Aug. 11, 1942. A. L. SMITH 2,292,670

WELL PERFORATING GUN

Filed Nov. 17, 1941

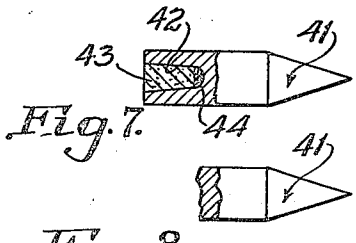


Fig. 7.

Fig. 8.

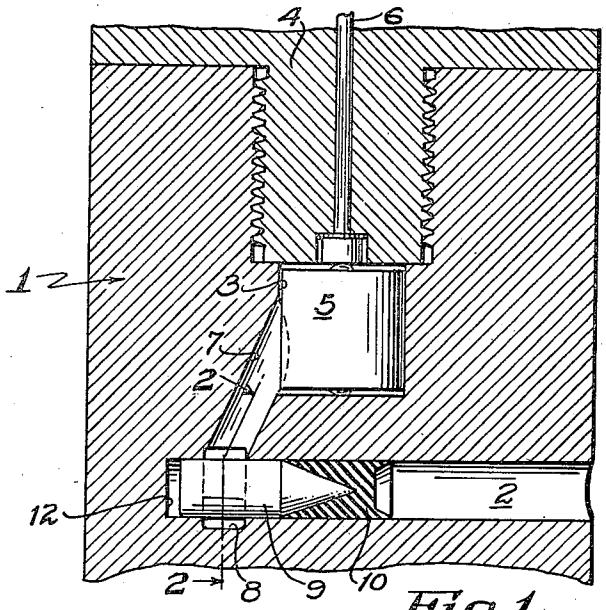


Fig. 1.

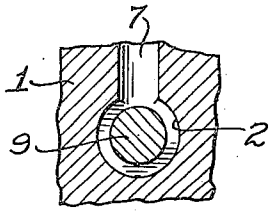


Fig. 2.

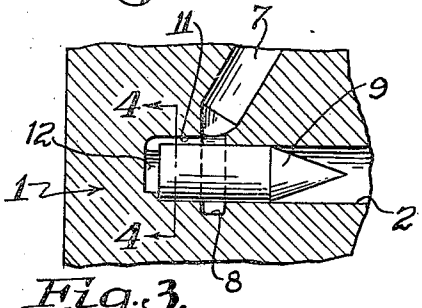


Fig. 3.

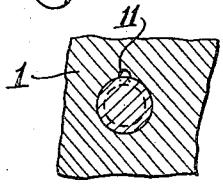


Fig. 4.

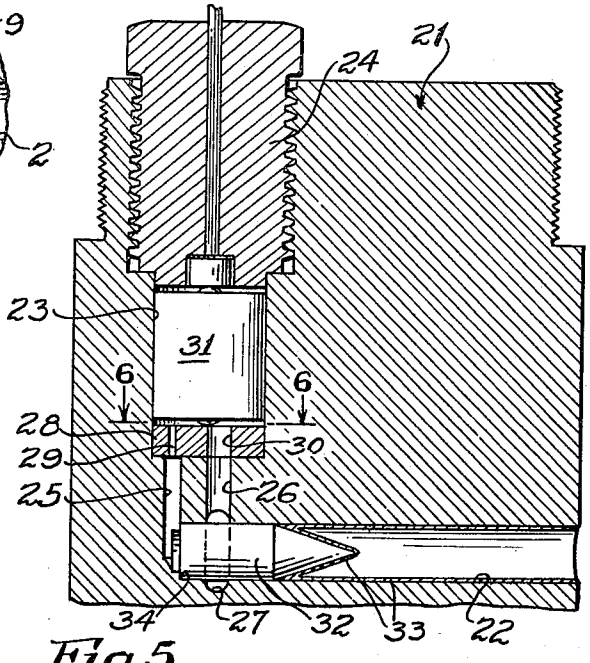


Fig. 5.

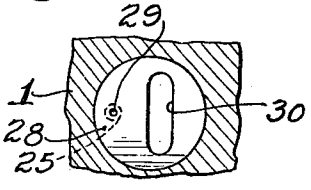


Fig. 6.

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UNITED STATES PATENT OFFICE

2,292,670

WELL PERFORATING GUN

Arthur L. Smith, Torrance, Calif.

Application November 17, 1941, Serial No. 419,461

17 Claims. (Cl. 164—0.5)

My invention relates to well perforating guns; that is, to guns adapted to be lowered into well casing for the purpose of penetrating the casing with bullets and permitting the entrance of well fluids.

An object of my invention is to provide a gun perforator which, in spite of its necessarily small diameter and restricted length of gun bore in order to fit within well casing, imparts a high velocity to the bullet sufficient to penetrate the casing with reserve energy to pass well into the formation through any surrounding cement.

A further object is to provide a gun perforator which is particularly designed to be used in casing or tubing of small diameter such as two and one-half or three inch tubing, but is equally applicable to larger casing.

A further object is to provide a gun perforator in which a time delay is interposed between ignition of the powder cartridge and the application of the full combustion pressure on the bullet so that the combustion pressure may build up to a predetermined high value by the time the full powder pressure is applied so that a tremendous acceleration is given to the bullet which compensates for the necessarily short length of the gun bore.

A still further object is to provide a gun perforator in which high acceleration is obtained without the use of shear discs or shear pins or other rupturable devices, but instead, the bullet itself serves as a valve to limit application of the initial combustion pressures until the required pressure is generated, whereupon the entire pressure is applied.

A still further object is to provide a novel bullet for gun perforators in which, after being fired, a portion of the bullet itself is disintegrated.

A still further object is to provide a novel means of sealing a bullet in the bore of a gun perforator from contact with liquids in which the gun perforator may be immersed.

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 drawing merely shows and the following description merely describes one embodiment of the present invention, which is given by way of illustration or example only.

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

Fig. 1 is a fragmentary longitudinal sectional view of a well casing perforator embodying one form of my invention.

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

Fig. 3 is a fragmentary longitudinal sectional view, similar to Fig. 1, of a modified form of my well casing perforator showing the bullet and adjacent portions of the gun body only.

Fig. 4 is a sectional view thereof taken through 4—4 of Fig. 3.

Fig. 5 is a fragmentary longitudinal sectional view of a further modified form of my well casing perforator.

Fig. 6 is a fragmentary sectional view thereof taken through 6—6 of Fig. 5.

Fig. 7 is a longitudinal sectional view of a bullet particularly adapted to my well casing perforator.

Fig. 8 is a similar view thereof as it appears after being fired.

My invention is directed particularly to the relative arrangement of gun bore, bullet and cartridge bore, to form a gun unit which may be incorporated in any conventional manner with other gun units to form a multiple unit well casing perforator capable of being fired electrically or by other conventional means. For simplicity of illustration, however, only a single unit is shown.

Reference is first directed to Fig. 1. A body member 1 is provided in which is formed a gun bore 2. At one side of and spaced from the gun bore a cartridge chamber 3 is formed in the body member. The cartridge chamber is threaded at its outer portion to receive a plug 4.

The cartridge chamber receives a conventional cartridge 5, which may be electrically responsive. In this event, the plug 4 may carry an insulated conductor 6 having a contact head engageable with one end of the cartridge, the other end of the cartridge being grounded.

The gun bore 2 is connected with the cartridge chamber 3 by a passage or port 7. At its intersection with the passage 7, the gun bore is provided with an annular channel 8. The channel or enlargement 8 is located a short distance forwardly of the inner or closed end of the gun bore.

A bullet 9 fits the gun bore and is initially positioned so that it bridges the channel 8 and, in effect, forms a piston valve closing communication between the passage 7 and the gun bore.

A plug 10, formed of rubber, fits over the pointed nose of the bullet and excludes well fluids,

well as retaining the bullet in its inner posi-
n.

Upon ignition of the cartridge the pressure rises
an ever increasing rate until a maximum pres-
re is obtained. That is, the pressure rises com-
ratively slowly at first, then faster as the com-
stion continues. Although this takes place in
matter of micro-seconds, if the pressure is
plied fully to the bullet from the first, it is
ssible for the bullet to move an appreciable
stance along the gun bore before the desired
gh pressure is applied. This results in a loss
efficiency; that is, it shortens the effective
ngth of gun bore, and the desired high muzzle
locity is not obtained.

If, on the other hand, the bullet can be re-
rained momentarily at or near the inner end of
e gun bore, the full effort of the combustion
essure may be utilized. Previously, this has
en done by rupturable shear discs or shear
ns which initially restrain the bullet.

With my invention, this beneficial result is at-
ined by other means, as follows:

Upon ignition of the cartridge, the bullet acts
; a valve, but the pressure leaks around the
llet to the back end. The rate at which the
essure builds up behind the bullet is slower
an the rate the pressure is simultaneously
ilding up in the cartridge chamber. Conse-
ently by the time the bullet has moved the
ght distance required to uncover the channel
a high pressure has been established in the
mbustion chamber capable of imparting an ex-
emely high acceleration to the bullet. By
roper choice of the clearance between the bullet
nd the gun bore, as well as the distance between
ie channel 8 and the inner end of the gun bore,
ie desired acceleration may be obtained.

Reference is now directed to Figs. 3 and 4. The
onstruction here illustrated is essentially the
ame as that shown in Figs. 1 and 2, with the
ddition of a groove 11 from the channel 8 to
ie rear end of the gun bore, and a small cavity
2 behind the bullet communicating with the
roove. The size of the groove governs the initial
ovement of the bullet to permit building up of
he required pressure in the combustion chamber,
s explained above.

Reference is now directed to Figs. 5 and 6. A
un body 21 is shown which has a lateral gun
ore 22. At one side of the gun bore, the body
s provided with a socket, located eccentrically
herein, the inner end of which socket forms a
artridge chamber 23 and the outer portion of
/hich is threaded to receive a plug 24. The in-
ier end of the cartridge chamber communicates
/ith the extreme inner end of the gun bore by
, pilot passage 25, and at a point forwardly of
ut adjacent the inner end of the gun bore by
main passage 26.

The gun bore 22 is provided at its point of in-
ersection with the main passage 26 with an an-
ular channel 27. Preferably, the main bore 26
s in the form of a slot having its smaller dimen-
ion along the axis of the gun bore and its
reater dimension transversely to the gun bore,
o as to occupy as little of the gun bore length
s possible while providing adequate cross sec-
ional area for the discharge of the combustion
ases.

In order to minimize erosion of the passages 25
nd 26, an orifice plate 28 is provided in the in-
ier end of the cartridge chamber 23. The plate
8 is provided with a meter opening 29 for the
ilot passage 25, the meter opening being pref-
erably smaller than the pilot passage, while its
other opening 30, which registers with the main
passage, may be equal to the area thereof. The
plate 28 is removable so that as its opening 29
wears, the plate may be replaced.

The cartridge chamber receives any suitable
cartridge 31. The gun bore 22 receives a bullet
32. To seal the bullet, the walls of the gun bore
and muzzle end of the bullet are electroplated by
a soft material 33, such as copper, zinc or lead.
Or the plating may be a coating of low melting
material, such as solder. The bullet is initially
positioned so as to close the main passage, but
the pilot passage remains in communication be-
tween the cartridge chamber and the back of
the bullet, by provision of a shoulder 34 in the
gun bore, which forms a stop for the bullet.

The structure shown in Figs. 5 and 6 operates
in the manner of the previously described struc-
tures. When the cartridge is ignited, the initial
movement of the bullet is controlled by the meter
opening and pilot passage, so that the bullet does
not reach the channel and main passage until
the desired combustion pressure has been at-
tained. The soft lining serves to lubricate the
bullet, as well as to exclude liquids.

Reference is now directed to Figs. 7 and 8.
The bullet 41 here illustrated is similar to the
bullets 9 and 32, and may be used in their stead.
A rudimentary pocket 42 is formed in the rear
end of the bullet 41. The pocket is filled with
an exothermic material, preferably "thermite,"
43. In addition, a small explosive charge 44 may
be provided in the inner end of the pocket.

By the time, or immediately after, the bullet
leaves the gun barrel, the thermite becomes ig-
nited by the heat of the burning gases. The
thermite rapidly burns and partially melts the
bullet. In the presence of water this acts almost
explosively so that the bullet is broken up. If
the explosive charge 44 is added, disintegration
of the bullet is insured as soon as the heat from
the thermite reaches the explosive.

The bullet 41 serves two functions. It serves
to break up the cement or formation after pene-
trating the casing, or in the event the bullet
should fail to penetrate the casing it breaks up
rather than anchors the gun perforator to the
casing. Failure of penetration, it should be
noted, occasionally occurs with any gun perfo-
rator, due largely to the fact that the gun perfo-
rators are usually fired under liquid and the pow-
der sometimes is dampened.

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 spir-
it and scope of my invention. I, therefore, do not
wish to restrict myself to the particular form of
construction illustrated and described, but de-
sire 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. A well casing perforating gun comprising:
means defining a gun bore; a bullet fitting the
gun bore; means for generating an explosive
pressure; means for diverting a limited portion of
the explosive pressure to propel the bullet into
position for full application of said explosive
pressure during an initial period calculated to
permit generation of the explosive pressure to a
high value.

2. A well casing perforator, comprising: a gun
body having a gun bore adapted to receive a bul-

let, and means for applying gas pressure into the gun bore at the side thereof; a bullet fitting the gun bore and positioned initially to close the gun bore to said gas pressure; and means for introducing a portion only of said gas pressure behind the bullet to move the bullet forwardly until the bullet opens said gun bore to the full gas pressure.

3. In a perforating gun, the combination of: a gun body having a gun bore adapted to receive a bullet, means for generating an explosive pressure, a port for introducing explosive pressure to the side of the gun bore, and means for diverting a limited portion of the explosive pressure to the rear of said gun bore; and a bullet fitting said gun bore and initially closing said port, said bullet being propelled initially at a comparatively low velocity under urge of the limited portion of the explosive pressure, and upon uncovering said port at a high velocity under urge of the entire explosive pressure.

4. A well casing perforating gun comprising: a gun body having a gun bore and a bullet fitting said bore; means for applying explosive pressure to said bore; and means for diverting a limited portion only of the explosive pressure against the bullet to urge it forward in the gun bore for a predetermined interval before exposing the bullet to the entire explosive pressure.

5. A well perforating gun comprising: a gun body defining a gun bore, a cartridge chamber and a passage connecting the cartridge chamber to the side of the gun bore; an explosive cartridge in the cartridge chamber; a bullet in the gun bore, the bullet positioned to separate the passage from the gun bore; and means providing restricted communication between the cartridge chamber and the base end of said bullet whereby, upon ignition of said cartridge, initial movement of the bullet along the gun barrel is impeded to permit rise of pressure in said cartridge chamber before the bullet uncovers said passage and receives the full application of said explosive pressure.

6. A well perforating gun comprising: a gun body defining a gun bore, a cartridge chamber, and a connecting passage extending laterally from the gun bore to the cartridge chamber; an explosive cartridge in said chamber; a bullet positioned in said gun bore to close said passage; the bullet and gun bore defining a restricted means of communication between the passage and the base end of the bullet to prevent full exposure to the pressures generated in the cartridge until the bullet uncovers said passage.

7. A well perforating gun comprising: a gun body defining a gun bore, a cartridge chamber and a passage extending from the cartridge chamber to a point in the side of but adjacent the inner end of the gun bore; an explosive cartridge for said cartridge chamber; a bullet for said gun bore initially fitting against the inner end of the gun bore to restrict communication between the passage and the base end of said bullet until the bullet is moved away from the inner end of the gun bore.

8. A gun perforator comprising: a gun body defining a gun bore, a cartridge chamber and a passage extending from the cartridge chamber and intersecting the gun bore adjacent its inner end; an explosive cartridge for said cartridge chamber; a bullet for said gun bore, said bullet conforming to the inner end of the gun bore and initially positioned thereagainst, and when so positioned forming a slide valve substantially closing communication between the passage and the gun bore, there being sufficient clearance between the bullet and gun bore to permit a limited portion of the explosive pressure generated by ignition of said cartridge to leak behind the bullet and propel the bullet forwardly at low velocity until it uncovers said passage thereby to introduce a time delay period between ignition of the explosive cartridge and full application of the resulting pressure on the bullet.

9. A well perforating gun comprising. a gun body having a gun bore, an explosive chamber, and a port connecting the chamber with the side of the gun bore; a bullet positioned in the gun bore and closing said port; means sealing the bullet from contact with the liquids in which the gun body may be immersed, said means being yieldable to the pressures of said liquids to hold said bullet against the inner end of said gun bore; and means for bypassing a limited portion of the pressure generated upon ignition of said cartridge, and directing the bypassed pressure against the base of the bullet to urge the bullet along the gun barrel in opposition to said liquid pressure until said bullet uncovers said port and is thereby exposed to the entire explosive pressure.

10. A method of imparting high acceleration to a bullet, characterized by: applying explosive pressure laterally into a gun bore through a port located forwardly of the inner end thereof, placing the bullet in an initial position at least partially closing communication between the gun bore and port to limit the effective application of pressure on the bullet until the bullet has moved forwardly and uncovered the port, thereby to introduce a delay between ignition of an explosive charge and full application of its pressure against the bullet.

11. A method of operating a gun perforator to obtain high muzzle velocity of the gun perforator bullet, characterized by: generating an explosive pressure, diverting while generating the explosive pressure, a limited portion of the pressure, propelling a bullet by the diverted portion for a period calculated to permit generation of the explosive pressure to a high value, then propelling the bullet by the fully generated force of said explosive pressure.

12. A well perforating gun comprising: a gun body having a gun bore, and means for applying gas pressure thereto; and a continuous soft metallic plating on the walls of the gun bore and the muzzle end of the bullet for sealing the bullet from contact with the liquids in which the gun body may be immersed.

13. A well perforating gun comprising: a gun body having a gun bore, and means for applying gas pressure thereto; and a continuous coating of metal having lubrication qualities lining the gun bore and muzzle end of the bullet to seal the bullet from contact with liquids in which the body may be immersed and to lubricate the bullet in its passage through the gun bore.

14. A well perforating gun comprising: a gun body having a gun bore, and means for applying gas pressure thereto; and a continuous thin metallic coating on the walls of the gun bore and the muzzle end of the bullet to seal the bullet from contact with the liquids in which the body may be immersed and forming a filler for the normal clearance space between the bullet and gun bore.

15. In a gun perforator: a gun body having a gun bore and means for applying explosive pres-

sure and heat to said gun bore; a bullet fitting said gun bore and having a cavity in its inner end; and an exothermic, non-explosive material filling the cavity and adapted to be ignited upon discharge of the bullet.

16. In a gun perforator: a gun body having a gun bore and means for applying explosive pressure and heat to said gun bore; a bullet fitting said gun bore and having a cavity in its inner end; and an exothermic, non-explosive material filling the cavity and adapted to be ignited upon discharge of the bullet; and an explosive in the base of the cavity adapted to be ignited by the burning of said exothermic material.

17. A method of imparting high acceleration to a bullet, characterized by: generating an explosive pressure by the burning of an explosive charge; diverting a predetermined limited portion of said explosive pressure to a bullet during the burning of the explosive charge, to move the bullet slowly from an initial position substantially unaffected by the explosive charge to a secondary position exposed to the full force of said explosive charge.

ARTHUR L. SMITH.

DISCLAIMER

2,292,670.—*Arthur L. Smith*, Torrance, Calif. WELL PERFORATING GUN. Patent dated Aug. 11, 1942. Disclaimer filed Apr. 17, 1945, by the assignee, *Lane-Wells Company*.

Hereby enters this disclaimer to claims 1 to 11 inclusive, and claim 17 of said patent.

[*Official Gazette May 29, 1945.*]

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