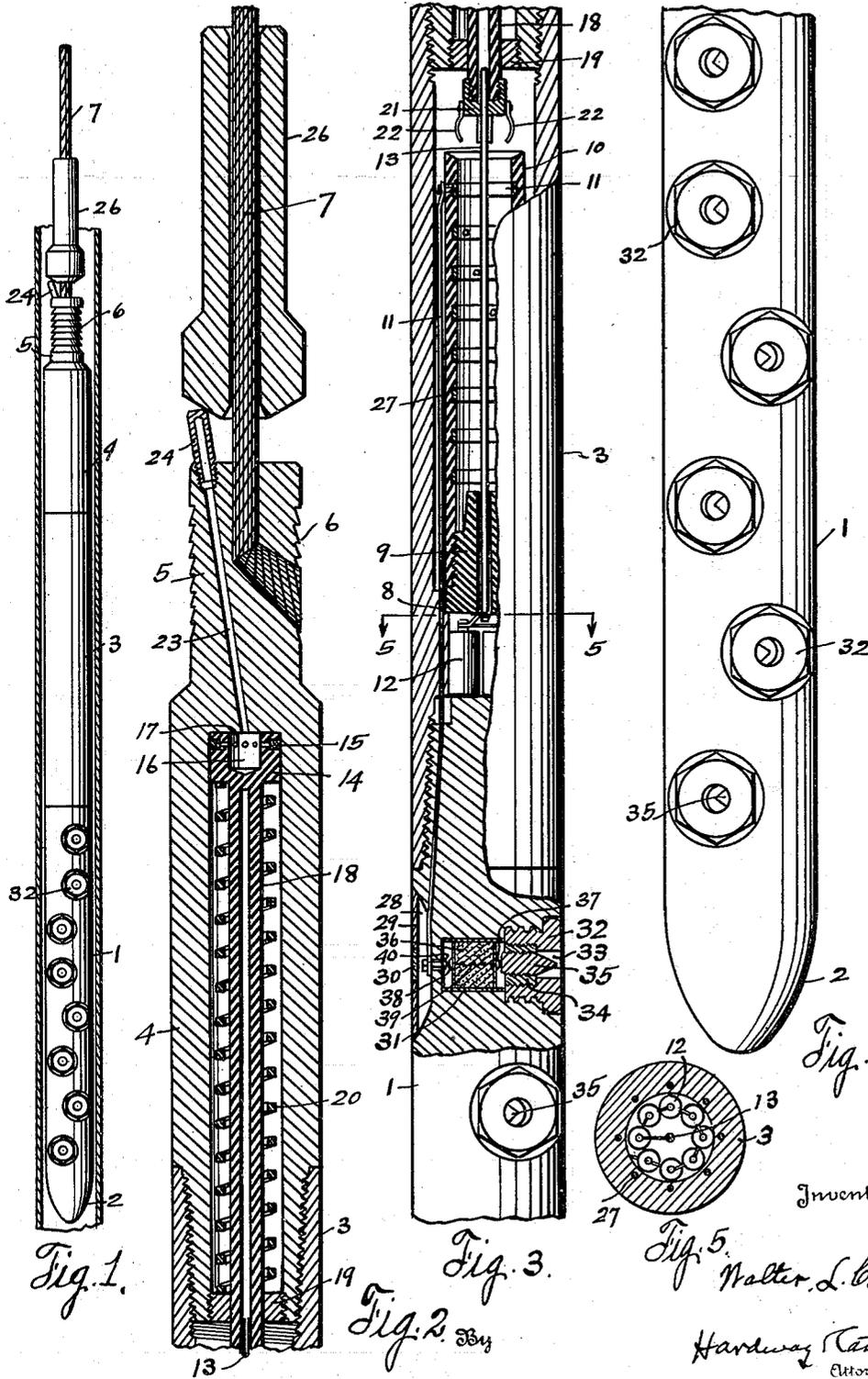


Fig. 4.

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PIPE PERFORATOR

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8 Claims. (Cl. 164—0.5)

This invention relates to a pipe perforator.

An object of the invention is to provide a perforator of the character described adapted to be lowered into a well for the purpose of perforating the pipe or casing set in the well opposite stratum supposed to contain oil or other fluid to be recovered.

Another object of the invention is to provide a perforator of the character described equipped with a self-contained firing apparatus, thus dispensing with the necessity of carrying the electrical conductor to the ground surface.

Electrical perforating apparatus heretofore employed is equipped with an electrical current conductor, usually enclosed within a cable, from the ground surface down to the perforating apparatus. It has been proven very difficult to maintain the conductor properly insulated when considerable depth has been reached. It is a prime object of this invention to provide apparatus of this character which is self-contained, that is, wherein the source of electrical supply is contained in a unit with the firing apparatus, and from which an electrical current may be completed through the explosive charge at will.

Another object of the invention is to provide perforating apparatus of the character described which eliminates the danger accompanying apparatus of this type wherein the explosive charges are mechanically ignited.

It is a further object to provide apparatus of this general character which is of very simple construction, may be cheaply and easily produced, and safely used, which is very efficient for the purpose intended, and which will not be substantially injured by use so that it can be reloaded and reused from time to time.

With the above and other objects in view, the invention has particular relation to certain novel features of construction, operation and arrangement of parts, an example of which is given in this specification and illustrated in the accompanying drawing, wherein:

Figure 1 shows a side elevation of the complete apparatus, shown in the well pipe to be perforated.

Figure 2 shows a vertical, sectional view of the upper end thereof.

Figure 3 shows a side view, partly in section, of an intermediate portion thereof.

Figure 4 shows a side elevation of the lower end thereof, and,

Figure 5 shows a cross-sectional view taken on the line 5—5 of Figure 3.

Referring now more particularly to the draw-

ing wherein like numerals of reference designate similar parts in each of the figures, the numeral 1 designates the body of the perforator which is formed of substantially solid metal and whose lower end is tapered, as at 2, to form a guide. Secured to the upper end of the body there is a tubular housing 3 and connected to the upper end of this housing there is a cylinder 4 whose upper end is closed and formed with a reduced neck 5 provided with the external, downwardly pitched teeth 6. A manipulating cable 7 has its lower end suitably secured in a socket whereby the apparatus may be lowered into and withdrawn from a well. The lower portion of the housing 3 is inwardly thickened forming an internal, annular shoulder 8, and seated on the shoulder there is an anchor 9 formed of insulating material. A supporting sleeve 10 has its lower end secured on the anchor 9 and upstands in the housing 3. This sleeve has the inside contact rings 11 therein and spaced apart from the upper end thereof downwardly. Enclosed within the housing 3 and seated on the upper end of the body 1, there are the electrical batteries 12, electrically connected in series and grounded, and also electrically connected to the contact rod 13 which extends axially upwardly through the anchor 9 and sleeve 10. Fitted within the cylinder 4 there is a plunger 14 having the surrounding packing 15 and internal socket 16 at its upper end with ports leading from said socket into the groove in which the packing is seated around the piston. The piston has a tubular depending stem 18 which may be formed integrally therewith, said stem being formed of insulating material and working through a gland 19 in the lower end of the cylinder.

A coil spring 20 surrounds the stem 18 and is seated on the gland 19 and normally holds the piston 14 in its upper position.

On the lower end of the stem 18 there is a metal contact preferably in the form of a cap 21. The upper end of the rod 13 works through said cap and is in constant contact therewith. The cap 21 carries the outwardly curved flexible contact fingers 22 adapted to contact successively with the rings 11 as the plunger 14 is moved downwardly. The neck 5 has a channel 23 leading downwardly therethrough from the upper end thereof into the socket 16 and the upper end of the channel is enclosed by a hollow cap 24 of frangible material which projects above the upper end of the neck 5 and is, therefore, exposed to the impact of a weight 26 which, at the proper time may be slipped over the upper end of the cable 7 and dropped into the well and

which will strike and break the cap 24. It is to be understood that fluid under pressure will be circulating downwardly through the pipe to be perforated and when the cap 24 is broken, the plunger 14 will be exposed to this pressure and will be forced downwardly overcoming the resistance of the spring 20 and carrying the fingers 22 successively into contact with the rings 11, as hereinabove indicated.

Suitable electrical current conductors 27 are connected at their upper ends to the respective rings 11, and they pass through bores in the inwardly thickened portion of the housing 3 which continue on throughout the body 1, and these conductors are insulated from the housing and terminate in oblong recesses such as 28 which are cut in the external surface of the body 1 and which may be covered after the electrical connections have been made by a cover plate 29 which may be welded in place and which has a removable plug 30 screwed into place so that it may be readily removed for access to the enclosed electrical connections.

Opposite the recesses 28 there are the deep bores 31 formed in the body 1 whose outer ends are enlarged and threaded to receive the plugs, as 32. These plugs are arranged along and around the body 1, as shown; each plug has a central opening 33 into the inner ends of which are screwed soft metal bushings, as 34, into which the projectiles 35 are screwed. The outer ends of these projectiles are pointed and are preferably formed of hard metal such as steel. Before the plugs 32 are screwed in place, cartons, as 36, containing an explosive, are inserted in the bores 31. These cartons have the contacts 37, 38, connected by an electrical conducting element 39, and the lower ends of the conductors 27 have contacts 40 arranged to contact with the corresponding contact points 38. The contacts 38 are suitably insulated from the housing 3 and grounded.

When the apparatus is located at the desired place in the well opposite the stratum thought to contain oil, the weight 26 may be dropped, as hereinabove explained, to break the cap 24 and thereupon the plunger 14 and stem 18 will be forced downwardly by the pressure of the fluid, carrying the fingers 22 successively into contact with the rings 11 from above downwardly. When said fingers contact with a ring 11, an electrical circuit will be completed through the corresponding conductor 39 which will thereupon become sufficiently hot to ignite the explosive charge 36 through which it extends. This charge is preferably a slow explosive and pressure will be built up behind the projectile 35 sufficient to strip the threads of the corresponding bushings 34, and thereupon the projectile will be ejected with sufficient force to penetrate the ordinary pipe or pipes in the well within which the apparatus is located.

As the plunger moves downwardly, the projectiles will be thus ejected, one at a time, and the well pipe will be thus perforated throughout the length of the body 1, and all the way around. Thereupon the apparatus may be withdrawn from the well and reloaded for further use and a new cap 24 installed and the apparatus will then be in readiness for another well-shooting operation.

Ordinarily the apparatus may be withdrawn from the well by the cable 7, but in case said cable should become broken, a cable cutter, commonly used, may be run into the well and the cable cut off closely above the upper end of the apparatus

and a grappling tool attached to the lower end of the string of pipe and run into the well and engaged over the neck 5 and with the teeth 6 and the apparatus then pulled from the well.

The drawing and description disclose what is now considered to be a preferred form of the invention by way of illustration only, while the broad principle of the invention will be defined by the appended claims.

What I claim is:

1. A pipe perforator comprising a body, explosive cartridges therein, projectiles in the body aligned with the cartridges, a source of electrical energy associated with the body and adapted to be lowered with the body into a well, electrical conductors leading from said source through the charges of the cartridges and means operable in continuous sequence by well liquid pressure for successively completing electrical circuits through the conductors whereby the charges will be ignited.

2. A pipe perforator shaped to be lowered into a well and comprising a body, radially directed projectiles therein, explosive charges arranged to eject the projectiles and electrical means arranged to be lowered with the body into the well and operable by the liquid pressure outside of the body and effective to successively fire said charges.

3. A pipe perforator shaped to be lowered into a well and comprising a body, radially directed projectiles on the body, explosive charges arranged, when exploded, to eject the projectiles, electrical means arranged to be actuated by pressure of the well liquid and effective to successively ignite said charges, said means including a series of fixed contacts and a movable contact arranged to be actuated by said pressure.

4. A perforator shaped to be lowered into a well and comprising a perforator body, radially directed projectiles anchored therein, explosive charges arranged, when exploded, to eject the projectiles, a source of electrical energy associated with the body and arranged to be lowered into the well with the body, electrical conductors connected with the source and including heating elements arranged to ignite the respective charges, a housing connected to the body, spaced contacts in the housing connected with said conductors, a switch element and means arranged to be actuated by the pressure of the well liquid to move said switch element into contact with said spaced contacts successively to complete the electrical circuits through the respective heating elements in continuous sequence.

5. A perforator shaped to be lowered into a well and comprising a perforator body, radially directed projectiles located therein, explosive charges arranged, when exploded, to eject the projectiles, a source of electrical energy arranged to be lowered with the body into the well, electrical conductors connected with the source and including heating elements arranged to ignite the respective charges, a housing associated with the body, electrical contacts within the housing and spaced apart, a cylinder associated with the housing, a plunger therein, a contact tongue movable with the plunger into successive contact with the respective electrical contacts whereby circuits may be completed through said conductors, said cylinder having an inlet channel through which liquid under pressure in the well may be exerted against the plunger, and a frangible closure for the outer end of said channel.

6. A pipe perforator comprising a body shaped

to be lowered into a well and having a liquid channel, a radially directed projectile carried by the body, and an explosive charge arranged when ignited, to project the projectile, electrical means arranged to be actuated by the pressure of the liquid in the well to complete an electrical circuit whereby the charge will be ignited, a frangible closure for said passageway normally preventing the actuation of the electrical means by said pressure.

7. A pipe perforator shaped to be lowered into a well and comprising a body, a radially directed projectile therein, an explosive charge arranged to eject the projectile and electrical means ar-

ranged to be lowered with the body into the well and operable by the well liquid pressure outside of the body and effective to fire said charge.

8. A pipe perforator comprising a body, an explosive cartridge therein, a projectile in the body aligned with the cartridge, a source of electrical energy associated with the body and adapted to be lowered with the body into the well, an electrical conductor leading from said source to the charge of the cartridge and means operable by well liquid pressure for completing an electrical circuit through the conductor whereby the charge will be ignited.

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