Aug. 8, 1950 A. E. HAMBLY 2,517,560

GUN PERFORATOR

Filed Jan. 15, 1945

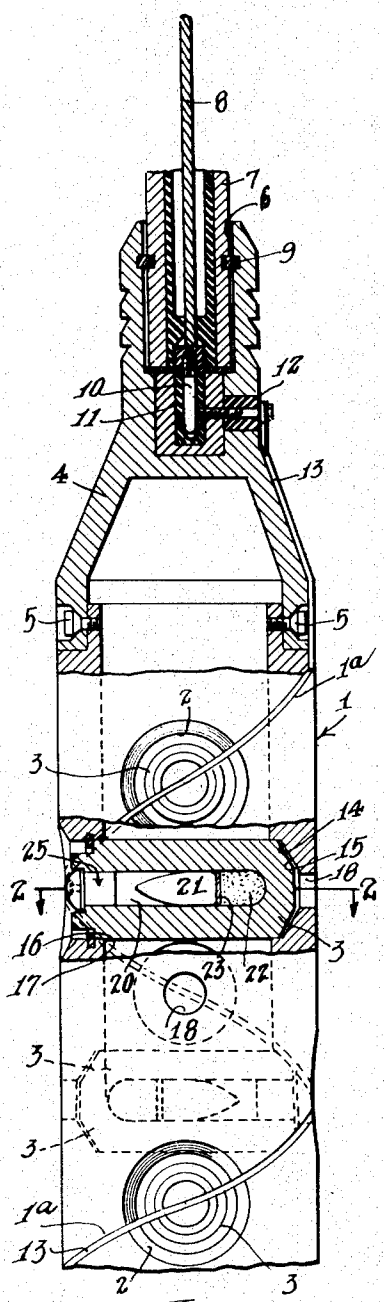


Fig. 1

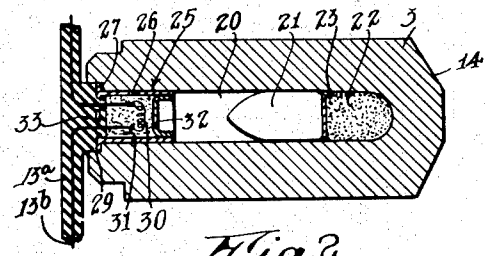


Fig. 2

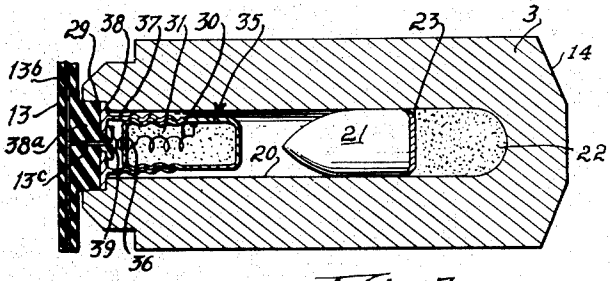


Fig. 3

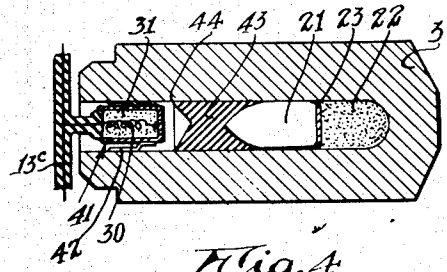


Fig. 4

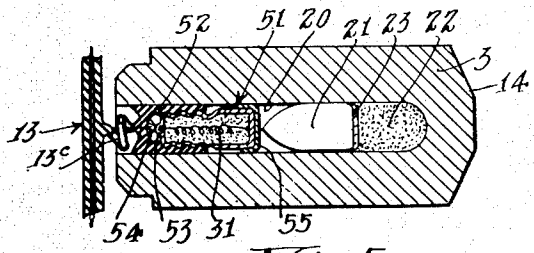


Fig. 5

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GUN PERFORATOR

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4 Claims. (Cl. 164—0.5)

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This invention relates generally to gun perforators for perforating well casing and the like, and is directed particularly to an improved system and apparatus for firing such guns.

A general object of this invention is to provide an improved firing system for gun perforators.

Another object is to provide a firing system for gun perforators wherein a cartridge containing an explosive charge is positioned in front of each bullet, and each explosive charge is individually ignited electrically.

A still further object is to provide a novel cartridge adapted to be inserted into the muzzle of the gun bore of a gun perforator.

A still further object is to provide a firing system for gun perforators which is of simple and economical construction and which can be readily assembled in a multi-shot gun perforator.

The manner in which the foregoing and other objects are attained will be apparent from the following detailed description of one embodiment and several modifications thereof, reference being had to the accompanying drawings wherein:

Fig. 1 is a view, partly in elevation and partly in longitudinal section, of the upper portion of a gun perforator embodying the invention;

Fig. 2 is an enlarged transverse sectional view taken substantially on line II—II of Fig. 1; and

Figs. 3, 4 and 5 are views similar to Fig. 2 showing modified forms of the invention.

Referring to Fig. 1 of the drawings, a preferred embodiment of the gun perforator comprises generally a body 1 of tubular construction in which are formed a vertically spaced series of laterally directed apertures 2 adapted to receive gun chambers 3. The apertures 2 are preferably arranged in angularly offset relation to each other, and as herein shown, adjacent sockets are disposed at right angles to each other.

A cable head 4 is attached to the upper end of the body 1 in any suitable manner, such, for example, as by cap screws 5 countersunk in recesses in the head. An axially extending socket 6 is provided in the head for the reception of a sleeve member 7 attached to the lower end of a cable 8, the sleeve member 7 being releasably retained in the socket by means such as a snap ring 9.

The cable 8, in addition to its function of supporting the gun while in use, also contains an insulated conductor for transmitting electric current to the gun firing mechanism. An electrode 10 is attached to the cable and extends into an insulated socket 11 in the head 4 to contact an insulated conductor pin 12 in the head, the head of the pin 12 forming a binding post to

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which is connected the upper end of a flexible, insulated conductor cord 13. The construction of the cable head and the electrical connection just described is described in the copending application of Raymond D. Elliott, Serial No. 558,581, filed October 13, 1944.

The conductor cord 13 is preferably wrapped helically around the gun body 1 so as to pass over the muzzle ends of the gun chambers 3, and the gun body is preferably provided with a helical groove 1a to accommodate the cord.

Referring now to the gun chambers 3 and their mounting in the apertures 2 in the gun body 1, it will be observed that each chamber is supported at opposite ends thereof in seats formed in the walls of the body, the aperture 2 supporting the forward end of the chamber, and the rearward end being supported by a seat 14. Rearward recoil movement of the chamber is limited by the frusto-conical seat 15 at the base of the seat 14. The chamber is releasably retained in its socket in the body by a snap ring 16 engaging an interial groove in the wall of the aperture 2 and abutting a shoulder 17 formed on the chamber. If desired, the chamber may be loosely mounted in the socket to permit limited recoil movement thereof between engagement of the shoulder 17 with the snap ring 16 and engagement of the rearward end of the chamber with the seat 15. An opening 18 may also be provided in the body 1 at the rear of the chamber to admit well fluid into the narrow clearance space between the chamber and the seat 15, and thus effect a fluid recoil snubbing action to cushion the impact of the chamber against the body when the bullet is discharged. The construction of the chamber and its mounting in the body are described and claimed in the copending application of Raymond D. Elliott, Serial No. 527,110, filed March 18, 1944, now Patent No. 2,402,153, granted June 18, 1946.

Each gun chamber 3 is bored axially from the front end to a point spaced from the rear end to provide the usual gun bore 20 for receiving a bullet 21 and a propellent powder charge 22. A disk or washer 23 of lead or other suitable plastic sealing material may, if desired, be interposed between the rear end of the bullet and the powder charge.

It will be particularly noted that there is no primer or explosion initiator directly associated with the propellent powder charge 22 to initiate the explosion by ignition, as is customary in gun perforators. Instead, I prefer to explode the charge 22 by the detonation of a charge of explosive in front of the bullet, in the manner

taught in the aforementioned copending application Serial No. 558,581. As set forth therein, this method of exploding the propellent charge causes a more rapid rate of combustion of the powder charge into gases, and producing an effect which is more akin to detonation than to explosion. In this manner, a higher muzzle velocity of the bullet is attained.

Referring to Fig. 1 of the drawing, explosion of the propellent charge 22 is effected by detonation of an electrically fired cartridge, generally designated 25, which is inserted into the muzzle of the bore 20. The cartridge may assume various forms, specific examples of which are shown in Figs. 2 to 5.

In the form shown in Fig. 2, the cartridge comprises a thin metallic cup-shaped case 26 of brass or other suitable material, which fits snugly in the gun bore and the outer end of which is provided with a flanged head 27 at its outer end adapted to seat against a shoulder formed by a counterbore 29 at the muzzle end of the gun bore 20. The case 26 may be molded or otherwise secured by its head 27 to the conductor cord 13 which, in this construction, includes a sheath 13a and a conductor 13b. If it is desired to arrange the cartridges for series connection, the conductor 13b is broken at intervals and the ends thus formed directed into the case 26 through small openings in the head 27. The conductor ends within the case are suitably connected by a filament 30 and the case filled with an explosive charge 31, preferably a high explosive of the detonating type adapted to be ignited by the filament. A cap 32 may close the inner end of the case. To minimize the possibility of shorting the filament, the interior of the case 26 may be coated with a thin layer of lacquer or other suitable material, not shown.

The head 27 of the case 26 has sufficient thickness to withstand the external fluid pressures, and may be convexed outwardly to increase its strength. The conductor cord may have molded plug portions 33 adapted to fill the counterbores 29 and form fluid seals for the cases 26.

In the embodiment shown in Fig. 3, a cartridge 35 is employed. This cartridge is in the form of an externally threaded sealed capsule containing as in the first construction, an explosive charge 31 and a filament 30. In this construction, one end of the filament is grounded to a wall of the capsule while the other is connected to an insulated terminal 36 provided in one end of the capsule.

The capsule is adapted to screwthread into a mating socket member 37 fitting within the gun bore 20. The socket is provided with a flanged end 38 adapted to fit the counterbore 29 and strong enough to withstand external fluid pressures. A suitable sealing element 38a or sealing material is employed to seal the external flange of the end 37 in place. A terminal element 39 is provided in the flanged end 38 for engagement by the terminal 36. The terminal element is connected to a lateral lead 13c from the conductor 13. In this construction conductor 13b is continuous and the several filaments are connected in parallel as each forms a grounding connection from the conductor 13b to the gun body.

Although the conductor cord 13 is shown as passing over the muzzle ends of the gun chambers, it is of course feasible to place the conductor cord at one side of the gun chambers and merely increase the lengths of the lateral leads 13c.

In the foregoing constructions, the gun bores are isolated from external pressure by seals at their outer ends. It is, however, feasible to subject the gun bore and therefore the bullet as well as propelling charge to the hydrostatic pressure. This is accomplished by the arrangement shown in Fig. 4. Here the cartridge 41 is in the form of a sealed capsule capable of withstanding the crushing force of the liquid in which the gun perforator may be immersed, and as in the previous constructions the cartridge 41 contains an explosive charge 31 and a filament 30 grounded at one end. The other end is connected directly to the lateral lead 13c which extends into the capsule through a suitably sealed and insulated opening. Contact and spacer springs 42 provide a grounded electrical contact between the cartridge 41 and the walls of the gun bore as well as spaces the cartridge, so that such well fluids as may enter the gun bore can flow between the cartridge and bullet. A sealing plug 43 of rubber or other suitable material covers the bullet. The plug 43 is preferably cupped at its outer end to form sealing lips 44. Because of the different mode of sealing, the counterbore 29 may be omitted.

In the modification illustrated in Fig. 5, a cartridge 51 is provided which is similar to the cartridge 41 but is threaded to fit a socket member 52. The socket member 52 may be formed of rubber or the like and is provided with a closed concave outer end adapted to form a slidable sealing connection in the gun bore 20. The socket members may be molded integrally with the conductor cord 13 forming ends for the lateral leads 13c. With this arrangement the lateral leads are made sufficiently long to permit rearward movement of the sockets 52 into the gun bores, the excess length of lead being coiled in the outer end of the bore as shown in Fig. 5.

The socket member 52 is provided with a terminal 53 which engages a terminal 54 provided in an end wall of the cartridge 51 and to which one end of the filament 31 is connected. The other end of the filament 31 is grounded to the cartridge and the cartridge is grounded to the walls of the gun bore 20 by a spring clip 55 provided at the inner end of the cartridge. The spring clip may also serve as a reinforcing to prevent crushing of the cartridge when forced against the bullet by fluid pressure before firing.

In the operation of the gun perforator, it is lowered into the bore hole to the desired elevation while suspended from the cable 8, whereupon a circuit is established from a source of electric current through the conductor embedded in the cable 8, the electrodes 10 and 12, the conductor 13 and the branch leads to each of the filaments 31 to detonate the explosive charges in front of the bullets. The resulting concussion forces the bullets rearwardly in the gun bores with sufficient force to explode the propellent charges 22 and thus discharge the bullets from the bores. This method of exploding the propellent charges results in a substantially higher muzzle velocity of the bullets than is the case when the charges are ignited by a heated filament or by the flame from a primer cap. The attainment of a higher muzzle velocity is believed to be due to a combination of several factors, to wit:

(1) The explosion of the propellent charge is in the nature of a detonation, characterized by a faster rate of combustion than that which occurs when it is exploded by ignition.

(2) The pressure wave produced by the detonation of the explosive charge in front of the bullet momentarily retards the outward move-

ment of the bullet, allowing the pressure behind the bullet to increase to a high magnitude before the bullet starts to move.

(3) As the bullet is discharged, the space in front of the bullet is filled with gas from the explosion of the charge in front of the bullet, instead of being filled with liquid as in the usual case, and hence the resistance to movement of the bullet is greatly reduced.

Aside from the advantages of the herein-described gun perforator from the standpoint of effectiveness in perforating casing, it possesses other desirable features. It is of simple construction and hence comparatively inexpensive to manufacture. The novel firing system facilitates assembly of the gun, both in the shop and when reloading at the site of operation. The conductor 13 with its branch leads and cartridges 25, etc., may be made up as units and tested electrically and for fluid leakage before being applied to the gun.

While I have shown the novel firing system as applied to a gun perforator embodying removable and replaceable gun chambers, it will be obvious that it is equally applicable to a gun perforator wherein the gun bores are formed directly in the gun body, as in the aforementioned copending application of Raymond D. Elliott, Serial No. 558,581. It will also be apparent that the explosive means in front of the bullets may assume other forms than those depicted, and hence the invention is not limited to the specific embodiments shown and described, but is of the full scope of the appended claims.

I claim:

1. In a gun perforator, a gun body structure defining a gun bore; a bullet in said gun bore; propellent explosive means rearwardly of said bullet; sealing means in said gun bore in front of said bullet; and a fluid-tight cartridge in said bore in front of said sealing means, said cartridge containing an explosive charge and an electric ignition means therefor.

2. A gun perforator comprising: a gun body having a gun bore therein; a propelling charge and bullet in said gun bore; a sealing means for the muzzle end of said gun bore; a threaded socket member extending into said gun bore from said sealing means; an ignition cartridge threaded into said socket member and containing an explosive charge and an electric ignition means therefor; and a conductor means entering the muzzle end of said gun bore and including contact terminals in said socket member and said cartridge for supplying electric current to said ignition means.

3. A construction as set forth in claim 2 wherein said gun bore is counter-bored at its muzzle end and said socket member includes a shoulder fitting said counter bore to restrain the socket member against inward movement.

4. A construction as set forth in claim 2 wherein said sealing means and socket member are an integral unit slidable in said gun bore and said cartridge includes a grounding contact forming a reinforcing for supporting said cartridge on the outer end of said bullet when said gun body is submerged.

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No references cited.