Aug. 17, 1943. L. SPENCER 2,327,141

GUN PERFORATOR

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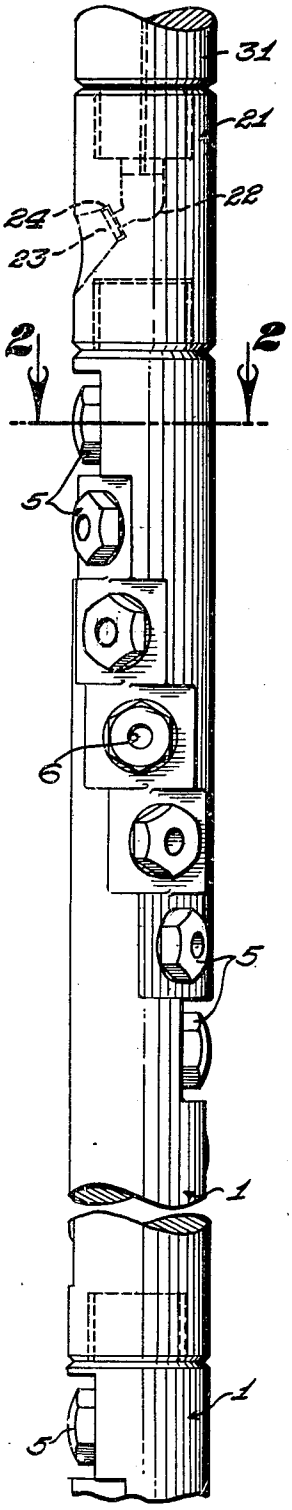


FIG. 1

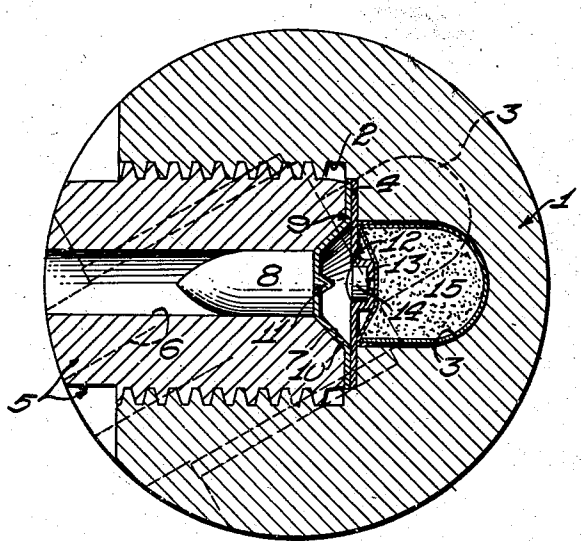


FIG. 2

INVENTOR

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GUN PERFORATOR

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10 Claims. (Cl. 164—0.5)

My invention relates to gun perforators; that is, to devices designed to fire bullets through well casing for the purpose of opening the casing to surrounding fluid. Among the objects of my invention are:

First, to provide a gun perforator which utilizes the concussion or pressure wave occurring in the medium in which the gun perforator is immersed, incidental to discharge of one gun unit to fire adjacent gun units;

Second, to provide a gun perforator wherein the detonator and its firing means is located between the bullet and cartridge of each gun unit and the bullet is exposed to fluid pressure and is therefore capable of driving backwardly to set off the corresponding detonator when subjected to excessive pressure applied through the muzzle of the gun bore;

Third, to provide a gun perforator which may be so arranged that it must be submerged in liquid to provide a medium to transmit a concussion or pressure wave of sufficient force from one unit to another, thereby providing a detonator type gun perforator which is relatively safe to handle;

Fourth, to provide a multiple unit gun perforator whereby all intercommunicating passages or wire conduits between the several gun units are eliminated, thereby providing a gun perforator which is particularly simple and economical of manufacture;

Fifth, to provide a multiple unit gun perforator which is inherently so arranged that the gun bores may be closely spaced and occupy a maximum proportion of the gun perforator's diameter, thereby providing a gun perforator of minimum weight and maximum firing power;

Sixth, to provide a gun perforator the operation of which may be initiated by any of the conventional gun firing means, that is, the gun perforator may be suspended from a conductor core cable and initially fired electrically or lowered on a wire line and fired mechanically by means of a go-devil or analogous devices; and

Seventh, to provide a gun perforator which may comprise a plurality of interchangeable gun sections, each incorporating a plurality of gun units, the gun sections being arranged to be connected end to end and as many sections connected together as desired or as may be limited by the strength of the cable from which it is suspended, thereby providing a gun perforator that is capable of firing a large number of shots.

With the above and other objects in view, as may appear hereinafter, reference is directed to the accompanying drawing, in which:

Figure 1 is a fragmentary longitudinal elevational view of my gun perforator; and

Figure 2 is an enlarged typical transverse sectional view thereof taken through 2—2 of Figure 1.

My gun perforator comprises a gun body 1 in the form of a cylindrical bar of metal having an internally threaded socket at one end and an externally threaded pin at the other, so that the gun body may be joined end to end with other gun bodies, as shown in Figure 1. Each gun body is provided with a plurality of laterally directed gun barrel sockets 2 which are internally threaded. At the inner end of each socket 2 is a cartridge chamber 3 of smaller diameter than the socket and therefore forming therewith a shoulder 4.

Each socket 2 receives a gun barrel 5 having a central gun bore 6. The inner or breech end of the gun bore 6 is beveled, as indicated by 7. Each gun barrel receives a bullet 8. A seal disk 9 is welded or otherwise secured to the base end of each bullet 8, or the bullet may merely rest thereagainst. The seal disk 9 comprises a flange portion adapted to be clamped between the inner end of the gun barrel 5 and the shoulder 4, and a conical portion 10 conforming to the beveled breech end 7 of the gun bore so as to form a structural member capable of withstanding considerable load applied by or through the bullet 8, but adapted to give way when a predetermined load is exceeded.

Also clamped between the gun barrel 5 and shoulder 4 is a detonator disk 12. The detonator disk 12 is flat except for a small central recess 13 which is perforated and which receives a detonator 14. The detonator may be similar to the conventional detonator used in the cartridges employed in pistols and rifles. An explosive cartridge 15 fits in the cartridge chamber 3.

The seal disk 9 is provided with a tip 11 which may be reinforced by a corresponding tip at the base end of the bullet. The tip 11 is in registry with the detonator 14 so that when the strength of the seal disk 9 is exceeded by pressure against the bullet, the bullet may be driven backwardly, causing the firing tip to strike the detonator and thereby set off the explosive cartridge.

The uppermost gun body is connected to an ignition sub 21 which contains a cartridge 22 from which extends a downwardly and outwardly directed blank bore 23 initially sealed by

a seal disk 24. The ignition sub in turn is supported by a suitable firing head 31 adapted to fire the cartridge 22 electrically or mechanically by conventional means.

The several sockets 2 in each gun body are preferably arranged so that they define a spiral path along the gun body, as shown in Figure 1 and indicated by dotted lines in Figure 2. The muzzle ends of the gun units are placed as close to each other as possible.

Operation of my gun perforator is as follows: It is preferred to operate the gun perforator under liquid. The seal disks 9 are made strong enough to resist the hydrostatic head of the liquid at the depth at which the gun perforator is discharged, but are not strong enough to withstand the concussion created by the discharge of an adjacent gun unit or by discharge of the cartridge 22. Thus when the cartridge 22 is discharged the bullets of the adjacent gun units are driven backwardly against their respective detonators, setting off their explosive cartridges. The concussion resulting from the discharge of the first gun unit is sufficient to set off the gun units not affected directly by the discharge of the cartridge 22; these in turn fire the next adjacent units until all of the gun units have fired.

Theoretically, if the gun is immersed in a liquid which is relatively incompressible the discharge of the cartridge 22 would set off all of the gun units. Actually, however, gas may be present in the liquid, the surrounding casing may expand slightly and air spaces exist behind the seal disk. All of these factors tend cumulatively to reduce the effective pressures as the distance between the cartridge 22 or discharging gun units and the one to be fired increases. However, it is only necessary to create sufficient concussive force to set off two or three adjacent gun units as these in turn will create the necessary force to set off their neighbors.

The concussive force, or pressure wave incidental to discharge of a gun unit, materially exceeds the hydrostatic pressure of the liquid in which the gun is immersed. At a distance embracing several, that is, three or four, of the gun units shown in Figure 1, the concussive pressure by a factor of at least two or three at great depth in "live" or gas-containing liquid and by a factor of as much as 100 at shallow depths. For example, in, say, 50 feet of water the concussive pressure is around 4000 to 5000 pounds per square inch, while at 5,000 feet it is around 8,000 to 10,000 pounds per square inch. Because of this wide margin between concussive and hydrostatic pressures, it is relatively easy to select a seal disk capable of withstanding hydrostatic pressure, but adapted to give way when subjected to the concussive pressure. Thus, in practice, the thickness of the seal disk is varied according to the liquid depth at which it is desired to discharge the gun, or portions of the seal disk are weakened to accomplish the same effect, a half dozen sizes sufficing for the range of conditions encountered.

It should be noted that immediately before a gun unit discharges its bullet is moving backward. The kinetic energy of the backwardly moving bullet must be overcome before it starts forward under the explosive pressure generated by the cartridge. This introduces a time delay, permitting increased generation of pressure before forward movement of the bullet. Also, the effective length of the barrel is increased as the bullet starts forward from a position in which it protrudes partly from the rear end of the barrel. Also, the rearward movement of the bullet reduces the effective volume of the cartridge chamber, thus increasing the powder density which contributes to increased penetrating power.

In some oil regions, particularly the area referred to generally as the "Mid-Continent area," it is customary to bail the well virtually dry before shooting, so that much of the gun perforating done in this region is in wells having a very low liquid head, that is, a head of 100 feet or so above the gun. This condition is obviously ideal for the operation of my gun perforator, as indicated by the approximately 100 to 1 difference between the concussive and hydrostatic pressures.

While it is preferred and recommended, because of the obvious safety advantages, to design the gun to fire only under liquid it is, of course, obvious that the bullet may be so lightly retained that the relatively nominal pressure surge in air is sufficient for operation. This permits operation of the gun perforator above the liquid level should this be desired for any reason.

Various changes and alternate arrangements may be made within the scope of the appended claims, in which it is my intention to claim all novelty inherent in the invention.

I claim:

1. A gun perforator comprising: means defining a cartridge chamber and a gun bore extending therefrom; a cartridge for said chamber; a bullet for said gun bore; and a detonator interposed between said cartridge and bullet.

2. A gun perforator comprising: means defining a cartridge chamber and a gun bore extending therefrom; a cartridge for said chamber; a bullet for said gun bore; a detonator interposed between said cartridge and bullet adapted to be set off when said bullet is driven backwardly in said gun bore toward said cartridge; and means initially restraining said bullet from pressure contact with said detonator, said means adapted to give way when a predetermined inward pressure against the bullet is exceeded.

3. A gun perforator comprising: a plurality of gun units, each including means defining a gun barrel and a cartridge chamber; bullets for said gun barrels; cartridges for said cartridge chambers; and detonators interposed between said bullets and cartridge chambers; the muzzle ends of the gun bores of adjacent gun units arranged in close proximity whereby the concussion incidental to the discharge of one gun unit tends to drive the bullets of at least the adjacent gun units inwardly against their respective detonators.

4. A gun perforator comprising: a plurality of gun units, each including detonator and concussion responsive striker means; the gun units being grouped in close proximity to each other whereby the concussion incidental to discharge of one gun unit actuates the striker means of at least the adjacent units to set off their respective detonators.

5. A gun perforator comprising: a plurality of gun units, each including means defining a gun barrel and a cartridge chamber; bullets for said gun barrels; cartridges for said cartridge chambers; a detonator and striker therefor interposed between said bullet and cartridge; sealing means excluding liquid from said cartridges; the muzzle ends of the gun bores of adjacent gun units being arranged in close proximity whereby, when the gun units are submerged in liquid, the con-

cussion incidental to the discharge of one gun unit causes the bullets of at least the adjacent gun units to be driven inwardly and cause coaction between their respective strikers and detonators.

6. A gun perforator comprising: a plurality of gun units, each including means defining a gun barrel and a cartridge chamber; bullets for said gun barrels; cartridges for said cartridge chambers; a flexible fluid sealing and hydrostatic pressure resisting diaphragm; a detonator and a striker therefor interposed between said bullet and cartridge; the muzzle ends of the gun bores of adjacent gun units being arranged in close proximity whereby, when the gun units are submerged in liquid, the concussion incidental to the discharge of one gun unit in excess of the strength of said diaphragm causes the bullets of at least the adjacent gun units to be driven inwardly to cause coaction between their respective strikers and detonators.

7. A gun perforator comprising: a plurality of gun units, each including a detonator and a hydrostatic pressure-resistant, concussive pressure actuated firing means therefor exposed to the pressure of the medium in which the gun units are immersed, said firing means of each gun unit being responsive to concussive pressures generated incidentally to the discharge of another gun unit.

8. A gun perforator comprising: a plurality of gun units; a detonator for each gun unit; a hydrostatic pressure-resistant, concussive pressure responsive firing means for each detonator, said firing means adapted to be immersed in liquid and susceptible to concussion incidental to discharge of an adjacent gun unit while under liquid.

9. A gun perforator comprising: a plurality of gun units, each having a gun bore and a cartridge chamber; a cartridge for said cartridge chamber; a detonator for said cartridge; and a pressure responsive means for each detonator, said means being responsive to concussive pressures incidental to discharge of another gun unit applied inwardly through said gun bores; and bullets for said gun bores.

10. A gun perforator comprising: a gun body having a plurality of laterally directed sockets arranged in consecutive series with their open ends adjacent each other, the outer end of each socket being adapted to receive a gun barrel and the inner end thereof forming a cartridge chamber; cartridges for said cartridge chambers; detonators for said cartridges; gun barrels having gun bores for said sockets; pressure responsive means secured in said socket by said gun barrels and positioned to engage said detonators when subjected to concussive pressures incidental to discharge of the cartridge asosciated with an adjacent socket and gun barrel; and bullets for said gun barrels.

LLOYD SPENCER.