Feb. 22, 1949. A. L. SMITH 2,462,784

WELL PERFORATING GUN

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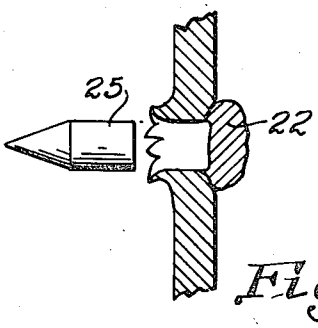


Fig.3.

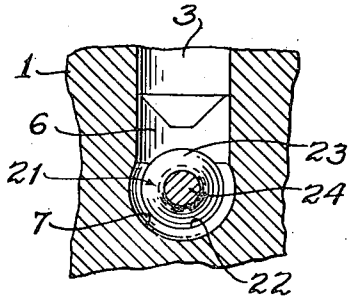


Fig.2.

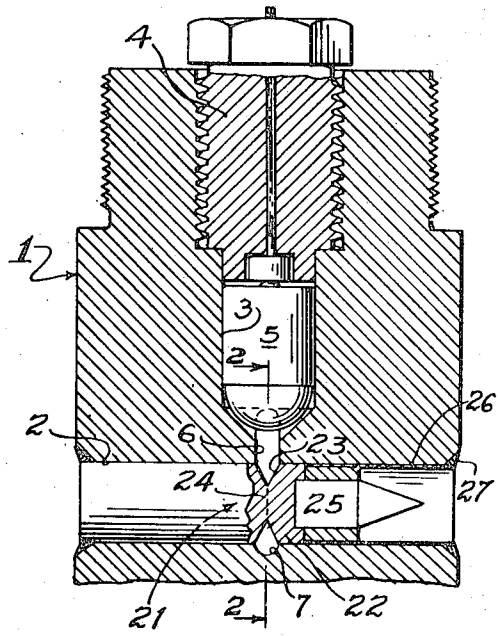


Fig.1.

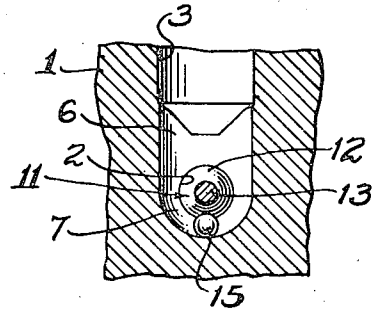


Fig.5.

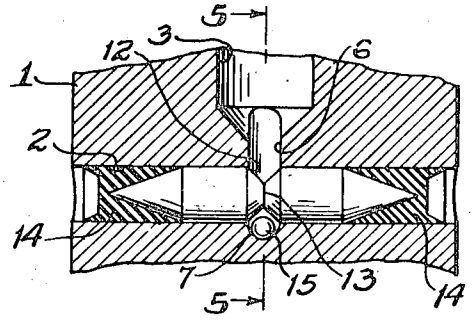


Fig.4.

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WELL PERFORATING GUN

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My invention relates to gun perforators; that is, to devices designed to be lowered into well casing for the purpose of firing bullets there through to form openings for the entrance of fluids.

An object of my invention is to provide a gun perforator wherein a time delay is introduced between ignition of the explosive charge and movement of the bullet in order to increase the effective pressure against the bullet and thereby increase its acceleration to compensate for the short length of gun bore, necessitated by the restricted diameter of the casing in which a gun perforator is inserted.

Another object is to provide a gun perforator wherein a pair of bullets are initially linked together by a fracturable or disjointable means designed to give way under a predetermined strain, and the explosive pressure from a single charge fires two bullets simultaneously in opposite directions.

Another object is to provide a gun perforator which utilizes a novel dual bullet having a casing piercing element and a burr flattening element, and wherein the casing flattening elements of a pair of dual bullets are joined by a fracturable or disjointable means and are acted upon by a single explosive charge.

A further object is to provide a gun perforator wherein the gun bore is materially larger than the casing piercing elements of the bullets, the casing flattening elements forming spacers to center the bullets in the gun bores and by reason of their larger area and added mass increase the effective pressure area and total mass of the bullets thereby increasing their penetrating power.

A still further object is to provide a gun perforator which incorporates a novel means for sealing against the entrance of water through the gun bore.

The invention also comprises novel details of construction and novel combinations and arrangements of parts, which will more fully appear in the course of the following description. However, the drawings merely show and the following description merely describes one embodiment of the present invention, which is given by way of illustration or example only.

In the drawings, like reference characters designate similar parts in the several views.

Figure 1 is a fragmentary longitudinal sectional view of a gun perforator embodying my invention.

Figures 2 is a fragmentary sectional view taken through 2—2 of Fig. 1.

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Figure 3 is a fragmentary sectional view of a well casing showing the manner in which the burr flattening portion of the bullets functions.

Figure 4 is a fragmentary longitudinal sectional view similar to Fig. 1 showing a modified form of my gun perforator.

Figure 5 is a fragmentary sectional view thereof taken through 5—5 of Fig. 4.

The present invention is directed to the construction of the gun unit per se of a gun perforator, that is to the arrangement and relationship of the explosive cartridge chamber, gun bore and associated elements. It is contemplated that the gun unit herein disclosed be joined in any conventional manner to others to form a complete gun perforator and that the several gun units be fired in any conventional manner such as electrically or by reason of the interconnection of the powder chambers such as disclosed in the following patents.

Patent No. 2,048,451, issued July 21, 1936, and 2,154,859, issued April 18, 1939.

A gun body 1 is provided with transverse gun bore 2 extending entirely through the body and forming in effect two alined diametrically oppositely directed gun bores. At one side of the dual gun bore 2 the gun body is provided with a socket the inner end of which forms an explosive chamber 3 and the outer end of which is screw threaded to receive a plug 4. The explosive chamber receives an explosive cartridge 5 which may be electrically fired by a conductor extending through the plug or ignited by other conventional means.

The explosive chamber 3 communicates with the dual gun bore 2 at its mid portion by a port 6. The port is preferably in the form of a slot having its wider axis disposed transversely to the gun bore and its narrower axis in the direction of the gun bore so as to occupy a minimum part of its length. In addition, the gun bore is provided with an annular channel 7 in registry with the port 6.

The construction shown in Figs. 1 and 4 are identical except that the dual gun bore in Fig. 1 is shown larger in diameter than the gun bore of Fig. 4, and different types of bullets, to be described hereinafter, are shown therein. In order to provide holes of different diameters in the well casing, gun perforators are provided with holes of different diameters, ranging from a quarter of an inch to three quarters of an inch in diameter. As the bullet diameter is decreased its mass and effective pressure area is decreased

decreasing proportionally the penetrating power of the bullet.

If the desired size of perforation is large enough, bullets such as shown in Fig. 4 may be used. The bullet 11 here illustrated is provided at its mid portion with an annular groove 12 leaving a neck 13 of predetemined area and designed to give way when a predetermined strain is applied. The two outer ends of the bullet are pointed, and upon breaking of the neck 13 two bullets are formed which discharge in opposite directions.

The groove 12 is positioned in registry with the channel 7 and port 6 so that the walls of the groove form pressure areas responsive to explosive pressures generated in the explosive chamber.

The ends of the bullet are covered by plugs 14, preferably formed of rubber which seal against well fluids. The plugs 14 provide friction to hold the bullet centered in the gun bore under normal conditions, but to insure against accidental displacement of the bullet, a small ball 15 may be dropped through the port 6 and into the groove 7 to form a key.

The purpose of the neck 13 is, of course, to introduce a time delay between ignition of the explosive charge and movement of the bullet in the gun bore. Several factors may be utilized jointly to obtain maximum efficiency for a given diameter of bullet and length of gun bore. The tensile strength of the neck 13 may be controlled by selection of the material forming the bullet as well as variation in the heat treatment of the bullet. In addition, the relative areas of the neck 13 and the effective pressure areas of the groove 12 may be varied; for it should be noted that as the area of the neck is increased, the effective pressure area of the groove is decreased, both tending to increase the explosive pressure required to split the bullet.

Also, it should be noted that the bullets may be made separately and joined together in any suitable manner, as by welding, brasing, soldering, or threaded connection; and further, that the groove and neck may take various forms. The requirement being in any case the provision of a weakened connection between the two halves of the bullet and pressure areas responsive to pressure applied through the port 6 to exert a tensional strain on such weakened portion.

Reference is now directed to Figure 1 and particularly the bullet construction shown therein. The construction here shown is particularly designed to form holes of relatively small diameter in the well casing and to eliminate the burr otherwise formed on the interior of the casing.

The bullet designated generally by 21 comprises a base member 22 having an annular groove 23 which forms a neck 24 of predetermined area. The base member is positioned in the center of the gun bore with the groove in registry with the channel 7. The outer ends of the base member 22 have slight recesses which receive the heel ends of casing piercing members 25. The piercing members 25 are pointed at their outer ends.

Extending in either direction from the base member and lining the gun bore are thin shells 26 which may be integral with the base member, or welded, soldered or otherwise sealed thereto. The shells 26 extended to the muzzle ends of the gun bore and are soldered or otherwise sealed thereto as indicated by 27. Spacers 28 of soft material such as wood, fiber, plastic, aluminum, lead, and the like materials may be placed around

the piercing members 25 and within the shells 26 to aid in centering the piercing members.

The operation of the bullet shown in Fig. 1 is essentially the same as that shown in Fig. 4; with certain additional features, as follows:

1. The effective area of the bullet is the cross section of the base member 22 in place of the lesser cross section of the piercing member 25, thereby reducing proportionally the required explosive pressure.

2. The base member increases the effective mass of the piercing member 25.

3. The base member moves as one with the piercing member striking the casing around the hole made by the piercing member to flatten the burr formed by the piercing member.

As is the case with the first dscribed bullet 11, the time delay between ignition of the explosive cartridge and discharge of bullet 22 is controlled by the relative areas of the groove and neck.

The mass of the base member 22 is so proportioned that its area of contact with the casing is sufficiently large that it does not penetrate the casing, but instead falls down the interior of the well casing. Furthermore, the base member is of relatively soft material as compared with the bullet and therefore tends to spread out or flatten against the casing and increase its area of contact.

While I have illustrated and described what I now regard as the preferred embodiment of my invention, the construction is, of course, subject to modifications without departing from the spirit and scope of my invention. I, therefore, do not wish to restrict myself to the particular form of construction illustrated and described, but desire to avail myself of all modifications that may fall within the scope of the appended claims.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. In a perforating gun of the character described, the combination of: a gun body having a plurality of gun bores to receive projectiles therein, and means for applying a gas pressure against the inner ends of said projectiles; projectiles in said gun bores; and restraining means at the inner ends of said projectiles operative when the gas pressure against the inner ends of said projectiles has built up to simultaneously release said projectiles so that said gas pressure may then discharge the same at high velocity from said gun bores; destructable liners extending from said projectiles along the walls of said gun bores to the extremities thereof, said projectiles being formed to engage and destroy said liners when the guns are fired; and means sealing the extremities of said liners to the extremities of said bores to exclude fluids in which the gun body may be immersed.

2. In a perforating gun of the character described, the combination of: a gun body having a bore extending through from side to side thereof and a firing charge chamber communicating with said bore between the ends thereof; means for igniting a charge in said firing charge chamber; and a double projectile in said bore comprising a member having a recess intermediate the ends thereof communicating with said firing charge chamber; a destructable liner extending from said member along the walls of said gun bore to the extremities thereof, said member being formed to engage and destroy said liners when the gun is fired; and means sealing the extremi-

ties of said liners to the extremities of said gun bore.

3. In a perforating gun of the character described, the combination of: a gun body having a bore extending through from side to side thereof and a firing charge chamber communicating with said bore between the ends thereof; means for igniting a charge in said firing charge chamber; and a double projectile in said bore comprising a member having a recess intermediate the ends thereof communicating with said firing charge chamber; a casing piercing element carried at each end of said member, said elements being materially smaller than said gun bore, and spacing means for holding said elements in centered relation in said gun bore.

4. In a perforating gun of the character described, the combination of: a gun body having a bore extending through from side to side thereof and a firing charge chamber communicating with said bore between the ends thereof; means for igniting a charge in said firing charge chamber; a double projectile in said bore having a recess therein intermediate the ends thereof communicating with said firing charge chamber; and means engaging said recess to position said projectile in said bore, said double projectile in said bore, comprising a burr flattening means; casing piercing members carried by said burr flattening means, said members being materially smaller in diameter than said burr flattening means, whereby upon discharge of said projectile said burr flattening means engages the margins of the openings made in a surrounding casing made by said casing piercing means to flatten the burrs formed in course of penetrating the casing.

5. A casing perforating gun comprising: a gun body having a transverse bore, and an explosive chamber communicating with the mid-portion thereof; an explosive cartridge for said chamber, and a bullet having a central portion filling said bore and including a reduced mid-section to form pressure areas exposed to and responsive to explosive pressures in said chamber to rupture said central portion at its mid-section; linings extending from said central portion and sealed at their extremities to the marginal extremities of said transverse bore, said central portion being formed to engage and destroy said lining when the gun is fired, separable casing piercing elements carried by said central portion and adapted to be driven thereby through a surrounding casing.

6. A casing perforating gun comprising: a gun body having a bore; a bullet member filling said bore and having a pressure area adapted to be exposed to a propulsive gas pressure; a separable casing-piercing element associated with said bullet member and adapted to be driven through a surrounding casing.

7. A casing perforating gun comprising: a gun body having a bore; a bullet member filling said bore and having a pressure area adapted to be exposed to a propulsive gas pressure; a separable casing-piercing element associated with said bullet member, said piercing element being of smaller diameter than said bullet member and adapted to be driven by said bullet member through a surrounding casing.

8. A casing perforating gun comprising: a gun body having a bore; an explosion chamber associated with said bore; a bullet member filling said bore and having a pressure area exposed to said chamber; a recess in the forward end of said bullet member; a separable casing-piercing element extending from said bullet member recess and adapted to be driven by said bullet member through a surrounding casing.

9. A casing perforating gun comprising: a gun body having a bore; an explosion chamber associated with said bore; a bullet member filling said bore and having a pressure area exposed to said chamber; a separable casing-piercing element associated with said bullet member, said piercing element being of smaller diameter than said bullet member and adapted to be driven by said bullet member through a surrounding casing; and a slidable guide spacer in said bore around said piercing element.

10. A casing perforating gun comprising: a gun body having a bore; an explosion chamber associated with said bore; a bullet member filling said bore and having a pressure area exposed to said chamber; a separable casing-piercing element associated with said bullet member, and adapted to be driven by said bullet member through a surrounding casing; and a thin destructable liner sleeve in said bore and making sealing engagement at one end with the muzzle portion of said bore and at the other end with said bullet member, said bullet member being adapted to engage and destroy said liner sleeve when said gun is fired.

11. A casing perforating gun comprising: a gun body having a bore; an explosion chamber associated with said bore; a bullet member filling said bore and having an intermediate section of reduced cross-sectional area forming opposite pressure areas exposed to said chamber; a separable, casing-piercing element carried at one end of said bullet member, said piercing element being of smaller diameter than said bullet member and adapted to be driven by a portion of said bullet member through a surrounding casing.

12. A casing perforating gun comprising: a gun body member having a bore; an explosion chamber associated with said bore; a double bullet member filling said bore and having an intermediate section of reduced cross-sectional area forming opposite pressure areas exposed to said chamber; separable, casing-piercing elements each carried at each end of said double bullet member, said piercing elements being of smaller diameter than said bullet member and each adapted to be driven by portions of said bullet member through a surrounding casing.

13. A casing perforating gun comprising: a gun body having a bore; a member closing an inner portion of said bore and having a pressure area adapted to be exposed to a propulsive gas pressure; a thin, destructable liner sleeve in said bore and making sealing engagement at one end with the muzzle portion of said bore and at the other with said member, said member being arranged to destroy said liner sleeve when said gun is fired.

14. A casing perforating gun comprising: a gun body having a bore; an explosion chamber associated with said bore; a member having a pressure area exposed to said chamber; a separable casing-piercing element associated with said member, said piercing element being of smaller diameter than said member and adapted to be driven by a portion of said member through a surrounding casing; and an annular spacer member slidable in said bore and positioned around said piercing element.

15. A casing perforating gun comprising: a gun body having a bore; an explosion chamber associated with said bore; a member having a pres-

sure area exposed to said chamber; a separable casing-piercing element associated with said member, said piercing element being of smaller diameter than said bore and adapted to be driven by a portion of said member through a surrounding casing; and an annular member slidable in said bore and positioned around said piercing element.

16. A casing perforating gun comprising: a gun body having a bore; an explosion chamber associated with said bore; a casing-piercing element having a rear area adapted to receive propulsive force from said chamber, said piercing element being of smaller diameter than said bore and adapted to be driven from said bore by said force from said chamber and through a surrounding casing; and an annular member slidable in said bore and positioned around a portion of said

piercing element and adapted to be driven from said bore together with said piercing element.

ARTHUR L. SMITH.

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