July 22, 1941. F. I. ALEXANDER 2,250,056

CASING PERFORATING GUN

Filed Nov. 3, 1939

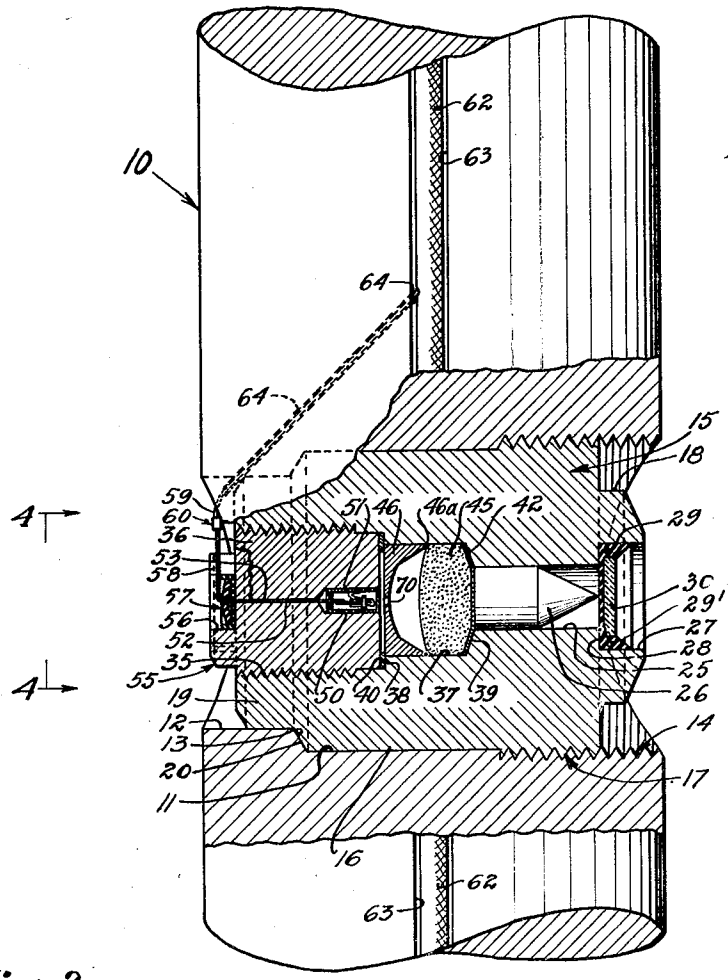
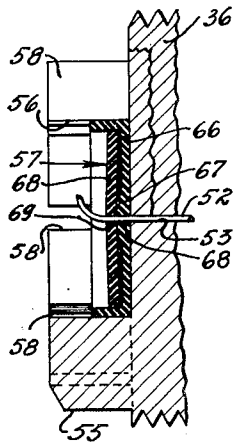


Fig. 1.

Fig. 2.



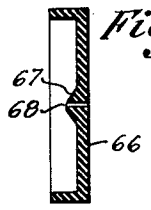


Fig. 3.

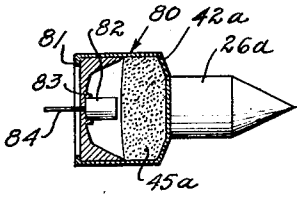


Fig. 5.

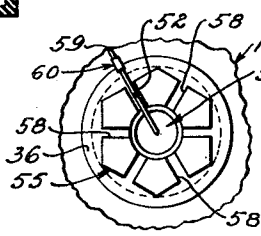


Fig. 4.

Inventor.
Ford I. Alexander.

Barhelew + Scantlebury

Attorneys.

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CASING PERFORATING GUN

Ford I. Alexander, Whittier, Calif.

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19 Claims. (Cl. 164—0.5)

This invention relates generally to perforating guns for well casing and more particularly to improvements in the shooting barrel and explosive chamber in casing perforating guns. The present invention may be considered as dealing in most of its aspects with improvements in that type of casing perforating gun in which there is provided a number of chamber blocks, usually of barrel form, mounted in lateral sockets or recesses in an elongated gun body, each such block or "barrel" containing or housing an explosion chamber and a shooting bore.

A general object of the invention may be stated to be the provision of an improved barrel of substantially increased strength and durability.

A further object of the invention is to provide a barrel construction having an explosion chamber so designed that increased firing power is developed.

A further object of the invention is to provide a form of barrel having a shooting bore of maximum length.

A still further object of the invention is the provision of a barrel in which access to the explosion chamber is readily gained and in which such access is not rendered more difficult by repeated firing.

A still further object of the invention is to provide improved means for sealing the explosion chamber against external liquid pressure.

It is also an object of the invention to provide a novel means for mounting the gun barrel within the elongated gun body, the mounting being such as to relieve the usual threaded connection between barrel and body of stress and strain during firing of the gun.

Further objects, features and advantages of my invention will appear in the course of the following detailed description of a present preferred embodiment thereof, reference for this purpose being had to the accompanying drawing in which:

Fig. 1 shows a portion of a gun body, with parts broken away to show the gun barrel of the present invention in longitudinal vertical section;

Fig. 2 is an enlarged detail taken from Fig. 1;

Fig. 3 is a detail of a sealing cup;

Fig. 4 is a detail taken as indicated by line 4—4 of Fig. 1; and

Fig. 5 is a modification showing a cartridge adapted for use within the barrel of the present invention.

A portion of the elongated gun body, preferably cylindrical in external form, is designated at 10. This gun body is formed in its side with a plurality (but one being illustrated in Fig. 1) of vertically spaced horizontal bores or sockets 11, each met by a reduced counterbore 12 extending inwardly from the opposite side of the gun body, the two bores being joined by an annular shoulder 13 which is here shown as beveled or conical. The forward end of bore 11 is screwthreaded, as indicated at 14.

The block or barrel, designated generally by numeral 15, has a preferably cylindrical body portion 16 of such a diameter as to slide freely within bore 11, the body being formed at its forward end with screwthreads 17 adapted to cooperate with threads 14, and with a hexagonal projection 18 by which it may be engaged with a wrench for the purpose of screwing it in or out of the gun body. The rearward end portion 19 of the barrel is reduced to such a diameter as will be received freely within reduced body bore 12, and the gun is formed with a beveled shoulder 20 adapted to seat against the aforementioned beveled body shoulder 13. Screwthreads 14 and 17 are designed to be sufficiently loose fitting that no substantial strain is placed thereon when the gun is fired, the reaction being received principally by body shoulder 13.

The barrel 15 is of comparatively large diameter, and is therefore relatively heavy. This is of advantage not only in providing a large amount of stock around the shooting bore, thereby reducing or eliminating the common tendency of the barrel to crack or split, but also reduces the kick-back of the barrel against the elongated gun body 10. The loose threaded connection between the barrel and the gun body serves to position the barrel against body shoulder 13, and while the majority of the reaction due to the explosion is absorbed by reason of the comparatively large mass of the barrel, what kick-back does occur is borne principally by shoulder 13. As stated, however, the larger share of the reaction due to the explosion is absorbed by reason of the large mass of the barrel, and the gun body may therefore be relatively light, serving principally simply as a carrier for the barrels.

The drawing shows a construction suitable for a gun designed for relatively small diameter casing. With larger casing, the diameter of body 10 and the length of barrel 15 can of course be increased, the increase in barrel length being preferably in the portion in which the shooting bore is contained, so as to provide a shooting bore of maximum possible length, it being of

course understood that the longer the shooting bore, the greater is the firing power of the gun. On the other hand, since, as pointed out above, the barrels 15 are of sufficient mass in themselves that no great kick-back is transmitted to the gun 10, there is no advantage in so increasing the diameter of the body 10, and the lengthened barrels 15 may in such cases be permitted to project from the gun body. In any such case it is of course desirable to equip the gun body with any suitable type of guides or guards which will prevent the projecting barrels from hanging up on the casing during vertical travel therein.

Barrel 15 is provided with an axial shooting bore 25, within which is positioned the usual projectile 26. This bore is preferably formed directly in the stock constituting the barrel 15, rather than in a small insert barrel, as in a common type of prior practice, this preferred construction being of such increased strength that barrel splitting is entirely eliminated. An enlarged counterbore 27 is drilled inwardly from the outer end of the barrel, forming an annular seating shoulder 28. A flexible cup 29, preferably of soft rubber, is seated on shoulder 28, its sides fitting snugly within counterbore 27, and a frangible disk 30 of a diameter somewhat larger than that of shooting bore 25 is pressed inside the cup and seated against the bottom thereof, the bottom being supported by shoulder 28.

The lip or side of the cup is tapered, as indicated at 29', so that the pressure of the external liquid will press the side walls of the cup into tight sealing engagement with the surface of counterbore 27. The pressure fluid also acts against disk 30, pressing the latter tightly against the bottom of the cup and thus pressing the cup into tight sealing engagement with seating shoulder 28. The higher the external liquid pressure, the tighter is the tapered edge or lip of the cup pressed against surface 27, and therefore the tighter is the liquid seal. It will be understood that the frangible disk 30, while of sufficient strength to withstand the external liquid pressure, is easily punctured by the projectile 28 when the gun is fired.

Extending inwardly into the rearward end of barrel 15, in coaxial relationship with shooting bore 25, is a screwthreaded socket 35 adapted to receive a screwthreaded breech plug 36, while extending inwardly from the inner end of socket 35 is an explosion chamber bore 37, of a diameter somewhat less than that of socket 35, yet greater than that of shooting bore 25, the inner end of bore 37 meeting bore 25. An annular seating shoulder 38 is formed at the juncture of socket 35 with explosion chamber bore 37, while a conical seating surface or shoulder 39 is formed at the juncture of explosion chamber bore 37 with shooting bore 25. External leakage pressure which might otherwise leak to the explosion chamber around plug 36 is sealed off by a sealing washer 40, preferably of lead, seated against shoulder 38 and tightly engaged by the inner end of breech plug 36. A conical sealing disk 42, complementary to conical seating surface 39, is seated on the latter, and is preferably attached to the rearward end of projectile 26, as by spot welding.

The powder charge is preferably in the form of a compressed powder pellet 45 placed inside chamber 37 immediately to the rear of disk 42. To the rear of this powder pellet 45 I preferably place a soft metal expansive cup 46, formed of brass, aluminum, or some similar soft metal, the cup being positioned with its depression side facing the powder charge and its base facing and held up to position by the inner end of breech plug 36, which, as illustrated, supports the washer 40 against the base of the cup. The side wall of the cup is preferably tapered to a sharp edge 46*a*, for a purpose which will appear later.

The inner end of breech plug 36 is formed with a socket or recess 50 for an electrically fired fuse 51, the fuse being provided with an electrical conductor 52 which extends outwardly through plug 36 via a central duct 53 leading from the bottom of recess 51 through the outer end of the plug. Fuse 51 may be of a type grounded to the plug 36 in which it is seated. This fuse is preferably of a "match-head" type, such as manufactured by the Atlas Powder Co., and projects a flame from its forward end when heated by passage of an electrical current. Such fuses are known and will require no detailed description herein.

The outer or rearward end of breech plug 36 is formed with a hexagonal projection 55 adapted for convenient engagement by a wrench, and this projection 55 has an annular recess 56 formed coaxially with duct 53, said recess being adapted to receive any suitable packing means for the fuse conductor, one preferred form of which is illustrated in the drawing at 57. Hexagonal projection 55 is provided with a number of notches 58 adapted to receive the fuse conductor 52. After the breech plug has been screwed home, the fuse conductor 52 is placed in the notch 58 closest to the extremity of an electrical conductor 59, the latter being arranged on the gun in any appropriate manner. Electrical connection is made between conductors 52 and 59, as at 60. It will be understood that the conductor 59 is part of a cable leading from the electrical control or firing system, not shown, and that any arrangement of such cable and its separate conductors on or within the gun body may be employed as desired. I here show a cable 62 positioned within a recess or groove 63 extending downwardly along the side of the gun body, the conductor 59 being led off via an angular passageway 64 to a point just above the breech plug 36, the connection between conductor 59 and fuse wire 52 being made as previously explained.

The preferred fuse wire sealing means illustrated at 57 (see Fig. 2) comprises a flexible cup 66, preferably of rubber, seated within recess 56 and formed with a central mound 67 having a central aperture 68 adapted to fit snugly about fuse wire 52. A disk 68 having a central aperture 69 adapted to pass a conductor 52 is seated inside cup 66, and compresses mound 67 tightly about wire 52, thereby forming a pressure-tight seal.

It will be seen that the cup member 46 is positioned between fuse 51 and powder charge 45. The base of this cup member is formed with a small central aperture 70, adapted to pass the fire from the fuse when the fuse is set off. Thus, when the conductor 59 is connected through a battery to a ground on the gun body, the fuse 51 is fired, the flame passing through aperture 70 and igniting powder charge 45. The small aperture 70 confines the flame to a small diameter jet, the flame thus being more concentrated and more forcefully directed than if the confining aperture 70 were not employed, with the result that

powder charge **45** is ignited with increased rapidity. The normal flame from a fuse of the type illustrated results in a comparatively slow burning of the powder charge; the jetted flame from the aperture **70**, on the other hand, heats the powder charge much more rapidly and results in a much more rapid explosion of the charge, thus building up very high explosive pressure within the explosion chamber before the projectile is ejected. It will be understood that if the powder burns relatively slowly, the projectile will be ejected from the shooting bore long before maximum pressure can be developed; on the other hand, by promoting substantially instantaneous burning of the powder charge, the greatest possible explosive pressure is developed, since under such conditions the pressure rises to its maximum before the projectile leaves the gun. The result is, of course, to impart to the projectile very greatly increased muzzle velocity.

As the explosive pressure is built up, the disk **42** is seated tightly, by this pressure, on the conical seat **39**, thus sealing against loss of pressure until the pressure is sufficient to rupture the disk **42**. The conical disk **42** pressed against seat **39** acts as a valve, sealing tightly against loss of pressure. These described provisions result in the explosive pressure being built up to substantially increased values before the disk **42** is ruptured and the projectile is discharged, with the result that much increased firing power is developed.

The explosion within chamber **37** results in expanding the tapered sides of cup **46**, thus pressing the sides of said cup into tight, pressure-sealing engagement with the walls of the explosion chamber, so that little back pressure escapes around the sides of said cup. The breech plug is sufficiently small in diameter that the total back force transmitted through cup **46** to the inner end of the breech plug when the gun is fired is not sufficient to place any undue strain on the breech plug threads. This is a feature of importance, since the avoidance of strain on the breech plug threads means that the threads will not become bound or deformed even after extensive service, and the plug may therefore always be easily and readily unscrewed. Attention is directed to the preferred use of powder charge in the form of a compressed powder pellet. Such a powder pellet occupies a much smaller space than a charge of loose powder, and the powder chamber may thus be of reduced size, which means increased explosive pressure when the charge is set off.

Fig. 5 shows a modification, in which the projectile, conical sealing disk, powder charge, expansive cup and fuse are made up as an integrated cartridge. In the illustrative form of Fig. 5, the sealing disk **42***a*, to which is attached projectile **26***a*, is formed as a part of a shell **80** encasing the powder charge **45***a* and expansive cup **46***a*, being crimped about the expansive cup as at **81**. The fuse **82** is seated within the cup, as at **83**, and has a fuse wire **84** extending through the base of the cup. The wire **84** is of course insulated from the cup, while the fuse is electrically grounded to the cup, and therefore, through shell **80**, to the barrel **15** and the gun body. This cartridge as thus described is placed within the barrel **15** of Fig. 1, the sealing washer **40** inserted, and the breech plug **36** screwed home. Of course, the fuse socket **50** in the end of the breech plug may in this case be eliminated.

The gun construction afforded by the present invention enables use of a barrel of relatively large size, in both diameter and length, for a gun body of a given diameter.

It will be understood the drawing and description are merely illustrative of one practical form of the invention, and that various changes in design, structure and arrangement may be made without departing from the spirit and scope of the invention or of the appended claims.

I claim:

1. In a barrel adapted to be mounted on a casing perforating gun body, an internal socket in the rearward end of said barrel, a shooting bore in said barrel alined with said socket and extending through the forward end of said barrel, and a breech plug mounted in said socket, there being an explosion chamber within said barrel between the inner end of said plug and the inner end of said shooting bore.

2. In a barrel receivable within a lateral recess in a casing perforating gun body, an internal screwthreaded socket in the rearward end of the barrel, a breech plug screwthreaded within said socket, an explosion chamber within said barrel forwardly of said breech plug, and a shooting bore in said barrel extending from said explosion chamber through the forward end of the barrel.

3. A barrel for a casing perforating gun, comprising an externally screwthreaded barrel body, a screwthread socket in the rearward end of said body, a reduced explosion chamber bore extending inwardly in the barrel body from said socket, there being an annular seating surface at the juncture of said socket and said explosion chamber bore, a sealing washer against said seating surface, a breech plug screwthreaded within said socket and engaging said sealing washer, and a shooting bore, of diameter less than that of the explosion chamber bore, extending from the inner end of said explosion chamber bore through the forward end of the barrel body.

4. A barrel for a casing perforating gun, comprising a barrel body having a screwthread socket in its rearward end, a breech plug screwthreaded within said socket, an explosion chamber bore extending inwardly in said body from said socket, a shooting bore extending from the inner end of said explosion chamber bore through the forward end of said barrel body, and an expansion cup disposed within the outer end portion of said explosion chamber bore, with its depression side facing toward the shooting bore, the space within said explosion chamber forwardly of said cup being adapted to contain an explosive charge, and the sides of said expansion cup being adapted to be pressed into sealing engagement with the explosion chamber bore when the charge within the explosion chamber is fired.

5. In a perforating gun, a body having an explosion chamber bore therein, a shooting bore extending from said explosion chamber, an expansion cup positioned within said explosion chamber bore, with its depression side facing toward the shooting bore, the space within said explosion chamber forwardly of said cup being adapted to contain an explosive charge, and the sides of said expansion cup being adapted to be pressed into sealing engagement with the explosion chamber bore when the charge within the explosion chamber is fired.

6. In a casing perforating gun, a body having a socket formed therein, a breech plug removably mounted in said socket, an explosion chamber

within said body extending inwardly of said breech plug, a shooting bore in said body extending from said explosion chamber, said shooting bore being of less cross-sectional area than the explosion chamber, and there being a conical seating surface formed at the juncture of said shooting bore with said explosion chamber, and a complementary conical frangible disk seated on said conical seating surface.

7. In a perforating gun, a body having a shooting bore therein, an enlarged counterbore at the forward end of said shooting bore, a flexible sealing cup seated within said counterbore, and a pressure holding disk seated within said cup.

8. In a casing perforating gun, a body having an explosion chamber, a shooting bore extending from one end of said explosion chamber, means for positioning a fuse adjacent said chamber, and a wall between the fuse carried by said positioning means and the firing chamber having a small fire-concentrating aperture opposite said fuse.

9. In a casing perforating gun, a body having a screwthread socket formed therein, an explosion chamber bore extending inwardly in said body from said socket, a shooting bore extending from the inner end of said explosion chamber bore, an expansion cup disposed within the outer end portion of said explosion chamber bore, with its depression side facing toward the shooting bore, the space within said explosion chamber forwardly of said cup being adapted to contain an explosive charge, a small aperture in the base of said cup, a breech plug screwthreaded within said socket, the inner end of said plug being adapted to support the base of said expansive cup when the charge within the explosion chamber is fired, and a fuse-receiving recess in the end of said breech plug opposite said aperture.

10. In a casing perforating gun, the combination of a gun body having a transverse socket extending entirely therethrough from one side to the other, a barrel mounted within said socket and extending substantially entirely through said gun body, a screwthread socket in the rearward end of the barrel, a breech plug screwthreaded within said socket, an explosion chamber within said barrel forwardly of said breech plug, and a shooting bore in said barrel extending from said explosion chamber through the forward end of the barrel.

11. In a casing perforating gun, the combination of an elongated gun body having a transverse socket extending therethrough from one side to the other, a barrel received within said socket and extending substantially entirely through said gun body, a rearwardly facing shoulder on said barrel and a cooperating shoulder within said socket adapted to be engaged by said barrel shoulder, a screwthread socket in the rearward end of the barrel, a breech plug screwthreaded within said socket, an explosion chamber within said barrel forwardly of said breech plug, and a shooting bore in said barrel extending from said explosion chamber through the forward end of the barrel.

12. In a casing perforating gun, the combination of an elongated gun body having a transverse socket extending therethrough from one side to the other, a barrel received within said socket, a rearwardly facing shoulder on said barrel and a cooperating shoulder within said socket adapted to be engaged by said barrel shoulder, coacting loose fitting screwthreads on said barrel and inside said socket, a screwthread socket in the rearward end of the barrel, a breech plug screwthreaded within said socket, an explosion chamber within said barrel forwardly of said breech plug, and a shooting bore in said barrel extending from said explosion chamber through the forward end of the barrel.

13. In a casing perforating gun, the combination of an elongated gun body having a transverse socket, a barrel received within said socket, a rearwardly facing shoulder on said barrel and a cooperating shoulder within said socket adapted to be engaged by said barrel shoulder, coacting loose fitting screwthreads on said barrel and inside said socket, a screwthread socket in the rearward end of the barrel, a breech plug screwthreaded within said socket, an explosion chamber within said barrel forwardly of said breech plug, and a shooting bore in said barrel extending from said explosion chamber through the forward end of the barrel.

14. In a barrel receivable within a lateral recess in a casing perforating gun body, an internal screwthreaded socket in the rearward end of the barrel, a breech plug screwthreaded within said socket, an explosion chamber within said barrel forwardly of said breech plug, and a shooting bore in said barrel, of lesser cross-sectional area than said explosion chamber, extending from said explosion chamber through the forward end of the barrel.

15. A relatively massive and thick-walled barrel for a casing perforating gun body, said barrel having an internal screwthreaded socket in its rearward end, a breech plug screwthreaded within said socket, there being an explosion chamber within said barrel forwardly of said breech plug socket, and a co-axial shooting bore in said barrel, of lesser cross-sectional area than said explosion chamber, extending from said explosion chamber through the forward end of the barrel.

16. In a casing perforating gun, the combination of a gun body having a transverse socket extending entirely therethrough from one side to the other, a barrel mounted within said socket and extending substantially entirely through said gun body, a screwthreaded-socket in the rearward end of the barrel, a breech plug screwthreaded within said socket, and being of sufficiently small diameter to be removable from the end of the barrel through the end portion of the transverse socket in the gun body while the barrel is mounted in the gun body, an explosion chamber within said barrel forwardly of said breech plug, and a shooting bore in said barrel extending from said explosion chamber through the forward end of the barrel.

17. In combination in a perforating gun, a shooting bore, an enlarged cartridge chamber at the breech end of said shooting bore, a shoulder between said bore and chamber, and a cartridge embodying a shear wall adapted to be positioned adjacent said shoulder and to overlap the breech end of the shooting bore all around, a cylindrical cartridge side wall extending rearwardly from said shear wall, and a closure disk closing the rearward end of said side wall, said cartridge being adapted to contain an explosive charge, and said shear wall being adapted to resist shearing over the area of said shooting bore until a relatively high explosive pressure has been built up inside the cartridge.

18. In combination in a perforating gun, a shooting bore, an enlarged cartridge chamber at the breech end of said shooting bore, a shoulder

between said bore and chamber, and a cartridge embodying a shear wall adapted to be positioned adjacent said shoulder and to overlap the breech end of the shooting bore all around, a cylindrical cartridge side wall integral with and extending rearwardly from said shear wall, and a closure disk closing the rearward end of said side wall, said cartridge being adapted to contain an explosive charge, and said shear wall being adapted to resist shearing over the area of said shooting bore until a relatively high explosive pressure has been built up inside the cartridge.

19. In combination in a perforating gun, a shooting bore, an enlarged cartridge chamber at the breech end of said shooting bore, a shoulder between said bore and chamber, and a cartridge embodying a shear wall adapted to be positioned adjacent said shoulder and to overlap the breech end of the shooting bore all around, a projectile attached to said shear wall at the center and adapted to be received in said shooting bore, a cylindrical cartridge side wall extending rearwardly from said shear wall, and a closure disk closing the rearward end of said side wall, said cartridge being adapted to contain an explosive charge, and said shear wall being adapted to resist shearing over the area of said shooting bore until a relatively high explosive pressure has been built up inside the cartridge.

FORD I. ALEXANDER.