Sept. 30, 1941. W. S. REYNOLDS 2,257,276

PERFORATING GUN AND PROJECTILE THEREFOR

Filed March 14, 1938

Fig. 1

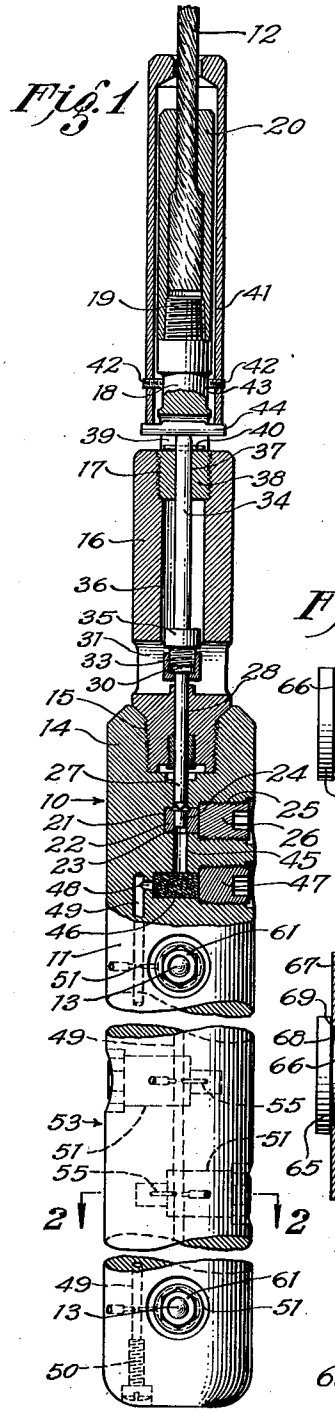


Fig. 2

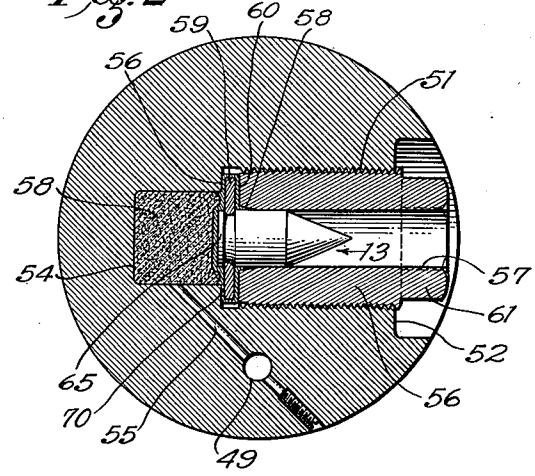


Fig. 4

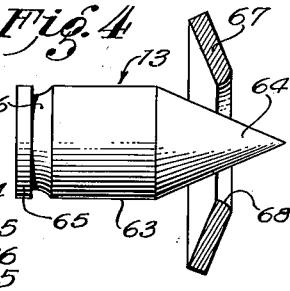


Fig. 5

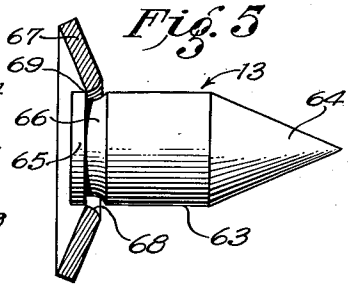


Fig. 6

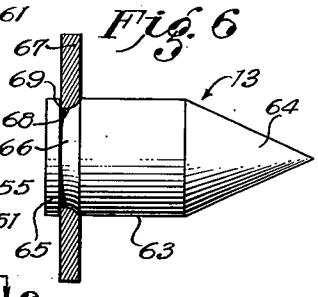


Fig. 3

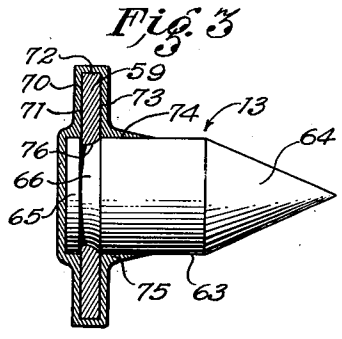
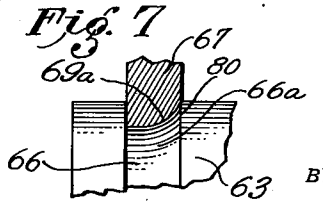


Fig. 7



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Patented Sept. 30, 1941 2,257,276

UNITED STATES PATENT OFFICE

2,257,276

PERFORATING GUN AND PROJECTILE THEREFOR

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Application March 14, 1938, Serial No. 195,759

4 Claims. (Cl. 89—1)

My invention relates, in general, to the perforating of well casing, and relates in particular to a device whereby such casing is perforated by projectiles which are driven therethrough at high velocity.

It is an object of the invention to provide a perforating device of the above character including a gun body including a gun barrel with a chamber for a firing charge of explosive material at the inner end of the gun barrel, with a projectile disposed at the inner end of such gun barrel, these parts being of simple form and cooperating in such manner that maximum velocity of the projectile for a given firing charge is, at all times, assured.

It is a further object of the invention to provide, in a perforating device of the above character, parts which are so formed in cooperating relation that maximum length of gun barrel may be maintained, and a longer projectile travel secured than has been heretofore possible in well casing perforating guns for a gun barrel of given diameter and length. For a given firing charge two of the factors which determine the penetrating capacity of the projectile are the muzzle velocity of the projectile and the mass of such projectile as compared to its diameter. Accordingly, by increasing the length of travel of the projectile in the gun barrel without increasing the length of the gun barrel, and without increasing the mass of the projectile, I have been able to materially increase the penetrating capacity of the projectile.

An additional factor entering into the penetrating capacity of a projectile propelled by a given firing charge is the control of movement of the projectile from its initial position until a high pressure is built up in the firing-charge chamber so that when the projectile is released it will be propelled forwardly by this high pressure produced by the burning of the firing charge. It is an object of the present invention to provide, in a gun perforating device for well casing, a projectile having a collar projecting radially from its inner end portion, and cooperating parts in the structure of the gun for gripping this collar when the projectile is in position within the gun, such collar providing a means for holding the projectile from outward movement until a desired high pressure has been built up in the firing-charge chamber, whereupon the collar is sheared and the projectile released and propelled at high velocity by the firing charge.

It is a further object of the invention to provide, in a well casing perforating gun, parts which will cooperate with a projectile having a collar at the inner end thereof in such manner that the outer end of the firing-charge chamber will be positively sealed against entrance of moisture, so that outward movement of the projectile cannot occur until the desired high pressure has been built up in the firing-charge chamber, and so that the projectile cannot be moved into the firing-charge chamber by well pressure applied to the outer end of a projectile when the perforating device is submerged in the fluid contents of a well.

It is a further object of the invention to provide a novel well casing perforating projectile having a collar at its inner end and also a novel method of forming a collared projectile of the character hereinbefore described.

It is a still further object of my invention to provide a method whereby a projectile may be provided with an outwardly extending sealing collar.

It is a still further object of my invention to provide such a method in which a tight seal is formed between the sealing collar and the projectile and in which the two are secured together so that the projectile will be released when a predetermined explosive pressure is applied thereto. One of the important advantages of my invention is that it is possible to produce large numbers of projectiles and collars in which the explosive pressure required to release the projectile from the collar is substantially uniform. This is desirable in one form of my invention in which when the gun is fired it is intended that all of the projectiles be released at substantially the same time.

It is a further object of the invention to provide a well casing perforating projectile having a collar at its inner end which cooperates with the gun structure in the manner previously described, and which shears, when the gun is fired, in a manner to leave a ring on the projectile which makes sealing engagement with the bore of the perforator gun barrel and prevents escape of propelling gases past the projectile during its travel through the gun barrel.

Further objects and advantages of the invention will be brought out in the following part of the specification.

Referring to the drawing which is for illustrative purposes only:

Fig. 1 is a partly sectioned view of a well casing perforating device embodying my present invention.

Fig. 2 is an enlarged cross-section taken on the plane indicated by the line 2—2 of Fig. 1.

Fig. 3 is an enlarged partly sectioned view of my new projectile.

Fig. 4 is a view showing cooperating parts of the projectile prior to the assembly.

Fig. 5 is a view showing a step in the method of assembling the cooperating parts of the projectile.

Fig. 6 is a view showing a stage in the assembly of the cooperating parts of the projectile wherein the collar is fixed on the projectile body.

Fig. 7 is an enlarged fragmentary sectional view showing my preferred form of engagement between the projectile body and the collar.

In Fig. 1 I show a well casing perforating device 10 comprising a gun 11 adapted to be lowered within a well casing by means of a cable 12 and carrying projectiles 13 adapted to be propelled outwardly at high velocity through the wall of the well casing by the explosive action of charges of powder. The gun 11 includes a body 14 having a threaded opening 15 at its upper end, into which an extension 16 is screwed, this extension having a threaded opening 17 at its upper end which receives a shank 18 provided with a threaded pin 19 to which a cable socket 20 is secured so as to connect the cable 12 to the gun 11.

In the upper part of the gun body 14 there is an opening 21 serving as a receptacle for a block 22 having a vertical opening 23 in the upper end of which a priming device in the form of a percussion cap 24 is received. One side of the opening 21 communicates with a threaded opening 25 through which the block 22 may be moved in and out of the opening 21, and having therein a threaded plug 26 for holding and sealing the block 22 in place. A replaceable firing pin 27 is disposed above the priming device 24, this firing pin extending within an opening in the upper part of the body 14, and through an opening 28 in the lower part of the extension 16, the firing pin 27 having a head 30 positioned in a lateral opening 31 in the lower part of the extension 16 and being connected by means of an internally threaded cup member to the threaded lower end 33 of a bar 34. The bar 34 has a head 35 on the lower end which may be moved downwardly through an axial opening 36 in the extension 16 to the position in which it is shown, and the upper end of the bar 34 projects through an opening 37 in the lower threaded end 38 of the shank 18, into a lateral opening 39 in such shank. The upper end of the bar 34 is provided with a transverse shear pin 40 which supports the bar 34 and the firing pin 27 in raised position, as shown. A percussion sleeve 41 surrounds the upper portion of the shank 18, and has screws 42 for frictional engagement with side walls 43 of the shank 18. Just prior to the lowering of the perforating device 10 into a well, a cross-bar 44 is placed in the opening 39 of the shank 18 in such position that it will engage the upper extremity of the bar 34 when the ends of the cross-bar 44 are in position to be engaged by the lower end face of the percussion sleeve 41.

The opening 23 in the block 22 is connected through a vertical opening 45 with an ignition-charge chamber 46, the outer end of which is closed and sealed by a plug 47 and the inner end of which communicates through a port 48 with an ignition passage 49 which extends down through one side of the body 14 to the lower end thereof, the lower end of the ignition passage 49 being closed by a screw 50. Extended inwardly in alternated relation from opposite sides of the body 14 are threaded openings 51, such openings being counterbored as clearly shown at 52 in Fig. 2. The intermediate section 53 of the body 14 is shown rotated through an angle of 90° so that the alternate relation of the openings 51 may be clearly shown. At the inner end of each opening 51 there is a firing-charge chamber 54 which is connected to the ignition passage 49 by means of an ignition port 55. The relative diameter of the openings 51 and the firing-charge chamber 54 are such that an outwardly faced shoulder 56 is formed between the outer end of the chamber 54 and the inner end of the opening 51.

A cylindrical member 56 is removably secured in each opening 51, preferably by use of threaded engagement between the exterior of the member 56 and the wall of the opening 51. The cylindrical member 56 provides a gun barrel having a bore 57, the inner end 58 of which bore is slightly flared, as shown. A projectile 13 is disposed at the inner end of each bore 57 so that when a firing charge 58 in the cooperating firing-charge chamber 54 is ignited, the projectile 13 will be propelled through the entire length of the bore 57. The projectile 13 is provided with a radially projecting collar 59, which collar 59 is in the form of a radially projecting flange and is fixed at or near the inner end of the projectile 13 so that at least the outer portion thereof will lie between the shoulder 56 and the inner end 60 of the removable member 56, to be tightly gripped or clamped therebetween when the member 56 is screwed in tightly by the application of a suitable wrench to the outer end 61 thereof.

The collar 59 is preferably made of such material that an annular center portion thereof will shear from that portion thereof which lies adjacent the end 60 of the cylindrical member 56, when a high pressure is built up in the firing-charge chamber 54. The center portion of the collar 59 which remains with the body of the bullet 13 forms a ring which has an external diameter slightly larger than the body of the projectile and serves as a sealing ring around the same as the projectile passes outwardly through the bore 57. The collar 59, by selective use of the factors of thickness and shearing characteristics, is enabled to maintain a desired control of the release of the projectile at a desired pressure produced in the chamber 54 by the ignition of a firing charge 58 therein. To positively seal the outer end of the firing-charge chamber 54, the inner end of the projectile 13 and the collar 59 are provided with a coating of gasket forming material 70, one type of which will be more fully described hereinafter.

The preferred form of my casing perforating projectile 13, as shown to enlarged scale in Fig. 3, is made in the following manner. As shown in Fig. 4, a cylindrical projectile body 63 is prepared for penetration, as by formation of a conical point 64 thereof. It will be understood however that this conical point 64 is not necessary in all practices of the invention, but the projectile body 63 may be prepared for penetration by other point forms. Near the inner end 65 of the body 63 an annular groove 66 is formed. A collar ring 67 is formed, which ring is dished so that the opening 68 therethrough will receive the projectile body 63. Then, as shown in Fig. 5, the collar ring 67 is moved onto the projectile body 63 to such position that the inner edge portion 69 thereof will coincide with the groove 66. As

shown in Fig. 6, the collar ring 67 is then flattened so that the inner edge portion 69 thereof will enter the groove 66 of the projectile body 63, thereby fixing the ring 67 on the projectile body 63 so as to form a radially projecting collar 59, such as shown in Figs. 2 and 3. The projectile body with its affixed collar is then held with the point 64 facing upwardly and the lower portion of the projectile structure is dipped in a soldering compound, for example soldering acid, after which the inner half of the projectile 13 is immersed in a bath of hot metal of solder-like characteristics, for example, lead, zinc or tin, or other suitable deformable gasket-forming alloy, thereby applying to the inner end of the projectile 13 a layer of deformable gasket-forming material 70 which covers the inner end 65 of the body 63, the inner face 71, the peripheral face 72, and the outer face 73 of the collar 59, and also that portion 74 of the projectile body 63 lying adjacent the outer face 73 of the collar 59. The portion 75 of the gasket coating 70 which surrounds and adheres to the portion 74 of the projectile body 63 is tapered, and when the projectile 13 is placed in the inner end of the bore 57, such portion 75 will extend into the flared enlargement 58 of the inner end of the bore 57.

Owing to the fact that the gasket layer 70 adheres to, or is fused onto, the projectile structure, the joint 76 between the collar 59 and the groove 66 will be perfectly sealed. Likewise, when the tapered portion 75 of the gasket layer 70 is forced into the flared enlargement 58 at the inner end of the bore 57, the tapered portion 75 will be compressed tightly into the annular corner formed by the outer face 73 of the collar 59 and the cylindrical face of the projectile body 63.

The inner end 65 of the projectile 13, as shown in Fig. 2, projects a short distance into the firing-charge chamber 54, which is accomplished preferably by setting the entire projectile inwardly. This is made possible, to any extent desired, by the distance of the collar 59 from the inner end of the projectile. When the cylindrical member 56 is screwed tightly into place so as to deform the gasket layer 70 into sealing conformity to or engagement with the shoulder 56 of the end 60 of the member 56, the inner end 65 of the projectile 13 may be employed to compress the firing charge 58. The projecting of the inner portion of the projectile body 63 through the collar 59 in the form of my invention illustrated adds approximately 20% to the length of travel of the projectile in the barrel without increasing the length of the projectile or bore 57. The projectile length is limited by the internal diameters of the relatively small casings required to be perforated. Some of these casings are only 2½" inside diameter. Therefore, it is highly important to secure as long a travel for the projectile as possible from the time the projectile is released from the restraining collar 59, until it is expelled from the barrel, which travel is required to build up velocity and energy. The muzzle of the barrel may be spaced approximately ¼" from the internal wall of the casing being perforated. The projectile is required to develop sufficient velocity to pierce two or more walls of such casings and cement between same and outside into the formation.

I prefer, as shown in Fig. 7, to flare the bottom wall 66*a* of the groove 66 in forward direction, so that such bottom wall 66*a* will slope outwardly in forward direction to meet the front edge 80 of the groove 66. The inner edge face 69*a* of the gasket ring 67 is outwardly flared in forward direction to correspond to the form of the bottom wall 66*a* of the groove 66, so that the inner edge face of the ring 67 will engage the wall 66*a* as shown in Fig. 7. The purpose of forming these cooperating parts in the manner described is so that when forward fluid pressure is applied to that portion of the ring 67, resting in the groove 66, when the collar 59 is sheared off, such forward fluid pressure will tend to move the ring of metal forward in the groove 66 so that the same will be expanded by the flaring wall 66*a* into tight engagement with the barrel 56.

I claim as my invention:

1. In a projectile and barrel assembly for a casing perforator having a body with an opening leading inward from a face thereof, said opening comprising a counterbore with an outwardly faced shoulder at the inner end thereof and a pressure chamber inward of said shoulder, the combination of: a barrel securable in said counterbore and having an inner end face confronting said shoulder and having a bore flared at its inner end; and a projectile having a flange projecting radially from its inner end so as to be gripped between said shoulder and said end face of said barrel with the portion thereof which lies forward of said flange extending within said bore, at least one radial face of said flange having a coating of relatively soft material thereon, a portion of said relatively soft material forming a conoidal enlargement to occupy the flared portion of said bore.

2. In a projectile and barrel assembly for a casing perforator having a body with an opening leading inward from a face thereof, said opening comprising a counterbore with an outwardly faced shoulder at the inner end thereof and a pressure chamber inward of said shoulder, the combination of: a barrel securable in said counterbore and having an inner end face confronting said shoulder and having a bore flared at its inner end; and a projectile comprising a body with a groove near its inner end, a flange seated in said groove and extending outwardly so as to lie between said shoulder and said face of said barrel, said body projecting forward into the inner end of said bore, there being a coating of relatively soft material on at least the front face of said flange and sealing the corner formed by the front face of said flange and the adjacent portion of said body, said relatively soft metal also forming a conoidal fillet to occupy the flared inner end of said bore.

3. In a projectile and barrel assembly for a casing perforator having a gun body providing a recess forming a firing-charge chamber and an opening extending outwardly from said firing-charge chamber to the exterior of said gun body, the combination of: an outwardly facing shoulder on said gun body between said firing-charge chamber and said opening; a removable gun barrel secured in said opening, said barrel having a bore extending therethrough and an end arranged in facing relation to said shoulder; a projectile extending into the inner end of said bore of said barrel and beyond said shoulder of said gun body and into said firing-charge chamber; an annular collar fixed on said projectile at a place a short distance from the inner end of said projectile and extending outwardly therefrom so that it lies between said shoulder and said end of said barrel in a position to be gripped between said shoulder and said end of said barrel, said collar supporting said projectile in a position retracted inwardly

of the inner end of said barrel so as to rest partly in said firing-charge chamber and partly in said bore, and said collar restraining said projectile from inward or outward movement until the charge in said firing-charge chamber has been ignited and sufficient pressure developed to shear said collar; a layer of deformable material operatively associated with said collar to form a seal when said collar is gripped between said shoulder and said end of said barrel; and means for firing the charge in said firing-charge chamber.

4. In a projectile and barrel assembly for a casing perforator having a gun body providing a recess forming a firing-charge chamber and an opening extending outwardly from said firing-charge chamber to the exterior of said gun body, the combination of: an outwardly facing shoulder on said gun body between said firing-charge chamber and said opening; a removable gun barrel secured in said opening, said barrel having a bore extending therethrough and an inner end arranged in facing relation to said shoulder; a projectile having its forward end disposed in the inner end of said bore of said barrel and having its rear end extending beyond said shoulder of said gun body and into said firing-charge chamber; walls forming an annular groove in said projectile spaced a short distance from the rear end thereof; an annular collar having an inner annular portion thereof resting in said annular groove, means securing said inner annular portion within said groove, said collar extending radially outwardly from said projectile so that it lies between said shoulder and said end of said barrel in a position to be gripped between said shoulder and said inner end of said barrel, said collar supporting said projectile in a position retracted inwardly of the inner end of said barrel so as to rest partly in said firing-charge chamber and partly in said bore, and said collar restraining said projectile from inward or outward movement until the charge in said firing-charge chamber has been ignited and sufficient pressure developed to shear said collar, and means for firing a charge in said firing-charge chamber.

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