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GUN PERFORATOR

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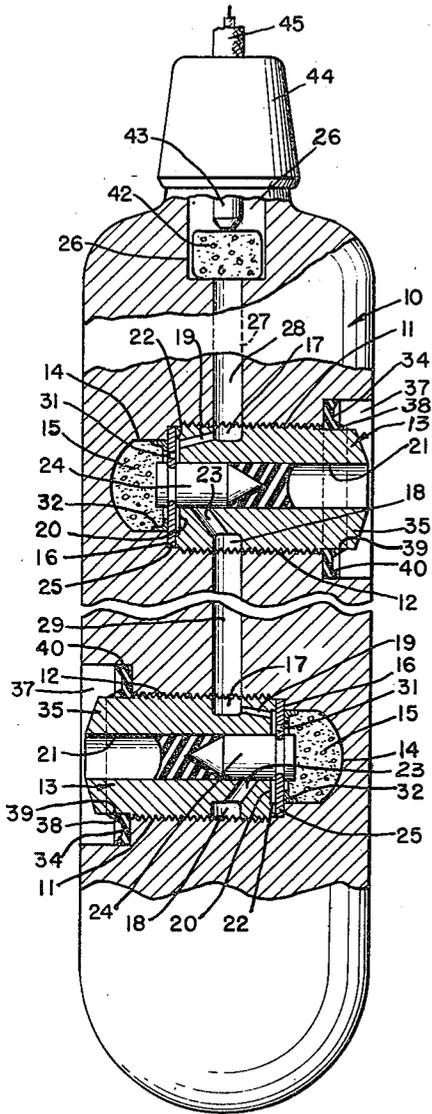


Fig. 1

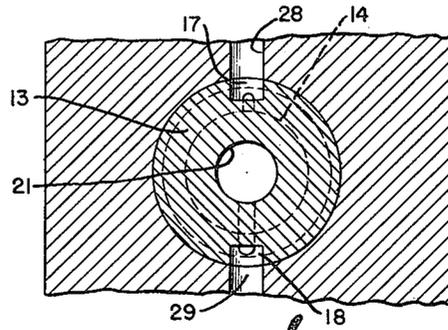


Fig. 3

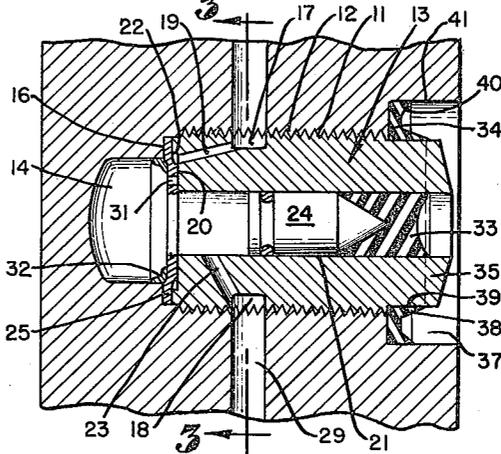


Fig. 2

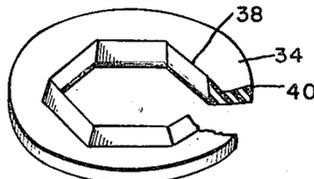


Fig. 4

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GUN PERFORATOR

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5 Claims. (Cl. 164—0.5)

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This invention relates to perforating guns for firing projectiles through the wall of a casing set in a well so that fluids may enter the casing from the adjacent formations.

It is an object of the invention to provide a perforating gun which is of simple and economical construction, and yet provides extremely high penetrating ability as the result of the efficient utilization of the driving force generated by the explosion of the powder charge.

It is an object of the invention to provide a perforating gun having means for restraining outward movement of the projectile until extremely heavy pressure in the powder chamber lying behind the projectile is built up, and having means for preventing escape of gases from the powder chamber until the projectile is discharged. By the use of this arrangement, all of the forces derived from the burning of the powder are applied against the rear end of the projectile, with no escape of gas or loss of effects thereof.

It is a further object of the invention to provide a perforating gun having a simple means for firing the powder charges, this simple firing means also resulting in simplification of the gun body.

A further object of the invention is to provide a perforating gun, wherein sequential firing of the powder charges, instead of simultaneous firing, is accomplished.

A further object of the invention is to provide a perforating gun having a body with a plurality of gun barrel recesses in which gun barrels are securable, there being powder chambers at the inner ends of the gun barrels, and ignition passages and ducts formed in the gun body and in the barrels in such a manner that the ignition effect resulting from the exposition of a priming charge accomplishes firing of the powder charges lying behind the projectiles.

It is a further object of the invention to provide a perforating gun of the character described in the preceding paragraph, wherein ignition passages are formed in the gun body, and the insertable barrels have therein ducts for carrying the ignition effect from the ignition passages in the gun body to the powder charge at the rear ends of the barrels, each gun barrel having therein an outlet ignition duct which connects the bore of the gun barrel with the ignition passage in the body leading to the next barrel of the gun, so that when a powder charge behind a projectile is exploded, so as to drive the projectile from the gun barrel, a portion of

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the combustion products resulting from the firing of the powder charges is directed through the outlet ignition duct to an ignition passage, these products of combustion forming an ignition effect which is carried to the powder charge of the subsequent powder chamber, thereby accomplishing a sequential firing of the projectiles from the gun.

It is a further object of the invention to provide a perforating gun of this character having simple means for forming a valve closure which will prevent reverse flow of gas through the inlet ignition duct of each barrel, thereby preventing loss of pressure from the associated powder chamber through the inlet ignition duct.

It is a further object of the invention to provide a perforating gun having intercommunicating ignition passages and/or ducts formed in the body and in insertable barrels, and means for sealing the outer ends of the barrels so that fluid will not enter the gun body around the exterior of the barrels or through the bores of the barrels.

It is a further object of the invention to provide a novel sealing means for use in a perforating gun of the general character described herein.

Further objects and advantages of the invention will be brought out in the following specification, wherein I have described a preferred embodiment of the invention for the purpose of making a full disclosure thereof without limiting the scope of the invention which is set forth in the appended claims.

Referring to the drawings, which are for illustrative purposes only,

Fig. 1 is a partly sectioned elevational view of a gun embodying the invention.

Fig. 2 is an enlarged fragmentary section showing a portion of the gun body, a gun barrel and a projectile moved outwardly in the gun barrel.

Fig. 3 is a fragmentary cross section taken on the line 3—3 of Fig. 2.

Fig. 4 is a perspective view of one of the external sealing members forming a part of the invention.

In Fig. 1 I show a gun body 10 of vertically elongate form and of such diameter that it may be lowered within a pipe or casing in a well, this gun body 10 having a plurality of gun barrel chambers 11 therein, these chambers being of circular cross section and having threads 12 so that externally threaded gun barrels 13 may be screwed into place and thereby secured in the chambers 11. The body 10 has therein chambers 14 to hold powder charges 15 adjacent

the inner ends of the barrels 13, these chambers 14 having diameters smaller than the diameters of the chambers 11 so that annular shoulders 16 are formed at the inner ends of the chambers 11.

As shown in Figs. 2 and 3, each barrel 13 has therein diametrically opposed depressions 17 and 18, the depression 17, for purpose of identification being referred to as the inlet depression and the depression 18 being referred to as the outlet depression. From the inlet depression 17, an ignition duct 19, as shown in Fig. 2, is extended to the rear end face of the barrel 13, the left hand or inner end of this duct 19 communicating with a shallow counterbore 20 around the inner end of the bore 21 of the barrel 13, this counterbore 20 forming a shallow channel 22 at the inner end of the barrel 13 as indicated in Fig. 1. From the bore 21 of the barrel 13, an outlet ignition passage 23, as indicated in Fig. 2, extends to the outlet depression 18.

Referring to Fig. 1, projectiles 24 are disposed in the inner ends of the barrel bores 21, the inner ends of these projectiles 24 extending into the powder chambers 15 and having thereon circular discs 25 which extend across the inner ends of the barrels 13 and are clamped against the shoulders 16 when the barrels 13 are screwed into place. The threads 12 of the chambers 11 and the threads of the barrels 13 are so cooperatively formed that when the barrels 13 are screwed tightly into place, the depressions 17 and 18 of the barrels 13 will lie on the axis of the body 10. From a recess 26 in the upper portion of the body 10, an opening or hole 27 is drilled so as to intersect the chambers 11 in the manner shown, this opening providing, when the barrels 13 are in place, a first ignition passage 28 in the gun body, which connects the recess or chamber 26 with the inlet depression 17 of the uppermost gun barrel 13 and an interconnecting ignition passage 29 connecting the outlet depression 18 of the uppermost gun barrel 13 with the inlet depression 17 of the succeeding gun barrel 13. It will be understood that although only two barrels 13 are shown in Fig. 1, any larger number of these barrels may be employed in the gun body, interconnected by ignition passages such as 29. Each of the discs 25 has therein a small ignition port 31 disposed in a position radially inwardly offset from the end of the inlet ignition duct 19. Although the ignition ports 31 are shown in a common plane with the ducts 19, it will be understood that this condition is not indispensable to the operation of the device. The discs 25 may be rotated up to 180° from the positions in which they are shown, but they will still be connected with the inner ends of the inlet ducts 19 through the shallow channels 22 formed by the shallow counterbores 20 in the inner ends of the barrels 13.

Further features of the invention lie in the provision of a sealing ring 32 of soft metal and of angle cross section as shown between each powder chamber 14 and positioned at the juncture of the side wall of the chamber 14 with the plate or disc 25. It will be understood that when a powder charge 15 is exploded, there is an extremely heavy pressure applied to the inner end of the barrel 13, resulting in a small movement of the barrel 13 away from the shoulder 16 through which some gas from the explosion of the powder charge 15 could escape along the face of the disc 25 and along the threads of the chamber 11 and barrel 13, were it not for the presence of the sealing ring 32. The gun barrels 13 are

externally sealed by novel sealing rings 34, shown in Fig. 2.

So that a wrench may be applied to the gun barrels 13 for the purpose of rotating the same, the outer end portions 35 of these barrels 13 are given a hexagonal form. Also, the outer ends of the chamber 11 and the outer end portions 35 of the barrels 13 are cooperatively formed so as to provide annular recesses or channels 37 to receive the sealing rings 34. As shown in Fig. 4, each sealing ring 34 comprises an annular body of a material which is referred to as rubbery for the reason that it has the general characteristics of rubber. The ring 34 may be made of a rubber compound or one of the well known synthetics. It is provided around the inner portion thereof with a hexagonal lip 38 adapted to engage the hexagonal circumferential face 39 of the end portion 35 of the barrel 13. The ring 34 also has an outer lip 40 to engage the cylindrical wall 41 of the channel 37 as shown in Fig. 2. Rubber plugs 33 seal the outer ends of the gun barrels 13 against external fluids and pressures.

Again referring to Fig. 1, the operation of the device is as follows: A priming charge 42 is disposed at the upper end of the ignition passage 28. This priming charge comprises a suitable powder and may be ignited by any of the means known to the art, so as to provide an ignition effect which will be transmitted downwardly through the passage 28. By ignition effect is meant the heavy gas pressure and/or flame produced by the burning of the priming charge 42, which pressure and/or flame passes downwardly through the ignition passage 28 to the inlet depression 17 at the lower end of the passage 28, then through the adjacent duct 19, through the shallow channel 22 and the ignition port 31 to the uppermost powder chamber 14 to set off the powder charge 15 therein. Accordingly, the means for firing the priming charge 42 may consist of an electrically ignited fuse or cap 43 held in the upper portion of the chamber 26 by an adaptor 44. An electrical cable 45 of the type used in oil wells is shown extending upwardly from the gun body 10. It will be understood that this cable 45 is connected to the fuse or cap 43 so that electric current may be delivered thereto at the proper time to accomplish firing of the gun.

As the gas pressure builds up in the uppermost chamber 14 as the result of the firing charge 15 therein, the portion of the disc 25 which lies over the counterbore 20 is forced into the counterbore 20 so as to cover and seal the inner end of the adjacent duct 19, thereby preventing reverse flow through the duct 19, and preventing escape of gas to the exterior from the uppermost chamber 14. Then, when the pressure in the uppermost chamber 14 has built up to such value as to shear the disc 25 around the projectile 24, this shearing of the disc will occur and the projectile 24 will be propelled outwardly through the bore 21 at extremely high velocity, passing, in its outward travel, through the position in which it is shown in Fig. 2. The manner in which the disc 25 is deflected into the counterbore 20 so as to form a valve closure for the inner end of the duct 19, is clearly shown in Fig. 2.

When the projectile 24 has moved outwardly to a position such as shown in Fig. 2, beyond the upper end of the port 23, a portion of the pressure and/or flame from the firing of the powder charge in the chamber 14 will pass downwardly through the feeder connecting ignition passage

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29, and this ignition effect will pass through the ignition duct 19 of the next or downwardly consecutive barrel 13, as in Fig. 1, and the powder charge 15 associated therewith will be ignited. If a large number of recesses and barrel assemblies are employed, the action just described will be repeated, and the ignition effect will be consecutively transmitted downwardly from one powder charge to the next until the lowermost powder charge in the gun is fired. The device gives extremely high penetration of the projectiles, even though a relatively small charge of powder is employed, and the invention is especially suited to use in guns of small diameter, since it makes possible reduction in the size of powder charge chambers and still maintains effective penetration.

I claim as my invention:

1. In a perforating gun having means for producing an ignition effect such as flame and/or pressure, the combination of: a gun body having a plurality of gun barrel chambers, powder chambers communicating with the inner ends of said gun barrel chambers to receive powder charges, and ignition passages communicating with sides of said gun barrel chambers; gun barrels securable respectively in said gun barrel chambers, each having a bore extending therethrough to receive a projectile, a surface depression communicating with one of said ignition passages and ignition ducts connecting said depression with the inner ends of said barrels, there being shallow channels in the inner end faces of the barrels communicating with said ignition ducts; projectiles disposed in the inner ends of said bores; restraining discs extending from said projectiles across the inner ends of said barrels and covering said channels, said discs having ports offset from the inner ends of said ignition ducts through which ignition effect may pass from said ignition ducts to the powder charges in said powder chambers, portions of said discs forming valve closures for the inner ends of said ignition ducts; and means for sealing the outer ends of said barrels against entry of fluid into said gun barrel chambers and said bores of said barrels.

2. In a perforating gun having means for producing an ignition effect such as flame and/or pressure, the combination of: a gun body having a plurality of gun barrel chambers, powder chambers communicating with the inner ends of said gun barrel chambers to receive powder charges, and ignition passages communicating with sides of said gun barrel chambers; gun barrels securable respectively in said gun barrel chambers, each having a bore extending therethrough to receive a projectile, a surface depression communicating with one of said ignition passages and ignition ducts connecting said depression with the inner ends of said barrels, there being shallow channels in the inner end faces of the barrels communicating with said ignition ducts; projectiles disposed in the inner ends of said bores; and restraining discs extending from said projectiles across the inner ends of said barrels and covering said channels, said discs having ports offset from the inner ends of said ignition ducts through which ignition effect may pass from said ignition ducts to the powder charges in said powder chambers, portions of said discs forming valve closures for the inner ends of said ignition ducts.

3. In a perforating gun having means for producing an ignition effect such as flame and/or pressure, the combination of: a gun body hav-

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ing a plurality of gun barrel chambers, powder chambers communicating with the inner ends of said gun barrel chambers to receive powder charges, and ignition passages communicating with sides of said gun barrel chambers; gun barrels securable respectively in said gun barrel chambers, each having a bore extending therethrough to receive a projectile, a surface depression communicating with one of said ignition passages and ignition ducts connecting said depression with the inner ends of said barrels; projectiles disposed in the inner ends of said bores; and restraining discs extending from said projectiles across the inner ends of said barrels, said discs having ports offset from the inner ends of said ignition ducts through which ignition effect may pass from said ignition ducts to the powder charges in said powder chambers, portions of said discs forming valve closures for the inner ends of said ignition ducts.

4. In a projectile and holding means for a perforating gun having means for producing an ignition effect such as flame and/or pressure, a gun body having a gun barrel chamber, a powder chamber communicating with the inner end of said gun barrel chamber to receive a powder charge, and an ignition passage receiving said ignition effect and communicating with a side of said gun barrel chamber: a gun barrel adapted to be secured in said gun barrel chamber having a bore extending therethrough to receive a projectile and an ignition duct connecting said ignition passage with the inner end of said barrel; a projectile disposed in the inner end of said bore; and a restraining disc extending from said projectile across the inner end of said barrel, said disc having a port through which said ignition effect may pass from said ignition duct to the powder charge in said powder chamber.

5. In a projectile and holding means for a perforating gun having means for producing an ignition effect such as flame and/or pressure, a gun body having a gun barrel chamber, a powder chamber communicating with the inner end of said gun barrel chamber to receive a powder charge, an ignition passage receiving said ignition effect and communicating with a side of said gun barrel chamber, and a gun barrel adapted to be secured in said gun barrel chamber having a bore extending therethrough to receive a projectile and an ignition duct connecting said ignition passage with the inner end of said barrel: a projectile to fit into the inner end of said bore; and a restraining disc extending from said projectile across the inner end of said barrel, said disc having a port through which said ignition effect may pass from said ignition duct to the powder charge in said powder chamber.

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