Dec. 11, 1956 | T. A. ANDREW | 2,773,424

GUN PERFORATOR

Filed June 1, 1951 | 3 Sheets-Sheet 1

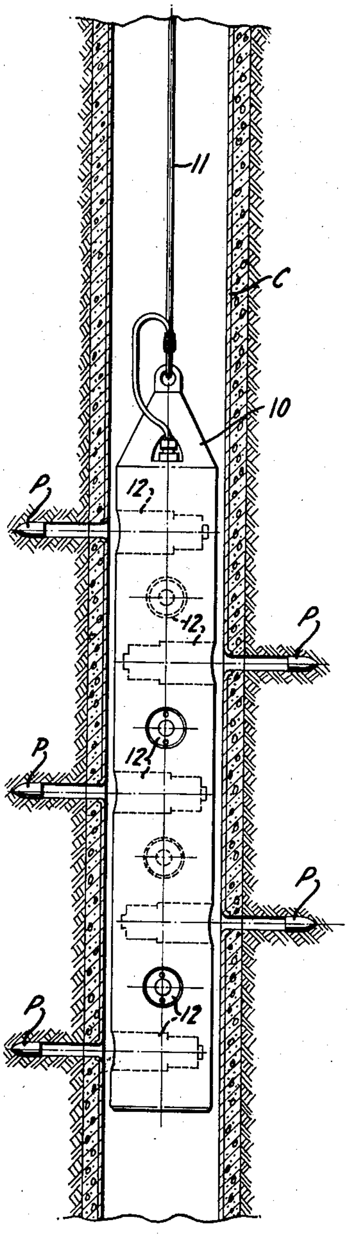

FIG. 1

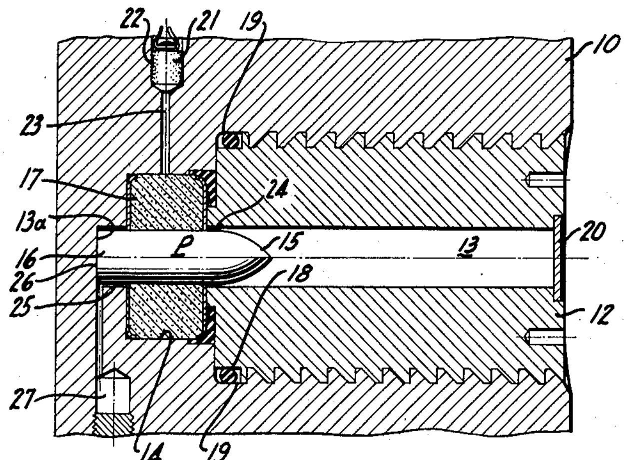

FIG. 2

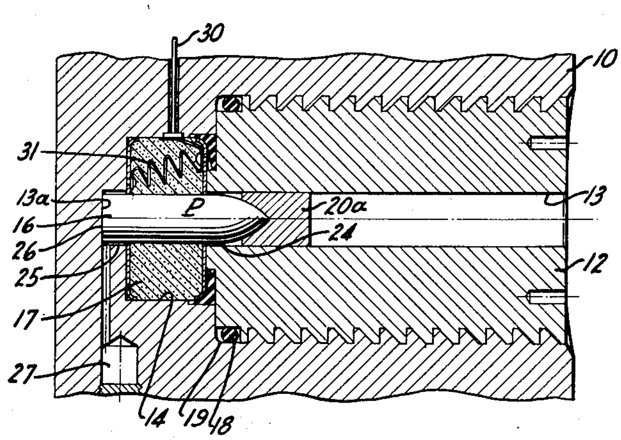

FIG. 3

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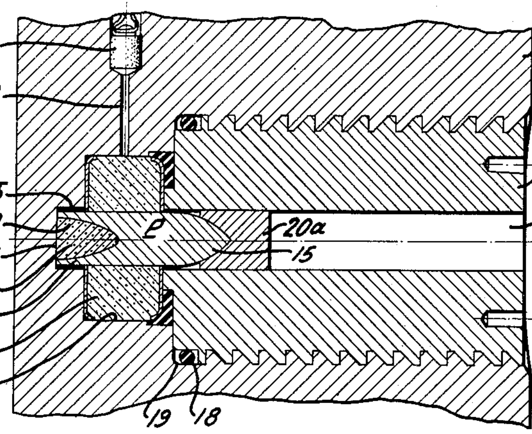

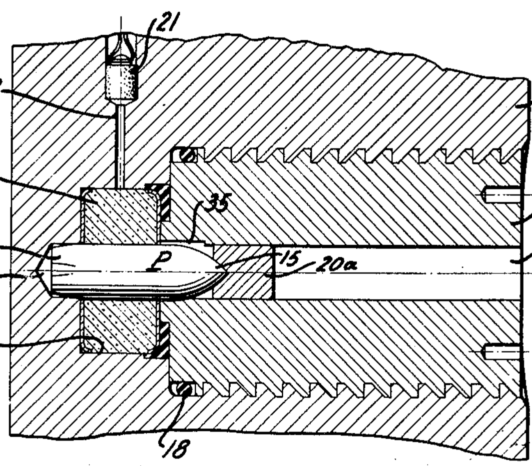

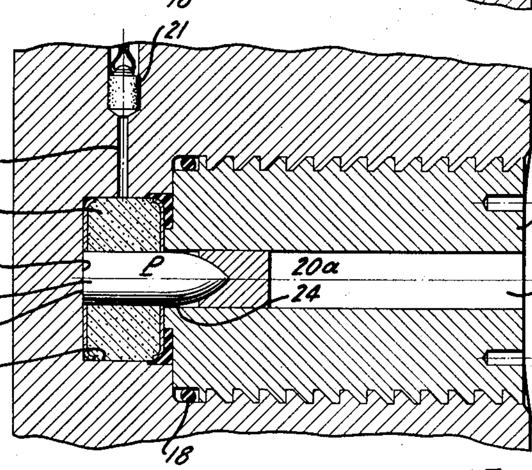

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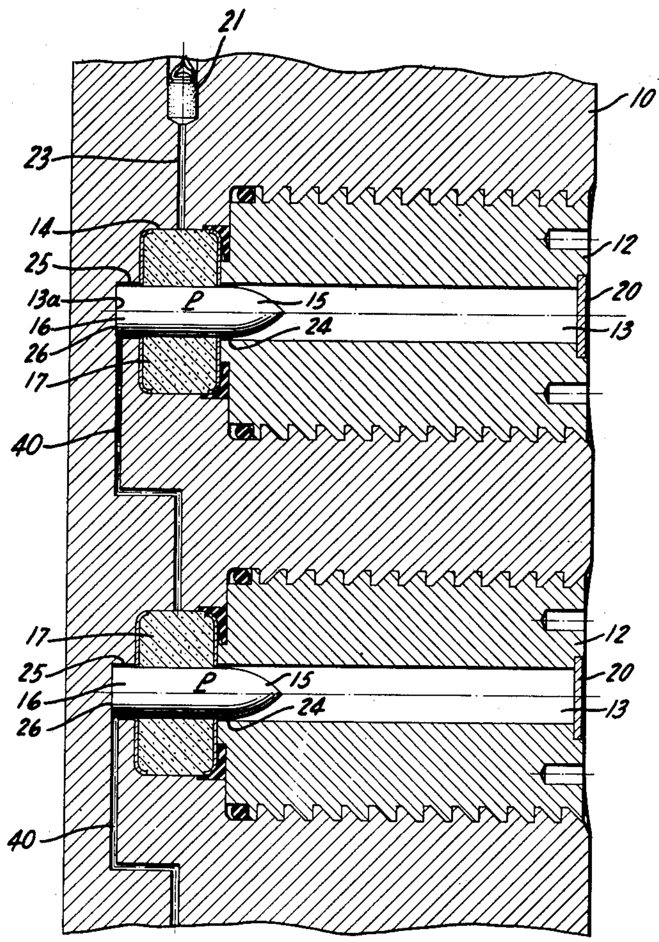

FIG. 7

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GUN PERFORATOR

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Application June 1, 1951, Serial No. 229,506

13 Claims. (Cl. 89—1)

The present invention relates to gun type perforators, and more particularly to perforators used in well bores to penetrate casing disposed therein, as well as the surrounding formation.

Gun perforators are lowered into a well bore on a cable, or other suitable running-in string, the axes of the gun barrels running transversely of the axis of the gun body and well bore. Inasmuch as the diameters of the well bores are comparatively small, the diameters of the gun bodies are also correspondingly small, causing the gun bores containing the bullets to be of comparatively short or restricted length. The short gun bore gives the bullet only a short distance in which to accelerate to casing penetrating velocity.

In order to develop the projectile velocity necessary for efficient penetration, restraining means of various types have been provided which either prevent the pressure developed by the burning propellant from acting on the bullet until a high magnitude of pressure has been produced, or which restrain the bullet from movement until propellent pressures of considerable magnitude have been developed.

One of the restraining means heretofore used comprises a rupturable disc placed between the propellant and the rear end of the bullet. This type of restraint leaves much to be desired, in that the rupturing disc fails in progressive stages and does not provide the restraining consistency desired. The disc expands into the gun bore, and while it appears on final inspection to have completely sheared at the gun barrel diameter, preliminary failures may have occurred in the center during the rupturing procedure that may have caused the bullet to start its travel through the gun barrel bore at propellent pressures much lower than that needed, which decreases the velocity of the bullet leaving the gun bore and its effectiveness in perforating the well casing.

Where a projectile restraining means is used, it is difficult to secure consistency of release and allow the bullet to have unimpeded travel down the gun bore once the initial pressure requirements developed by the propellant have been attained.

Heretofore, a bullet restraining means has involved the use of the ambient pressure or hydrostatic well pressure against the seal resting against the tip of the bullet, the pressure forcing the bullet against the propellant. Bullet movement commences when the burning propellent pressure equals the ambient pressure, but due to the large magnitude and variation of the ambient pressure under which a gun perforator must operate, depending upon the hydrostatic head of the well fluid surrounding the gun, this arrangement produces variations in the penetrative force of the bullets fired from the gun.

Gun perforators usually employ sealing elements to keep the external well fluid from the bullet and barrel, and these elements must be removed by the bullet. This impedance tends to slow the bullet, robbing it of some of its penetrative ability. In addition, the bullet may also have to eject well fluid from the gun barrel ahead of the sealing element and must also pierce the well fluid between the gun and the well casing. All of the foregoing factors tend to diminish the extent of subsequent penetration of the bullet into and through the well casing and the surrounding well bore walls.

When a number of gun chambers are fired at the same time in a well bore, they have heretofore reached their maximum explosive pressures at approximately the same instant, and, following ejection of the bullets, the well bore pressure is raised to such a great extent that damage might be done to the well bore walls, in some instances splitting the casing.

Accordingly, it is an object of the present invention to provide for a longer bullet travel in a well bore gun, despite the relatively small diameter of the gun and at the same time maintain a high mean pressure on the bullet during its longer travel.

Another object of the invention is to maintain a bullet in its initial position within the gun barrel by means of gas pressures until propellent pressures of considerable magnitude have been developed.

A further object of the invention is to force impeding elements in advance of the bullet, such as the barrel sealing element, any well liquid in the gun bore bearing against the sealing element and the well liquid between the gun and the well casing, from the bullet path before their initial locations are reached by the bullet, thereby insuring that the bullet will have an unimpeded trajectory, with maximum velocity and penetration into and through the well casing and the portions of the well bore surrounding it.

Yet another object of the invention is to minimize the danger of splitting or damaging well casing, or damaging other equipment in the well bore, by preventing a plurality of gun chambers fired at the same time from reaching their maximum pressure simultaneously, thereby greatly reducing well pressures attributable to the simultaneous firing of the propellants in the gun chambers.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of several forms in which it may be embodied. Such forms are shown in the drawings accompanying and forming part of the present specification. These forms will now be described in detail, illustrating the general principles of the invention; but it is to be understood that such detail description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

Fig. 1 is a side elevation of a gun body disposed in a well casing, into which it has been lowered on a cable, with bullets represented as having been fired from the gun and penetrating the casing and the surrounding well bore;

Fig. 2 is an enlarged longitudinal section through a single gun barrel portion of the gun body;

Fig. 3 is a view similar to Fig. 2 of yet another embodiment of the invention;

Fig. 4 is a view similar to Fig. 2 of another embodiment of the invention;

Fig. 5 is a view similar to Fig. 2 of still another form of the invention;

Fig. 6 is a view similar to Fig. 2 of yet another embodiment of the invention;

Fig. 7 is an enlarged fragmentary longitudinal section of a plurality of gun devices disposed in the gun body.

In Fig. 1, a typical gun body **10** is disclosed secured to an electric cable or line **11**, by means of which it is lowered in a well casing. This body may have a plurality of gun barrels and bullets therein arranged in longitudinally spaced relation to one another, so as to be capable of firing a plurality of bullets through a well casing C to perforate the latter, the bullets continuing on into the surrounding well bore.

As disclosed in Fig. 2, the gun body **10** has a gun barrel **12** threaded thereinto, the axis of the barrel being disposed transversely or laterally of the longitudinal axis of the gun body. The barrel has a central gun bore **13** coaxially thereof which extends from the discharge end of the barrel rearwardly to an explosive chamber **14** provided in the gun body **10**. Behind the explosive chamber is a rearward continuation **13***a* of the gun bore, being disposed coaxially of the latter.

The bullet P is disposed in the gun bore **13** and across the explosive chamber **14**. The forward portion **15** of the bullet is disposed in the gun barrel bore in advance of the chamber **14**, the trailing portion **16** of the bullet being disposed in the gun bore **13***a* formed in the body behind the explosive chamber **14**.

The explosive or propellent material **17** is provided in the explosive chamber **14** and surrounds a bullet P. In order to prevent leakage of well fluid through the threaded connection between the gun barrel **12** and gun body **10**, and the leakage of gases resulting from firing the propellant **17**, a suitable seal ring **18** is disposed in a circumferential groove **19** in the gun body **10** which is in sealing engagement with the periphery of the gun barrel **12**. This seal ring **18** may be in the form of a rubber or rubber-like O ring, which is capable of effecting a seal between the gun barrel and gun body, preventing leakage in both directions therebetween. Leakage of the well fluid is also prevented by a sealing disc **20** disposed across the mouth of the gun bore **13**, or it could be provided by use of a sealing element **20***a* disposed in the gun bore and bearing against the tip **15** of the bullet, as illustrated in Fig. 3.

The explosive propellant **17** may be ignited in any suitable manner. As illustrated in Fig. 2, a propellant igniter **21** is disposed in a chamber **22** in the body communicable with the explosive chamber **14** through an interconnecting hole or passage **23**. When the igniter **21** is fired, either electrically or by percussion, the force of the explosion travels through the passage **23** to ignite the propellant **17** contained in the explosive chamber **14**. The force of this propellant **17** is at first incapable of acting upon the bullet to fire it through the gun bore **13**. Instead, several preliminary actions first occur.

It is to be noted that there is a small clearance space **24** provided between the periphery of the forward portion **15** of the bullet and the gun barrel **13**, which establishes a flow path between the explosive chamber **14** and the gun bore **13** in advance of the bullet P. Similarly, a small clearance space **25** is provided between the periphery of the rear **16** of the bullet P and the wall of the rear gun bore **13***a*, which establishes a flow path between the chamber **14** and the rear face **26** of the bullet, and also with a comparatively small volume cavity **27**, communicating with the end of the rear gun bore **13***a* and the clearance space **25** around the rear portion **16** of the bullet.

Inasmuch as the propellant **17** surrounds the bullet P, there is no bullet area, except that of its periphery, exposed directly to the pressure developed in the chamber **14** upon ignition of the propellant. It is manifest that axial movement of the bullet can be urged by pressures developed in the gun bore **13** ahead of the bullet P, or by pressures developed at the end of the rear gun bore portion **13***a* behind the bullet. Such pressures are obtainable in the present instance by allowing the propellent gas under pressure to pass through the clearance spaces **24**, **25** provided around the forward and rearward portion **15**, **16** of the bullet P.

When the propellant **17** is ignited, the gas pressure is ineffective at first to eject the bullet through the gun bore **13**. Instead, some gas under pressure first passes through the small clearance space **24** around the forward portion **15** of the bullet and into the gun bore **13**, this pressure tending to force the bullet P rearwardly against the gun body. At the same time, the propellent gas under pressure has passed through the rear clearance space **25** into the small cavity **27**, being capable of acting upon the rear end **26** of the bullet to urge it in a forward direction. As the pressure in the propellant chamber **14** increases, the burning propellent gases leak past the bullet through the forward clearance space **24** into the gun bore **13**, exerting a pressure force against the sealing disc **20** and tending to force it from the gun barrel. Eventually, this pressure in the gun bore **13** equals and then exceeds the hydrostatic head of the well fluid bearing upon the sealing disc **20** and tending to hold it in closed position across the gun barrel bore **13**. When this condition arises, the gas pressure in the gun bore blows the sealing disc **20** out of the way. During all this time (actually of exceedingly short duration), the burning propellent gases are also moving through the small clearance space **25** around the rear **26** of the bullet into the rear cavity **27**, and when this pressure exceeds the pressure in the gun bore acting against the nose **15** of the bullet, the bullet is shifted forwardly until its rear end **26** is disposed in the transverse plane of the burning propellant **17**, which can now act with full force on the rear face **26** of the bullet and project the bullet at a high velocity through the gun bore.

The propellants **17** used in gun perforators develop their maximum pressures very quickly on ignition, requiring a time interval of a very short duration. In connection with the foregoing description, it is to be realized that the time delay during which the burning gases are leaking past the bullet is very short, being sufficient to give the propellant **17** time to develop its maximum pressure, after which the rear **26** of the bullet is exposed to the full force of the propellent pressure as the bullet moves forwardly in the barrel **12**. The time interval of delay before the bullet commences moving forward in the barrel may be adjusted, depending upon the extent of clearance **25** around the rear portion of the bullet and the volume of the cavity **27** communicating with the clearance space **25** around the bullet. The clearance space **24** around the forward portion of the bullet should be greater than that around the rear periphery of the bullet, to insure that the pressure developed in the bore **13** in advance of the bullet will exceed that developed behind the bullet at the first instant of detonation, to insure that the sealing disc **20** will be ejected before the bullet P commences its movement in the gun bore **13** to the point in which its rear face **26** is exposed to the maximum pressure of the explosive propellant **17**.

The bullet, in moving through the gun bore **13** and into the surrounding well casing, is unimpeded by any intervening elements. It is to be noted that before the bullet P begins advancing through the gun bore, the propellent gases in the gun bore in advance of the bullet have ejected the sealing disc **20** from the gun barrel **12**, and such propellent gases also cleared away the well bore liquids from the path of the bullet. Accordingly, the bullet P is free to travel through the gun bore **13**, to strike the casing C with maximum velocity. As noted above, the time delay imposed by the propellant arrangement, and the manner in which the gases can leak in both directions past the bullet P, insure the maximum pressure of the explosive propellant for action upon the bullet, which will provide maximum velocity to the bullet.

Since the propellent gases in advance of the bullet have cleared away the well bore liquids, the bullet travels through a passage unobstructed by solids or liquids. Accordingly, the bullet will be projected against the well casing with the same velocity, regardless of the magnitude of the hydrostatic or other pressure in the surrounding well bore.

The construction just described, in which the propellant **17** initially surrounds the bullet, allows a longer gun bore **13** to be used for the same diameter of gun body

10 and gives the bullet P maximum travel, allowing the explosive forces to act on the bullet for a longer period of time, thus insuring a greater penetrating velocity than has heretofore been obtainable for the same charge of propellant **17**.

Another important advantage of this construction is that a substantial portion of the bullet travel is through the power chamber. Tests made by me indicate that the pressures maintained on the bullet during its travel in the power chamber are much higher than the pressures effective against the bullet when traversing the barrel. I am not certain of the reasons for this phenomenon, but believe that this difference in pressures may be due to a large pressure drop due to viscous flow of the gases or due to the bullet velocity exceeding the velocity of pressure propagation when traveling down the barrel. The velocity of pressure propagation increases with increases of temperature of the gases. Therefore, in the above construction, a considerable amount of the bullet travel takes place in the powder chamber where the gases are hottest and where the gases are not required to travel down a barrel to be effective against the bullet.

It follows, therefore, that, in the present invention, not only has a longer bullet travel been obtained, but obtained in a manner to maintain a high mean pressure on the bullet during its travel. Consequently, a higher bullet speed has been obtained than would be obtained in a construction where the distance of bullet travel is the same as in the instant case, but wherein the travel is entirely through a barrel.

The form of invention disclosed in Fig. 3 is essentially the same as that shown in Fig. 2. Instead of employing a propellant igniter **21**, as in Fig. 2, the propellant **17** in the explosive chamber **14** in Fig. 3 is ignited by an insulated conductor pin **30** capable of passing current through a fuse **31**, for the purpose of igniting the propellant. In addition, instead of placing a sealing disc **20** at the mouth of the gun barrel, in Fig. 3 a sealing element **20***a* is placed within the gun bore **13** against the nose **15** of the bullet. In all other respects, the apparatus disclosed in Fig. 3 operates in the same manner as the device shown in Fig. 2. Before the bullet P commences moving in the barrel, the propellent gases leaking past the forward portion **15** of the bullet from the firing chamber **14** will first eject the sealing element **20***a* and well fluid in advance thereof from the gun bore **13**, the blast of gases also removing the well fluid between the gun body **10** and well casing C from the path of the bullet P before the latter is projected out of the gun bore.

In the form of invention disclosed in Fig. 4, a cavity **32** is provided in the rear of the bullet P to furnish the required volume to be filled by the gases leaking in a rearward direction from the propellant chamber **14** along the periphery of the bullet and across its back face **26**. By properly selecting the volume of this cavity **32**, the rate at which the pressure increases behind the bullet can be determined with respect to the increase in pressure in advance of the bullet by the gases leaking through the forward clearance space **24**; so as to furnish the necessary time delay that will insure ejection of the sealing element **20***a* and well fluid from the gun bore **13**, as well as removing the well liquid from the space between the gun body **10** and the well casing C in alignment with the gun bore. This time delay will also be sufficient to insure the development of the maximum pressure by the burning gases in the chamber **14** for action upon the rear **26** of the bullet or projectile.

If desired, the cavity **32** in the rear of the bullet P may be filled with an explosive powder **33**. Ignition of the main explosive or propellant **17** develops pressure in the propellant chamber **14**, which leaks through the rear clearance space **25** to the rear of the bullet. As the pressure increases and reaches the proper magnitude, the bullet P is ejected. Inasmuch as the clearance space **25** around the rear portion **16** of the bullet is not great enough to sustain flame propagation, the explosive **33** in the cavity **32** will not ignite until the bullet has moved partially in the gun bore **13** to expose its rear portion **26** to the flame in the main propellant chamber **14**. At this point, the explosive **33** in the cavity will ignite, the resultant gaseous pressure developed providing a booster action, which sustains the pressure as the bullet passes down through the barrel **13**; so as to provide a higher average pressure during its ejection from the gun, with a resultant increase in velocity and penetrating force into the casing C.

As disclosed in Fig. 5, the cavity **34**, instead of being provided in the bullet P, may be provided in the gun body **10** immediately to the rear of the bullet. This cavity **34** will have sufficient volume to provide the desired retarding in the movement of the bullet, by delaying the build-up of gas pressure behind the bullet, with respect to the gas pressure in advance of the bullet for a sufficiently long time (which need only be a very small fraction of a second); to insure increase in the burning gas pressure in the main chamber **14** to its maximum value before the bullet is projected through the gun barrel **13**.

Instead of merely providing clearance **24** around the periphery of the bullet P, the bullet may have a relatively tight fit in the gun barrel bore **13**, the amount of leakage past the bullet being obtainable through a shallow groove **35** (Fig. 5) formed in the wall of the gun bore **13**, effecting intercommunication between the propellant chamber **14** and the gun bore **13**.

The arrangement disclosed in Fig. 6 may be employed in connection with propellants **17** having an extremely fast burning rate. The back **26** of the bullet P is placed against the rear wall **36** of the powder chamber **14**, which shields the rear end **26** of the bullet and provides a restriction to the flow of the burning propellent gases as they tend to get behind the bullet. Pressure is built up by passing from the propellant chamber **14** and leaking between the bullet P and the back surface **36** of this chamber. This arrangement provides a comparatively short delay in time, which is, nevertheless, sufficiently appreciable to delay the movement of the bullet until the prescribed amount of gas pressure has been developed in the propellant chamber **14**. As disclosed in Fig. 6, the gases under pressure can leak through the clearance space **24** around the forward portion **15** of the bullet and into the gun bore **13**, for the purpose of ejecting the seal **20***a*, and well fluid in the gun bore **13**, and displacing the well liquid between the gun body **10** and wall of the well casing C from the path of the bullet.

A plurality of gun devices is disclosed in Fig. 7 as being carried by the same gun body **10**. It is desired to fire the bullets P in the gun devices substantially simultaneously, but to avoid the development of maximum propellent pressures simultaneously, which might tend to damage the well equipment and the well casing.

Each gun barrel assembly is essentially the same as that disclosed in Fig. 2, there being connecting channels or passages **40** extending from the back end of the rear gun bore **13***a* to the next lower propellant chamber **14**. The propellant **17** in the upper chamber **14** is first ignited, following firing of the igniter **21**, and it is this propellant which furnishes the high pressure gases that will travel through the interconnecting channel **40** to the next lower propellant chamber **14**, to fire the propellant **17** in the latter. In the same manner, the propellant in the lower chamber develops gases under high pressure which can flow through the interconnecting channel **40** that leads to the next lower propellant chamber, and so on. Accordingly, it is apparent that the propellants **17** in the various chambers are fired in series.

A time delay is introduced between the firing of an upper propellent charge **17** and a lower propellent charge.

Following firing of the upper propellent charge, the small clearance space **25** around the rear portion **16** of the upper bullet causes a delay in the build-up of pressure around this bullet and in the interconnecting channel **40** therebelow. Accordingly, the firing of the next lower charge of propellant **17** is delayed, and, upon its firing, the building up of pressure in the next lower interconnecting channel **40** is delayed, through the necessity for the burning gases to pass through the comparatively small clearance space **25** around the rear **16** of the second bullet. This same retarding in the build-up of pressure continues in a series sequence down through the gun body, igniting all of the propellent charges in succession.

Accordingly, it is apparent that the propellent charges **17** will develop their maximum pressures in sequence to eject their associated projectiles P, there being a time delay between the maximum pressures developed between the upper chamber and the next lower chamber, from the next lower chamber to the one therebelow, and so forth throughout all of the chambers in the gun body. Since the maximum pressures are not obtained simultaneously, the well bore pressures developed as a result of firing all of the charges are at a substantially lesser magnitude than if all of the propellent charges were exploded simultaneously and developed their maximum pressures simultaneously. In this manner, the decreasing of the effective pressures in the well bore minimizes the danger of damaging equipment in the well casing.

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

1. In a casing perforator: a gun body having a bore to receive a projectile; a projectile in said bore; said body having a propellent chamber communicable with said bore in advance of the rear face of the projectile when the projectile occupies its firing position in said bore; and means providing gas flow restricting passages between said chamber and the gun bore in advance of the projectile and behind the rear face of the projectile only when the projectile occupies its firing position in said bore.

2. In a casing perforator: a gun body having a bore to receive a projectile; a projectile in said bore; said body having a propellent chamber communicable with said bore in advance of the rear face of the projectile when the projectile occupies its firing position in said bore; and means providing gas flow restricting passages between said chamber and the gun bore in advance of the projectile and behind the rear face of the projectile only when the projectile occupies its firing position in said bore, said passage to the gun bore in advance of the projectile being greater in area than the passage to the gun bore behind the projectile to provide a greater propellent gas pressure ahead of the projectile than behind the projectile.

3. In a casing perforator: a gun body having a bore to receive a projectile; a projectile in said bore; said body having a propellent chamber communicable with said bore in advance of the rear face of the projectile when the projectile occupies its firing position in said bore; and means providing gas flow restricting passages between said chamber and the gun bore in advance of the projectile and behind the rear face of the projectile only when the projectile occupies its firing position in said bore to provide a greater propellent gas pressure ahead of the projectile than behind the projectile.

4. In a casing perforator: a gun body having a bore to receive a projectile; a projectile in said bore; said body having a propellent chamber communicable with said bore in advance of the rear face of the projectile when the projectile occupies its firing position in said bore; means providing gas flow restricting passages between said chamber and the gun bore in advance of the projectile and behind the rear face of the projectile only when the projectile occupies its firing position in said bore; and means providing a chamber communicating with the gun bore behind the projectile to initially provide less pressure in the gun bore behind the projectile than in advance of the projectile.

5. In a casing perforator: a gun body having a bore to receive a projectile; a projectile in said bore; said body having a chamber communicable with said bore and adapted to contain a propellant for firing the projectile from the bore; and means providing a flow restricting passage between said chamber and the gun bore in advance of the projectile only when the projectile occupies its firing position in said gun bore, in order that the propellant can force substances from the gun bore in advance of the projectile.

6. In a casing perforator: a gun body having a bore to receive a projectile; a projectile in said bore; said body having a propellent chamber communicable with said bore in advance of the rear face of the projectile when the projectile occupies its firing position in said bore; means providing gas flow restricting passages between said chamber and gun bore in advance of the projectile and behind the rear face of the projectile only when the projectile occupies its firing position in said bore; and means providing a chamber in the gun body behind the projectile communicating with the gun bore behind the projectile to initially provide less pressure in the gun bore behind the projectile than in advance of the projectile.

7. In a casing perforator: a gun body having a bore to receive a projectile; a projectile in said bore; said body having a propellent chamber communicable with said bore in advance of the rear face of the projectile when the projectile occupies its firing position in said bore; means providing gas flow restricting passages between said chamber and the gun bore in advance of the projectile and behind the rear face of the projectile only when the projectile occupies its firing position in said bore; means providing a second chamber communicating with the gun bore behind the projectile; and an explosive propellant in said second chamber.

8. In a casing perforator: a gun body having a bore to receive a projectile; a projectile in said bore; a propellent chamber surrounding said bore and communicating with said bore between the ends of the projectile when the projectile occupies its firing position in the bore; and means providing gas flow restricting passages between said chamber and the gun bore in advance of the projectile and behind the rear face of the projectile only when the projectile occupies its firing position in said bore.

9. In a casing perforator: a plurality of gun bodies connected together in superposed relation each having a bore to receive a projectile, each of said bores having a portion of enlarged diameter adjacent its rear end but spaced from said end, said enlargement constituting a propellent chamber, a projectile in said bore, said projectile bridging said propellent chamber when in its firing position, means forming a restricted passageway from said propellent chamber to the gun bore in front of said projectile only when said projectile is in its firing position, means forming a restricted passageway communicating between said propellent chamber and the gun bore behind said projectile when said projectile is in its firing position, and means providing a restricted passageway from the rear end of the gun bore of each of said gun bodies to the propellent chamber of the next lower gun body.

10. In a casing perforator: a gun having a bore to receive a projectile, said bore having a portion of enlarged diameter adjacent its rear end, said enlargement constituting a propellent chamber a projectile in said bore, said projectile bridging said propellent chamber when in its firing position, means forming a restricted passage from said propellent chamber to the gun bore in front of said projectile only when said projectile is in its firing position, and means forming a restricted passageway communicating between said propellent chamber and the gun bore behind said projectile when said projectile is in its firing position.

11. In a casing perforator: a gun having a bore to receive a projectile, said bore having a portion of enlarged diameter adjacent its rear end, said enlargement constituting a propellent chamber, a projectile in said bore, said projectile bridging said propellent chamber when in its firing position, means forming a restricted passage from said propellent chamber to the gun bore in front of said projectile only when said projectile is in its firing position, means forming a restricted passageway communicating between said propellent chamber and the gun bore behind said projectile when said projectile is in its firing position, the ratio of the total volume of the last mentioned restricted passage and the space behind the projectile to the cross-sectional area of said restricted passage behing greater than the ratio of the total volume of the forwardly directed restricted passageway and the space in front of the projectile to the cross-sectional area of the forwardly directed restricted passage whereby the pressure will initially build up faster in front of the projectile than in the rear thereof to restrain said projectile against movement until the pressure in front thereof exceeds the hydrostatic well pressure and clears the well fluids from the bore and whereby the pressure behind the projectile subsequently exceeds the pressure in front thereof and forces the projectile outwardly through the cleared bore.

12. In a casing perforator: a gun having a bore to receive a projectile, said bore having a portion of enlarged diameter adjacent its rear end, said enlargement constituting a propellent chamber, a projectile in said bore, said projectile bridging said propellent chamber when in its firing position, means forming a restricted passage from said propellent chamber to the gun bore in front of said projectile only when said projectile is in its firing position, means forming a restricted passageway communicating between said propellent chamber and the gun bore behind said projectile when said projectile is in its firing position, the ratio of the total volume of the last mentioned restricted passage and the space behind the projectile to the cross-sectional area of said restricted passage being greater than the ratio of the total volume of the forwardly directed restricted passageway and the space in front of the projectile to the cross-sectional area of the forwardly directed restricted passage whereby the pressure will initially build up faster in front of the projectile than in the rear thereof to restrain said projectile against movement until the pressure in front thereof exceeds the hydrostatic well pressure and clears the well fluids from the bore and whereby the pressure behind the projectile subsequently exceeds the pressure in front thereof and forces the projectile outwardly through the cleared bore, said projectile completely filling said bore after moving from its firing position to prevent further bypass of gases forwardly thereof.

13. In a casing perforator: a gun having a bore to receive a projectile, said bore having a portion of enlarged diameter adjacent its rear end, said enlargement constituting a propellent chamber, a projectile in said bore, said projectile bridging said propellent chamber when in its firing position, means forming a restricted passage from said propellent chamber to the gun bore in front of said projectile only when said projectile is in its firing position, means forming a restricted passageway communicating between said propellent chamber and the gun bore behind said projectile when said projectile is in its firing position, the ratio of the total volume of the last mentioned restricted passage and the space behind the projectile to the cross-sectional area of said restricted passage being greater than the ratio of the total volume of the forwardly directed restricted passageway and the space in front of the projectile to the cross-sectional area of the forwardly directed restricted passage whereby the pressure will initially build up faster in front of the projectile than in the rear thereof to restrain said projectile against movement until the pressure in front thereof exceeds the hydrostatic well pressure and clears the well fluids from the bore and whereby the pressure behind the projectile subsequently exceeds the pressure in front thereof and forces the projectile outwardly through the cleared bore, said projectile completely filling said bore after moving from its firing position to prevent further bypass of gases forwardly thereof, a seal in said gun bore and engaging the nose of said projectile, said seal defining a gas space in front of said projectile connected to said forwardly directed restricted passage, said seal being adapted to be blown out with said well fluids ahead of said projectile.

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