May 23, 1944. W. S. REYNOLDS 2,349,677

METHOD OF MAKING PROJECTILES

Filed Oct. 31, 1939

Fig. 1

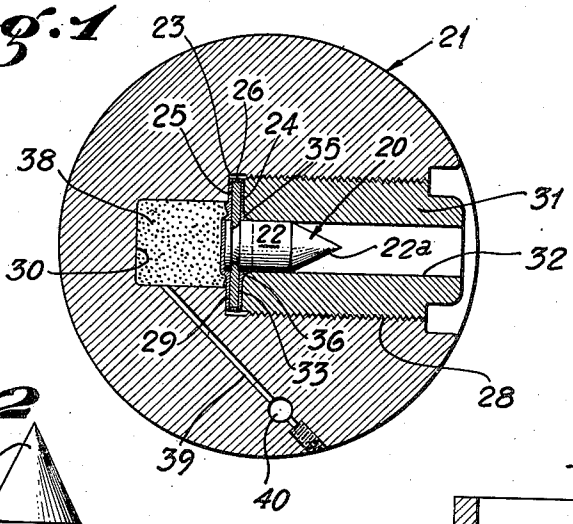


Fig. 2

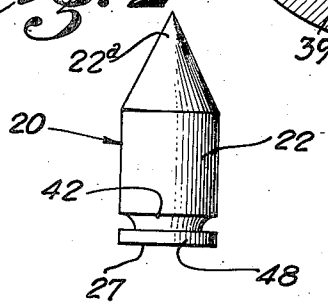


Fig. 4

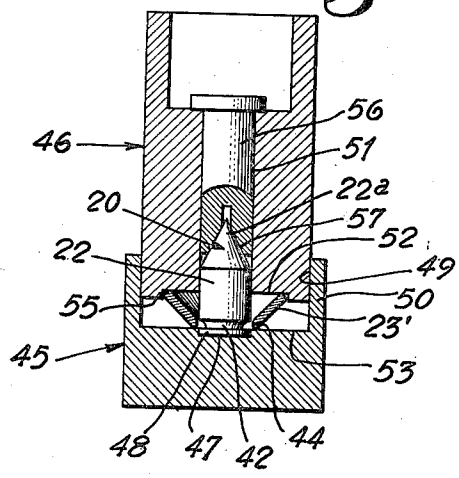


Fig. 3

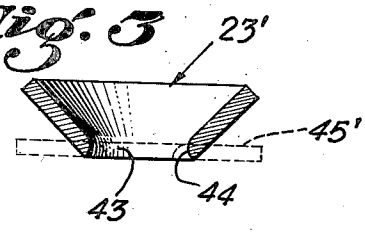


Fig. 5

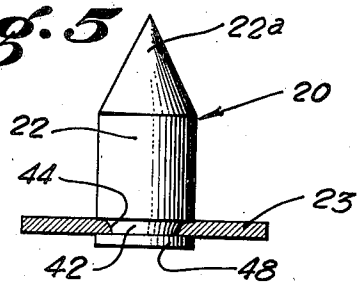
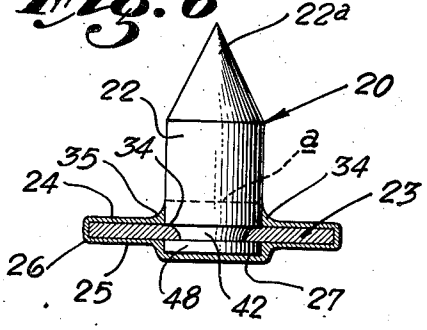


Fig. 6



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2,349,677

METHOD OF MAKING PROJECTILES

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Application October 31, 1939, Serial No. 302,160

7 Claims. (Cl. 29—1.22)

My invention relates to a method and apparatus for making a projectile having principal utility in a well casing perforating gun. This application is a continuation-in-part of my copending application, Serial No. 195,759, filed March 14, 1938, now Patent No. 2,257,276, granted September 30, 1941, for Perforating gun and projectile therefor.

Well casings are being perforated so as to provide entrance openings by projectiles fired from a gun which is lowered into a well to a desired position by use of a suitable suspension means such as a steel cable. To assure complete perforation under all conditions of operation it is necessary that the projectile be propelled at high velocity. The projectile made in accordance with the invention herein disclosed is provided with a radially extending collar which serves several valuable purposes, among which is the restraining of the projectile from movement until an extremely high pressure is built up on the powder chamber whereupon the collar is sheared and the projectile is suddenly released and propelled at high velocity.

It is an object of the invention to provide a simple method and a simple apparatus whereby a projectile may be readily made having a collar preferably at its inner end, which collar is made as a part separate from the projectile body and is securely fixed in operative position on the projectile body.

It is a further object of the invention to provide a method of making a projectile wherein the projectile body is provided with a radially extending collar and wherein a suitable layer of relatively soft seal forming material is applied to the projectile so as to cover at least one face of the collar in a manner to be engaged and deformed by a supporting wall in the perforator gun with which the projectile is used, thereby positively sealing the inner end of the gun barrel against leakage of water into the powder chamber.

It is a further object of the invention to provide a method of making a projectile wherein the projectile body is provided with a radially extending collar and a layer of yieldable seal forming material is applied to the inner end portion of the projectile in a position to cover at least the front and rear faces of the collar and the portion of the projectile body adjacent the front or outer face of the collar.

A further object of the invention is to provide a method of making a projectile wherein a projectile body is provided with a groove preferably near its inner end and a dished washer having an opening defined by an inner edge wall is seated in the groove by flattening the washer while the inner edge is maintained in alignment with the groove so that as the diameter of the opening in the washer is decreased, such inner edge will be contracted into the groove.

A further object of the invention is to provide a device usable in carrying out the method, having a pair of cooperating parts, one of which has means for holding the projectile body and the inner edge of the dished plate in cooperative position, and the other of the parts has an opening to receive the projectile body and also a wall or shoulder to engage a side portion of the washer so as to flatten the same, thereby causing the inner edge of the washer to enter the groove of the projectile body.

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 cross-section showing a projectile, according to my invention, in operative position in the barrel bore of a well casing perforating gun.

Fig. 2 is an enlarged elevational view of a projectile body.

Fig. 3 is an enlarged cross-section showing a dished washer which is to be secured on the projectile body of Fig. 2 in the manner to form a collar.

Fig. 4 is a sectional view showing the projectile body and dished washer in position in a device for applying the plate to the body.

Fig. 5 is a partly sectioned view of a projectile after the washer has been secured on the body.

Fig. 6 is an enlarged partly sectioned elevation showing the finished projectile.

In Fig. 1 I show a projectile 20 in operative position in a perforator gun 21. The projectile 20, as shown in Fig. 6, has a cylindrical body 22 which may be provided with a point 22a at its front end. On the rearward or inner portions of the projectile body 22 there is a radially extending collar 23 having layers 24 and 25 of yieldable seal forming material on the outer and inner faces thereof. The layers 24 and 25 are preferably integral parts of a continuous layer 26, extending from a circumferential line a on the projectile body 22, over the exposed surfaces of the collar 23, and in some instances over the inner extremity 27 of the projectile body 22. This layer of yieldable material 26 is preferably lead

or similar fusible, metallic substance affixed to the projectile as shown by fusion.

Referring again to Fig. 1, the perforator gun has a threaded opening 28 with a shoulder 29 at its inner end and a powder chamber 30 leading rearward or leftward from the shoulder 29. A gun barrel 31 is externally threaded so that it may be screwed into the opening 28, this barrel having a bore 32 and a rear end face 33 which lies in spaced relation to the shoulder 29 when the barrel 31 is in operative position. The body 22 of the projectile 20 lies in the inner end of the bore 32 and the collar 23 projects outward between the shoulder 29 and the rear end face 33 of the barrel 31, so as to be tightly clamped between the shoulder and the face 33 when the barrel 31 is screwed into position. As the result of pressure applied by the screwing of the barrel 31 into place, the shoulder 29 presses into the layer 25 of yieldable material, thereby forming a tight seal around the front end of the powder chamber 31. It will be noted that the layer of sealing material extends across and/or into the joint 34 between the projectile body 22 and the collar 23 so that there can be no leakage of fluid at this joint into the powder chamber. As shown in Fig. 6, the inner portion of the layer 24 extends across the joint 34 and forms a fillet 35 in the corner between the outer face of the collar 23 and the surface of the projectile body 22 lying adjacent thereto. As shown in Fig. 1, this fillet 35 enters into a flared space 36 formed at the inner end of the bore 32, the result being that when the barrel 31 is screwed tightly into position, the material entering into the fillet 35 will be forced tightly down into the joint 34 so that the maintenance of a perfect seal is assured.

The powder chamber 30 receives a charge of powder 38 which is fired by a flame which is conveyed through an ignition passage 39 from a flame passage 40 in the body of the perforating gun 21. As this powder burns the pressure builds up in the chamber 30 until the shearing strength of the collar 23 is exceeded, with the result that the collar is sheared off substantially even with the outer face of the projectile body and the projectile 20 is propelled at high velocity through the bore 32.

In the making of the projectile 20, the body 22 is formed with a groove 42 at its inner end, as shown in Fig. 2. As shown in Fig. 3, an annular dished washer 23' is formed, this washer having an opening 43 of such diameter that it may be passed over the projectile body 22 to a position wherein the inner edge 44 of the washer 23 will coincide with the groove 42. The dished washer 23' may be formed by stamping out a flat washer from sheet metal, as indicated by dotted lines 45' in Fig. 3, and the washer 45' may be stamped to dished shape as shown in full lines. The projectile body 22 and the dished washer 23' are placed in the device shown in Fig. 4, which device comprises a pair of cooperating parts 45 and 46. The part 45 may comprise a base having therein a recess 47 to receive the short cylindrical portion 48 of the body 22 which projects below the lower edge of the groove 42. The part 46 may comprise a traveling head guided by engagement at 49, with a wall 50 which projects upward from the base 45. This head 46 has an opening 51 to receive the projectile body 22 and has a lower face 52 which will engage the upper side of the dished washer 23' which is placed around the projectile body in such position that the inner edge 44 thereof will rest against the face 53 of the base 45 in a position around the groove 42. Downward movement of the head 46 will force the dished plate 23' down against the face 53, thereby flattening the dished plate 23' and causing the inner edge 44 thereof to enter the groove 42, as shown in Fig. 5, thereby securing on the body 22 a radially projecting plate 23. The head 46 has at its lower end, in a position around the face 52, an inwardly faced shoulder 55 which limits the expansion of the peripheral portion of the dished plate 23 as the same is flattened, thereby assuring that the inner edge 44 thereof will be fully contracted in the groove 42. A plunger 56, having a conical socket 57 in its lower end to receive the point of the projectile body 22, is placed in the opening 51 and serves as a means for ejecting the projectile from the head 46 after the securing of the collar 23 on the projectile body 22.

The layer 26 of seal forming material is then applied. This is preferably accomplished in the following manner. The inner portion of the projectile, that is, that portion having the collar 23 thereon, is first dipped in a soldering compound, after which the inner portion of the projectile is immersed in a bath of hot metal of solder like characteristics, for example, lead, zinc, tin, or other deformable gasket forming alloy. The projectile is preferably lowered into the body of melted metal to such position that the circumferential line *a* will be substantially even with the surface of the molten metal, the result being that there is applied to the inner end of the projectile a layer of gasket forming material which coats the inner and outer surfaces of the collar 23 and also adheres to the portion of the projectile body adjacent the outer face of the collar 23, the portion of the applied metal which adheres to the body 22 being tapered and forming the fillet 35. The bottom wall of the groove 42 is preferably flared in forward direction so that it will enlarge forwardly with respect to the direction of travel of the projectile. The inner edge 44 of the collar 23 is flared in a corresponding manner to match the shape of the groove 42. The purpose of forming these cooperating parts in this manner is so that when gas pressure is applied to that portion of the collar 23 left in the groove when the collar 23 is sheared, such forward gas pressure will tend to move the ring of metal forward in the groove so that the same will be expanded by the flaring bottom wall of the groove 42 into tight engagement with the barrel 31. The inner end 48 of the projectile body 22 projects a short distance into the powder chamber 30, thereby adding to the distance the projectile 22 may travel in the gun barrel 32, before clearing the end of same and thereby increase the velocity of the projectile.

I claim as my invention:

1. A method of making a projectile of the character described having a collar spaced from its inner end, comprising: forming a projectile body with an annular groove in its circumferential face; forming a dished washer having an opening of such size that said washer may be placed on said body with its opening coinciding with said groove; flattening said dished washer so as to contract the annular portion thereof surrounding said opening into said groove, whereby said washer will be secured in said groove and form a collar projecting from said projectile body; and fusing layers of relatively soft metal on the inner end of said projectile so that the same will cover the front and rear faces of said

collar and the portion of said body adjacent the front face of said collar.

2. A method of making a projectile of the character described having a collar spaced from its inner end, comprising: forming a projectile body with an annular groove in its circumferential face; forming a dished washer having an opening of such size that said washer may be placed on said body with its opening coinciding with said groove; flattening said dished washer so as to contract the annular portion thereof surrounding said opening into said groove, whereby said washer will be secured in said groove and form a collar projecting from said projectile body; and fusing a layer of relatively soft metal on at least one face of said collar so as to cover the joint formed between said collar and said body.

3. A method of making a projectile of the character described having a collar spaced from its inner end, comprising: forming a projectile body with an annular groove in its circumferential face; forming a dished washer having an opening of such size that said washer may be placed on said body with its opening coinciding with said groove; flattening said dished washer so as to contract the annular portion thereof surrounding said opening into said groove, whereby said washer will be secured in said groove and form a collar projecting from said projectile body; and affixing a layer of yieldable, seal forming material to said projectile so as to extend across at least one face of said collar.

4. A method of making a projectile having a collar near its inner end, for use in a well casing perforating gun of the character described, comprising: forming a projectile body with an annular groove near the inner end thereof; forming a collar with an opening of smaller diameter than the portion of said projectile body adjacent said groove; dishing said collar so that the opening thereof will be increased to such size that said collar may be moved onto said body to a position wherein the inner edge thereof will coincide with said groove; flattening said collar so as to cause said inner edge thereof to rest in said groove; and fusing a layer of relatively soft metal on the inner end of said projectile so that the same will cover the inner end of said body, the front and rear faces of said collar, and the portion of said body adjacent the front face of said collar.

5. A method of making a projectile having a collar spaced from its inner end, for use in a well casing perforating gun of the character described, comprising: forming a projectile body with an annular groove in the circumferential face thereof; forming a collar with an opening of smaller diameter than the portion of said projectile body adjacent said groove; dishing said collar so that the opening thereof will be increased to such size that said collar may be moved onto said body to a position wherein the inner edge thereof will coincide with said groove; flattening said collar so as to cause said inner edge thereof to rest in said groove; and fusing relatively soft metal on said projectile so that the same will cover a face of said collar and a portion of said body adjacent said collar.

6. A method of securing on a projectile body having a groove, a dished washer having an opening defined by an inner edge, comprising: holding the projectile body and the washer so that said inner edge and said groove will align; and producing relative movement of the inner and outer portions of said dished washer in opposite directions while restricting radial outward movement of its periphery so as to cause said inner edge thereof to enter said groove and to cause the periphery of said washer to have a predetermined external diameter.

7. A method of securing on a projectile body having a groove, a dished washer having an opening defined by an inner edge, comprising: holding the projectile body and the washer so that said inner edge and said groove will align; flattening said washer; and restraining radial expansion of the peripheral portion of said washer during flattening thereof.

WALDO S. REYNOLDS.