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MEANS AND METHOD OF PERFORATING WELL CASINGS

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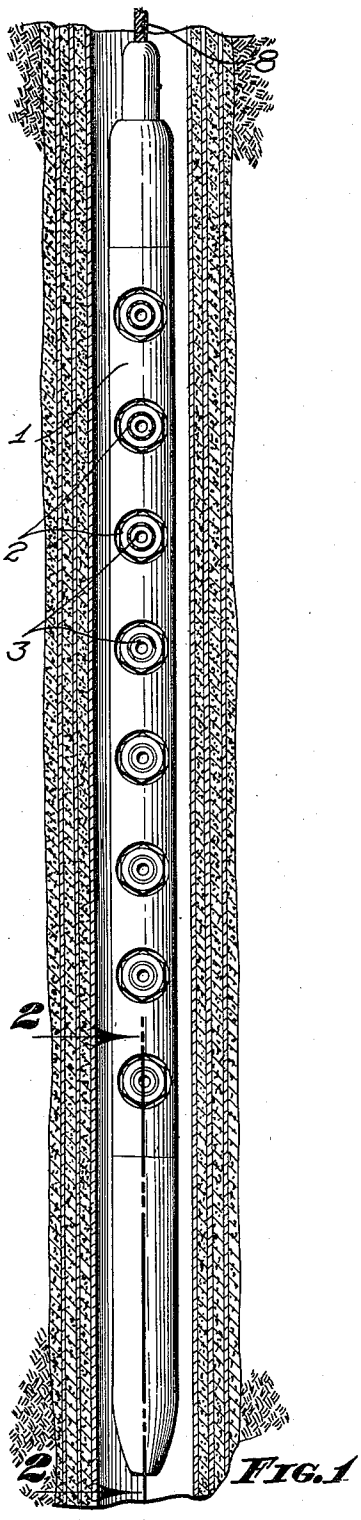


FIG. 1

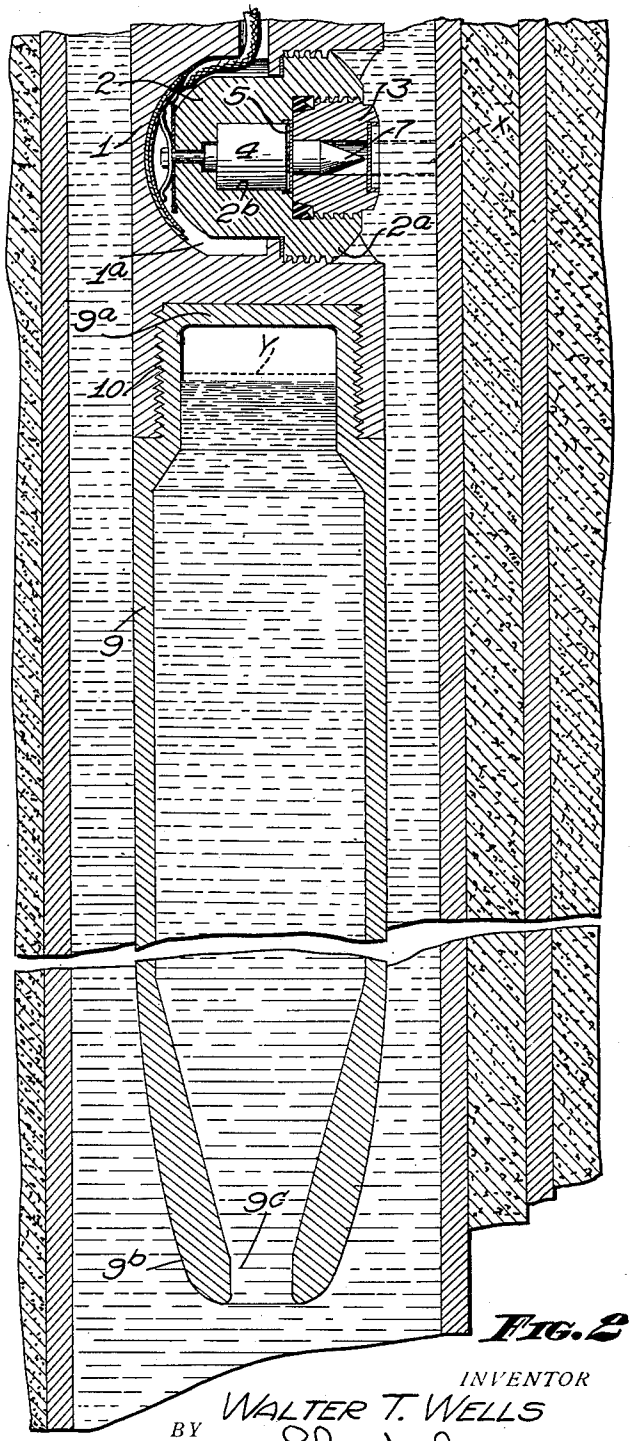


FIG. 2

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MEANS AND METHOD OF PERFORATING WELL CASINGS

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19 Claims. (Cl. 81—188)

My invention relates to means and method of perforating well casing, and the objects of my invention are:

First, to provide a means of perforating well casing which involves the firing of projectiles through the well casing;

Second, to provide a means of this class which is particularly designed for firing projectiles while submerged to great depths in water, oil-well mud or the like, there being incorporated an arrangement whereby the fluid through which the projectile must pass is readily displaced;

Third, to provide a method of perforating well casing which involves perforating the casing by gun-fire while submerged in a non-compressible fluid, but providing a compressible region in proximity to the location being perforated whereby the effect of the gun fire on the inertia of the non-compressible fluid head is minimized;

Fourth, to provide a means and method of this class which is particularly applicable to the perforating of a plurality of concentric casings as well as what cement there may be between and around the casings; and

Fifth, to provide on the whole a novel means of perforating well casing which is simple of construction, and positive in its operation.

With the above and other objects in view as may appear hereinafter attention is directed to the accompanying drawing, wherein similar characters of reference refer to similar parts and portions.

In the drawing; Figure 1 is an elevational view of a gun type perforator embodying my invention and showing the same within a well bore wherein several casings are provided; and, Figure 2 is an enlarged fragmentary sectional view of the perforator taken through 2—2 of Figure 1.

The gun type perforator which is incorporated with my improved means consists generally of an elongated, cylindrical body member 1 in which are formed a plurality of staggered, laterally directed sockets 1*a*. These receive gun casings 2 which are preferably removable from the body member.

Each gun casing is provided with a recess 2*a* which is enlarged at its outer portion and receives a short gun barrel 3. The remaining portion of the recess 2*a* forms chamber 2*b* which receives an explosive containing cartridge 4. The gun barrel forms a sealed connection with the casing and its bore is sealed from the chamber 2*b* by a partition 5. The partition 5 is relatively strong to cause an initial pressure to be built up in the chamber 2*b* before the explosive ruptures the partition and discharges through the gun bore. A projectile 7 is fitted in the gun bore.

The cartridge 4 is provided with an element not shown adapted to be heated to incandescence by suitable electrical means including a conductor extending through a cable 8 which supports the body 1. Also a selector device, not shown, is incorporated in the electrical means and mounted within the body number I, for the purpose of firing the gun units one at a time or in prearranged groups.

I do not claim the above described structure per se but in combination with the apparatus hereinafter set forth; inasmuch as said structure is the invention of one Wilfred G. Lane and embodied in a co-pending application Serial Number 642,410, filed November 12, 1932.

It is desirable and often mandatory that the gun type perforator be discharged while submerged to relatively great depths in water, oil-well mud or the like. The water or oil-well mud is incompressible so that in order for a projectile to leave the perforator the whole column of liquid must be displaced upwardly sufficiently to compensate for the volume of the projectile. When such liquid column is long the inertia is so great that much of the energy is dissipated in moving the column.

I overcome this difficulty by providing a compressible medium in proximity to the gun unit, that is within a few feet of the gun unit. In the form shown, an air receiver 9 is secured to the lower end of the body member 1, preferably by a screw connection 10. Said receiver is in the form of an elongated hollow cylinder having a closed upper end 9*a*, and a blunt pointed lower end 9*b* with a centered opening 9*c* therein.

The air receiver is sufficiently long that when the perforator is submerged to its working depth and water or oil well mud has compressed air into the upper end of the receiver, the volume of such entrapped air will be greater than the volume of liquid to be displaced. Sufficient excess volume of air should be provided so that the necessary reduction in its volume will not cause a material change in its pressure thereby reducing to a minimum the energy dissipated in moving the liquid. In Figure 2, the character "X" designates approximately the liquid to be displaced and "Y" in the air receiver designates the corresponding rise in liquid and the displacement occurs in the direction of the arrows.

This construction forms a surge chamber for displaced fluid that acts as a shock absorber for the pressure resulting from the discharge of the

gun unit and minimizes the retarding action that the inertia of the incompressible fluid head would have on the velocity of the projectile.

The gun perforator is designed to fire one gun unit at a time and a sufficient interval occurs between firing that the liquid returns to its static pressure and the excess liquid flows out of the air receiver.

Under some conditions the casing is sufficiently yieldable to permit operation of the perforator, but when it is necessary to perforate several casings with cement between or a single casing with an excessive amount of cement thereabout, the casing is practically rigid and my device becomes particularly effective. It should be understood, however, that under all conditions regardless of a slight yieldability of the casing, my device increases the efficiency of the perforator.

My method of perforating well casing consists in lowering a gun type perforator into a well casing while maintaining the casing full of an incompressible liquid such as water or oil well mud in order to prevent "blow outs" or other difficulties caused by subterranean pressures, then firing the perforator while so submerged, and cushioning the pressure or absorbing the shock of said firing in proximity to the perforator. And further, where there are several gun units carried by a single body member, each or a predetermined group of gun units is fired selectively with sufficient pause to enable the liquid to regain its static condition.

I claim:

1. The combination with a gun type perforator adapted to be submerged in an incompressible medium; of an air receiver secured to the perforator, said receiver being closed at its upper end and open at its lower portion whereby said medium compresses air therein when submerged.

2. The combination with a gun type perforator adapted to be submerged in an incompressible medium; of an air receiver secured to the perforator, said receiver being closed at its upper end and open at its lower portion whereby said medium compresses air therein when submerged, the air receiver having sufficient capacity that the resulting volume of air therein when the perforator is submerged to its working depth is greater than the volume of said medium to be displaced upon discharge of said perforator.

3. In a well casing perforator, a submergible gun unit arranged to discharge a projectile laterally through a well casing, firing means therefor, and a yieldable means disposed in proximity to the gun unit and responsive to variation in the pressure of an incompressible medium in which the gun unit is submerged, to permit displacement of said medium upon the discharging of a projectile from said gun unit.

4. In a well casing perforator, a submergible gun unit arranged to discharge a projectile laterally through a well casing, firing means therefor, and a compressible fluid receiver disposed in proximity to the gun unit, said receiver also arranged to receive an incompressible fluid into which the gun unit is submerged, to permit displacement of said medium upon the discharging of a projectile from said gun unit.

5. In a well casing perforator, a body member, a plurality of gun units carried thereby, and arranged to discharge laterally, and an air receiver secured to said body member arranged to contain a quantity of air forming a cushion to permit displacement of an incompressible liquid when the gun units are discharged while submerged therein.

6. The combination with a device for perforating a well casing in place within a well hole which device comprises a body, an explosive charge within the body, said body having means for directing the force of the explosive against a well casing, and being of sufficient strength to resist the destructive force of said charge and means for detonating the charge when lowered down a liquid filled well hole; of a compressible means in proximity to said body to facilitate displacement of said liquid.

7. In a device for perforating a well casing in place in a well hole, the combination of an explosive charge, a body holding the explosive charge, said body being sufficiently strong to resist the force of the explosive charge, lateral ways for directing the force of the explosive towards the well casing, slugs normally closing the ways, means for detonating the explosive while in place within a liquid filled well hole, and a compressible instrumentality in proximity to said body to facilitate displacement of said liquid upon discharge of said slugs.

8. The combination with an explosive charge, means for submerging the charge in an incompressible medium, and an instrumentality for firing the charge while so submerged; of a variable volume fluid cushion means disposed in proximity to the explosive charge and arranged to accommodate a quantity of said medium displaced upon firing of said explosive charge.

9. The combination with an explosive charge, means for submerging the charge in an incompressible medium, and an instrumentality for firing the charge while so submerged; of a compressible fluid; and a container therefor adapted to be submerged with the explosive charge in proximity thereto; said container normally communicating with the incompressible medium whereby upon firing the explosive charge a quantity of said medium is displaced into a portion of the space occupied by the compressible fluid.

10. A gun type perforator adapted to be positioned in a well casing containing an incompressible medium, means for discharging the gun when submerged, and a shock absorber for the discharge pressure on the incompressible medium disposed in proximity to the perforator.

11. The combination with a gun type perforator adapted to be submerged in an incompressible fluid in a well casing, of a shock absorber for the pressure on the incompressible fluid resulting from the discharge of the gun when submerged positioned in proximity to the perforator.

12. The combination with a gun type perforator adapted to be submerged and fired in an incompressible fluid in a well casing, of a surge chamber for the incompressible fluid carried thereby.

13. A gun type perforator adapted to be submerged in a well casing containing an incompressible fluid and fired therein, and means for cushioning the fluid displacement resulting from the firing in proximity to the perforator.

14. In a well casing perforator, a gun unit submerged in a well casing containing an incompressible fluid, a projectile fired therefrom and passing through the fluid and casing, and means for cushioning the effect of the fluid displaced in the path of the projectile arranged in proximity to the perforator.

15. A gun type perforator adapted to be submerged in an incompressible fluid, means for fir-

ing the gun when submerged, and said perforator containing a confined compressible fluid in communication with the incompressible fluid for taking up the surge resulting from the discharge of the gun.

16. A method of perforating a well casing in place in a well hole and containing an incompressible medium which comprises submerging a gun type perforator therein, discharging a projectile therefrom by gun fire through the medium and casing, and absorbing the medium displaced by the passage of the projectile therethrough in proximity to the perforator.

17. A method of perforating a well casing containing an incompressible fluid which comprises submerging a gun type perforator containing a compressible fluid therein, discharging the gun while submerged to perforate the casing, and cushioning the pressure resulting from the discharge of the gun through compression of the fluid in the perforator.

18. A method of perforating a well casing in place in a well hole and containing an incompressible fluid which comprises submerging a gun type perforator therein, discharging the gun while submerged to perforate the casing, and cushioning the pressure resulting from the discharge of the gun in proximity to the perforator.

19. A method of perforating a well casing containing an incompressible fluid which comprises submerging a plurality of perforator guns therein, successively firing said guns to perforate the casing, cushioning the pressure resulting from each gun discharge on the incompressible fluid in proximity to the gun, and allowing a sufficient time interval to elapse after each firing for the incompressible fluid to become static.

WALTER T. WELLS.