Jan. 5, 1943. A. J. COLLINS 2,307,360

WELL PERFORATING GUN

Filed Dec. 9, 1940 2 Sheets-Sheet 1

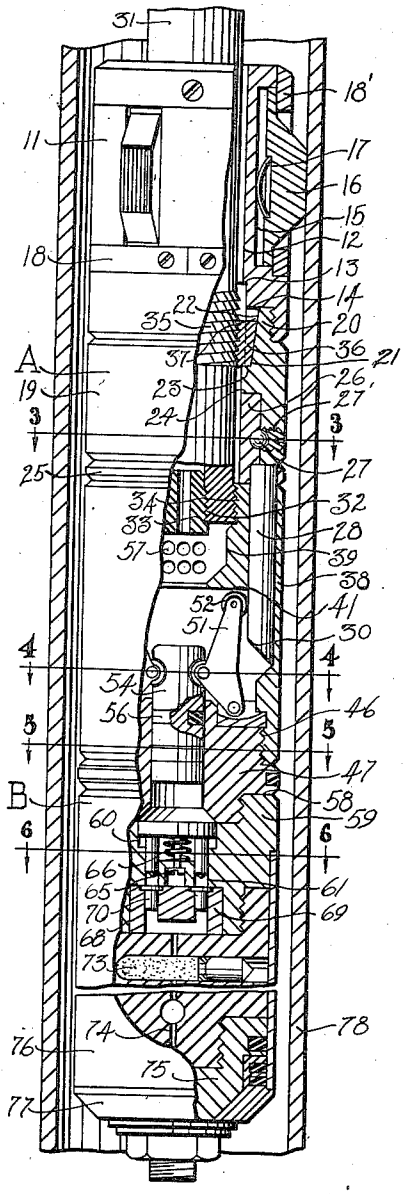


Fig. 1

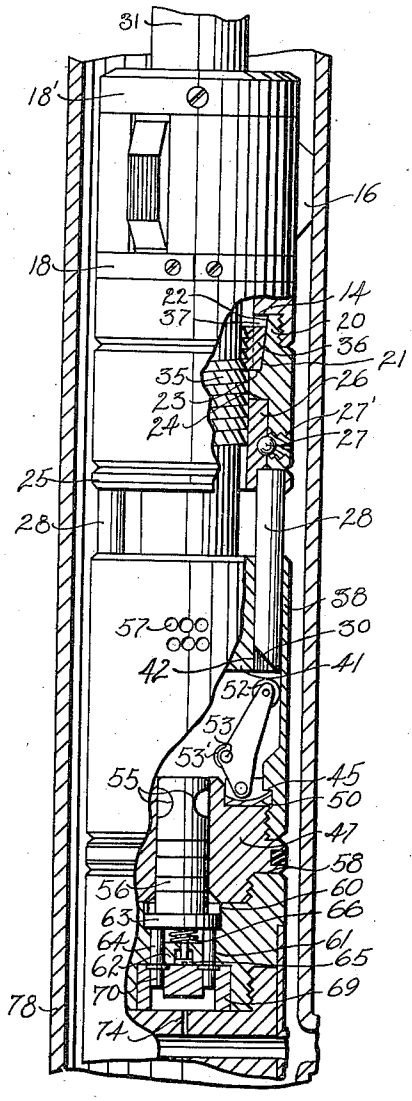


Fig. 2

Inventor

Authur J. Collins

By Jack R. Ahley

Attorney

Jan. 5, 1943. A. J. COLLINS 2,307,360

WELL PERFORATING GUN

Filed Dec. 9, 1940 2 Sheets-Sheet 2

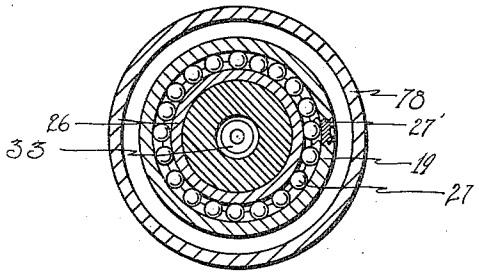


Fig. 3

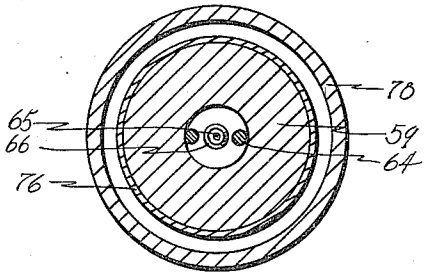


Fig. 6

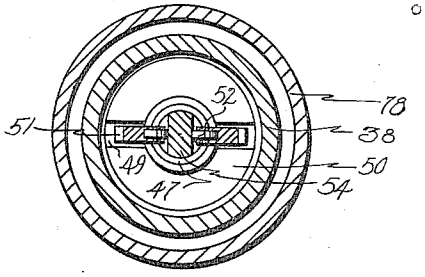


Fig. 4

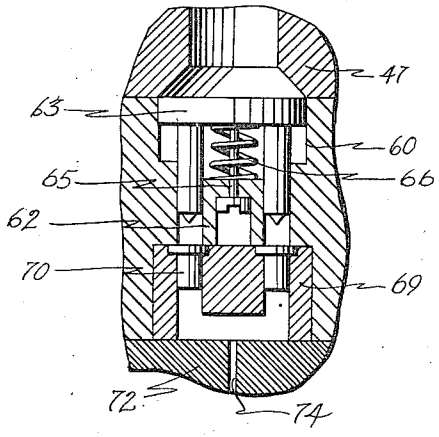


Fig. 7

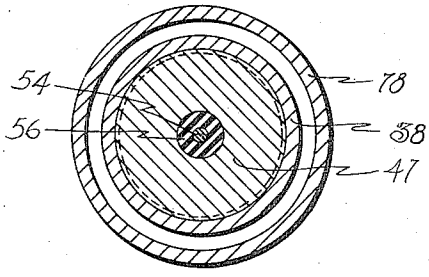


Fig. 5

Inventor

Arthur J. Collins

By Jackson & Ahley

Attorney

Patented Jan. 5, 1943

2,307,360

UNITED STATES PATENT OFFICE

2,307,360

WELL PERFORATING GUN

Arthur J. Collins, Corpus Christi, Tex.

Application December 9, 1940, Serial No. 369,147

10 Claims. (Cl. 164—0.5)

This invention relates to new and useful improvements in methods of and means for firing well perforating guns.

There are several types of perforating guns which are now commonly used, and are referred to as electrical guns and mechanical guns. In the field today an electrical gun is the most commonly used, and a user of an electrical gun has a certain degree of control over the firing of the gun which is not true of the present type of mechancal gun. However, an electrical gun has numerous disadvantages. The electrical circuit of the gun may develop a short, thereby causing the gun to fire accidentally, or it may be fired accidentally by static electricity set up in the gun while it is being run into the well casing. These disadvantages make an electrical gun dangerous to run.

It is pointed out that a mechanical gun has numerous disadvantages also, such as the operator not having the degree of control over the firing mechanism that he has in an electrical gun. A mechanical gun is usually fired by dropping a go-devil through the running tubing or along a wire line so as to fall upon a trigger or the like and cause said trigger to fire the gun. The dropping of a go-devil oftentimes has its disadvantages as said go-devil may hang up within the casing, thereby not permitting it to fall so as to trip said trigger; and also the mud within the tubing retards the downward travel of the go-devil. It has often been experienced that when the gun did not fire, it was brought to the surface, the go-devil becoming dislodged fell and fired the gun.

As can be seen, both an electrical and a mechanical gun may fire accidentally due to the lack of control over the firing mechanism; and, therefore, it is one object of this invention to provide an improved method of firing a gun whereby the gun is under the positive control of the operator at all times and can not be accidentally fired.

An important object of the invention is to provide an improved method, of the character described, wherein a gun equipped with mechanical firing means is lowered into the well and the firing means is subjected to a pressure fluid by holding it under restraint and the firing mens is then released from the surface of the well whereby the pressure fluid operates the firing means.

A further object of the invention is to provide an improved method of actuating the firing elements of a perforating gun entirely by fluid pressure.

Another object of the invention is to provide an improved method of firing a perforating gun either by fluid pressure in the well bore or by an auxiliary pressure fluid introduced into the bore of the gun.

A still further object of the invention is to provide an improved method of firing a gun wherein the efficiency of the gun is not affected by the depth of the well, but, to the contrary, the efficiency of the gun is increased due to the fluid pressure within the well.

Another object of the invention is to provide an improved gun of the type described, wherein the explosive charge is mechanically detonated by means normally held in restraint and adapted to be impelled by a pressure fluid when released.

Still another object of the invention is to provide a gun of the type set forth, wherein the mechanical detonating means, which is under fluid pressure, is released from the surface, thus providing definite control thereof.

A further object of the invention is to provide an improved method wherein the firing charge is mechanically detonated, and the mechanical means is actuated by a pressure fluid.

A construction designed to carry out the invention will be hereinafter described, together with other features of the invention.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawings, in which an example of the invention is shown, and wherein:

Figure 1 is a view, partly in elevation and partly in section, of a gun constructed in accordance with the invention and adapted to carry out the method, and

Figure 2 is a view, similar to Figure 1, showing the gun after it has been fired,

Figure 3 is a horizontal cross-sectional view taken on the line 3—3 of Figure 1,

Figure 4 is a horizontal cross-sectional view taken on the line 4—4 of Figure 1,

Figure 5 is a horizontal cross-sectional view taken on the line 5—5 of Figure 1,

Figure 6 is a horizontal cross-sectional view taken on the line 6—6 of Figure 1, and

Figure 7 is an enlarged vertical view, partly in section and partly in elevation, showing the detonating and percussion caps.

In the drawings, the numeral 10 designates a sectional gun. The gun has a head A at its upper end which forms its upper section, and a firing portion B at its lower end which forms its lower section. The head A includes a tubular

sleeve 11 at its upper end, and the sleeve is provided with a bore 12 extending therethrough. The lower end of the bore 12 is counterbored to form a shoulder 13. Below the shoulder 13, the bore is enlarged to provide a lower shoulder 14, and the enlarged portion below the shoulder 14 is internally screw-threaded. The exterior of the sleeve 11 is provided with a plurality of inwardly-extending vertical recesses 15 adapted to receive dogs 16. The dogs are forced outwardly beyond the surface of the sleeve by an upright flat spring 17 disposed within the recesses. A collar 18 lies around the lower end of the recesses 15 and is embedded within the sleeve 11. A similar collar 18' lies around the upper end of said recesses and is also embedded within the sleeve. The ends of the dogs underlie the collars, thereby the collars retain the dogs and the springs 17 are urging the dogs outwardly at all times.

A sleeve 19 is provided with an upstanding screw-threaded pin 20 on its upper end which is screwed into the enlarged portion of the sleeve 11 so as to abut the shoulder 14. The sleeve 19 is provided with a bore 21 which is enlarged and tapered outwardly at its upper end to form a bowl 22 and a shoulder 23 at the lower end of said bowl. Below the shoulder 23, the bore is further enlarged to form a shoulder 24. A ring 25 abuts the lower end of the sleeve 19, and has an annular upstanding neck 26 provided on its periphery. A plurality of balls 27 lie between the upstanding neck and the inner periphery of the sleeve 19 so as to rotatably lock the neck and sleeve together. It is pointed out that the balls are inserted through an opening 27' in the sleeve 19 in the usual manner. The ring 25 carries a plurality of depending rods 28 which are securely fastened to the ring 25. It is pointed out that the ring 25 and the upstanding neck 26 are free to rotate in relation to the sleeve 19. The lower ends of the rods 28 are each cut on its inner side so as to form a wedge 30.

A mandrel 31 extends through the head A and has its upper end connected to the tubing, or other suitable means, upon which the device is run into the well. The lower end of the mandrel is provided with internal screw threads 32 to which is connected a choke 33. The mandrel is also provided with external screw threads 34. A portion 35 of the outer surface of the mandrel 31 is provided with screw threads which are of saw-tooth or ratchet cross-section. Surrounding the mandrel 31, and engaging within the bowl 22 of the sleeve 19, is a split nut 36 which has its outer surface tapered correspondingly to the bowl 22, and its inner surface screw-threaded to mate with the screw threads 35 of the mandrel 31.

In order to hold the nut aganist rotation, a key 37, embedded in the bowl, engages in the split or gap of said nut. Thus the construction of the teeth of the mandrel and the bowl are so as to permit the mandrel to be moved upwardly through said nut. The nut is elevated in the bowl sufficiently to permit the nut to expand, thereby allowing the threads to pass each other. When the nut is moved upwardly into the enlarged portion of the bowl 22, it will be free and may spread so that the threads will not be in constant engagement and will not act to screw said mandrel downwardly; but, as the threads engage, the nut will spread and snap over the threads of the mandrel. However, when the nut is down within the lower portion of the bowl 22, the threads will act so as to screw the mandrel downwardly when the mandrel is rotated. This is clearly brought out in my co-pending application, Serial No. 318,050, filed February 9, 1940.

A sleeve 38, having a bore 39, is attached to the lower end of the mandrel 31 by means of the screw threads 34 which mate with the screw threads of the bore 39 within the sleeve 38. The bore 39 is decreased in size so as to form an orifice 40. Below the orifice 40, the bore is again enlarged greater than that portion above the orifice, so as to form an annular shoulder 41. The sleeve 38 is provided with a plurality of downwardly-directed openings 42 through which the rods 28 may pass (Figure 1). At a point below the shoulder 41, there is provided an inwardly-directed annular flange 43. The lower portion of the flange 43 forms a shoulder 45, and the sleeve below the shoulder is internally screw-threaded at 46.

A cylinder block 47 is connected to the sleeve 38 by means of the screw threads 46. The block is provided with an axial bore 48 extending therethrough. The upper end of said block is countersunk to form an annular recess 49 surrounding the bore 48. It is pointed out that the recess does not come in contact wtih the shoulder 45 of the flange 43. Disposed between the shoulder and the recess is an annular ring 50 which is securely held in place by the shoulder 45 and the bottom of the recess 49. A plurality of arms 51 are pivotally connected to the ring 50, and are provided with a roller 52 at their upper ends. An inwardly-directed lug 53, carrying a roller 53', is provided on each of said arms below the roller 52 and above the ring 50. It is pointed out that the arms are always in alinement with the rods 28 and the openings 42.

A piston or hammer 54 has a tight sliding fit within the axial bore 48 of the block 47, and is provided near its upper end with a plurality of recesses 55 so that when the hammer is in the position shown in Figure 1, the rollers 53' may enter said recesses and hold the hammer in said position, due to the fact that the rods 28 are urging the arms 50 inwardly. Below the recesses 55, the hammer is provided with a plurality of packing rings 56, so that fluid from the bore 39 may not flow downwardly past the hammer. The sleeve 38, above the orifice 40, is provided with a plurality of openings 57 which establish communication between the bore 39 and the exterior of the sleeve 38. The lower end of the block 47 is reduced to form a shoulder 58, and the portion below the shoulder is externally screw-threaded. Attached to the lower end of the block 47 is a sub 59. The sub has its upper end countersunk and internally screw-threaded so as to mate with the lower end of the block 47, and the central portion of the countersunk portion of the sub 59 is further countersunk so as to form a recess 60. Depending downwardly from the recess 60 is a plurality of longitudinal openings 61, and lying in between the lower ends of the openings 61 is a guide member 62.

A piston 63 is slidable within the countersunk recess 60, and has a plurality of depending firing pins 64 which are slidable within the openings 61. Attached to the piston 63, and slidable within the guide member 62, is a pin 65 which limits the upward travel of the piston 63. Confined between the upper end of the guide 62 and the lower side of the piston 63, is a coiled spring 66, which spring is acting to urge the piston 63 upwardly at all times, and the pin 65 limits this upward movement.

The lower end of the sub 59 has its outer

circumference reduced to form a shoulder 67, and is provided with an enlarged recess 68 on its bottom. Slidable within the recess 68 is an initial firing means 69 which contains a pair of cartridges 70 that are in axial alinement with the openings 61. A gun barrel 71 is attached to the lower end of the sub 59. As will be seen in the drawings, the upper end of the barrel is provided with a countersunk portion 72, and is internally screw-threaded so as to confine the initial firing charge within the recess 68. The barrel is preferably cylindrical in shape, and is provided with a plurality of elongate transverse recesses or firing chambers 73 extending inwardly toward the center of said barrel. It is pointed out that the chambers are preferably cylindrical in cross-section, and constitute a plurality of firing chambers so that cartridges or explosive charges may be inserted therein. An axial channel 74 extends throughout the barrel 71, and is so disposed as to underlie the cartridges 70. The lower end of the barrel is reduced and internally screw-threaded so as to receive a collar 75 which is attached thereto. A sleeve 76 surrounds the gun barrel 71, and is suitably packed off so as to prevent moisture from entering said barrel. The lower end of the collar 75 is reduced and receives a retaining collar 77. The collar 77 abuts the lower end of the sleeve 76 and acts to retain the same on said barrel.

In the operation of the gun herein described, the gun is lowered into the well by means of a tubing, or other suitable means, which is connected to the upper end of the mandrel 31. When the point at which it is desired to perforate has been reached, the tubing is rotated. In the usual case the well has a certain amount of fluid within the casing 78, but the amount of fluid is not sufficient to flow to the top of the well. In some instances, it may be desired to shoot a well which is flowing for various reasons; however, when the stratum or point has been reached at which the casing 78 is desired to be perforated, as above stated, the pipe is rotated which will rotate the mandrel 31. The dogs 16, being in engagement with the casing 78, will not allow the head A to rotate. However, the portion B of the gun will rotate due to the fact that the lower end of the mandrel 31 is connected therewith.

The rods 28, being within the openings 42, will rotate with the portion B, and the ring 25 and the upstanding neck 26 will also rotate with the portion B. As the mandrel 31 is rotated, the head A will not be rotated but will remain stationary. The mandrel will be fed through the nut 36 due to the fact that the pipe is lowered as it is rotated, thereby lowering the portion B away from the portion A and withdrawing the rods 28 out of the openings 42 until said rods have reached the position shown in Figure 2. At this time the arms 51 are free to pivot outwardly, thereby releasing the hammer 54. The hammer has a tight sliding fit within the bore 48 of the block 47 and therefore will not readily fall. Pressure exerted by the fluid within the casing is free to enter through the ports 57 and act upon the top of the hammer 54, thereby causing the hammer to move downwardly and strike the piston 63, which will also be carried downwardly. The pins 64 will strike the cartridges 70, thereby exploding the same, and the flame of the explosion will be conducted down through the channel 74 to the cartridges within the chamber 73. The firing may be accomplished by pins or a fire train as is disclosed in my copending application, Serial No. 318,049, filed February 9, 1940; thus causing the casing 78 to be perforated.

In the event the hammer 54 should accidently fall and strike the piston 63, when there is no pressure exerted on the top of said hammer, the spring 66 is of sufficient strength to hold the hammer upwardly, together with the piston 63, so that the cartridges 70 may not be discharged until pressure is applied to the top of the hammer. Thus, as will be seen, this gun depends upon pressure acting upon the top of the hammer 54 to fire the same.

In some instances, there is not enough fluid within the casing 78 to apply sufficient pressure to the top of the hammer. In this case, the ports 57 may be left out of the gun or suitably blocked by a sleeve (not shown), or in any other suitable manner. Fluid may then be pumped down through the tubing and through the mandrel 31 so that it will act upon the top of the hammer 54. Thus the gun cannot be accidently fired due to the fact that pressure is required to fire the gun and the atmospheric pressure under which the gun is assembled is not sufficient to fire said gun.

It is further pointed out that as the gun is lowered farther into the well, there will be more fluid above the hammer 54. In this manner there will be a hydrostatic pressure built up above the hammer and, in the instance where pressure is introduced into the tubing, there will be built up a hydrostatic pressure within the tubing. In many instances, where there is not a sufficient amount of fluid within the casing 78 to fire the gun, auxiliary fluid may be introduced into the casing so as to build up a hydrostatic head to fire the gun. This particular method of firing a gun by pressure can be applied to various guns and is not limited to the structure herein disclosed; however, the structure illustrated may be used to perform the method of this invention and eliminates disadvantages of guns now in common use.

Various changes, alterations and modifications may be made in the size, shape and arrangement of the herein described elements, within the scope of the appended claims.

What I claim and desire to secure by Letters Patent is:

1. A well bore perforating apparatus composed of a gun having a cartridge carrying member, spring tensioned means in the member to fire the cartridge, a hammer slidably within the member, means to latch the hammer at points spaced from the firing means, means for unlatching the hammer, and means for supplying fluid pressure to the member to act upon the hammer thereby to cause same to actuate the firing means.

2. A well bore perforating apparatus in accordance with claim 1, wherein the spring means is of a strength to resist operation of the firing means upon the hammer moving into engagement therewith when not under the influence of the fluid pressure.

3. A well bore perforating apparatus including an upper member receivable in the casing, means carried by the member and engageable with the casing to hold the member against rotation, a lower member, a rotatable mandrel extending through the upper member and into the lower member, means which upon rotation of the mandrel effects sliding movement of the lower member away from the upper member and while the latter remains stationary, cartridge firing means in the lower member, a slidable hammer in the lower member for actuating the firing means, means

for releasably holding the hammer inoperative, means having connection with the upper member for releasing the means which holds the hammer inoperative, and means for conveying fluid pressure into the lower member to act upon the hammer thereby to move same to cartridge firing position.

4. A well bore perforating apparatus in accordance with claim 3, wherein the means to releasably hold the hammer inoperative consists of pivoted latches and wherein the means to release the hammer holding means consists of rods having connection with the upper member to partake of the sliding movement thereof and slidably connected to the lower member, to move the latches to unlatched position thereby to release the hammer.

5. A well bore perforating apparatus composed of a gun having a cartridge carrying member, a second member, a rotatable mandrel connecting the members, a hammer for firing the charge carried by one of the members, means to latch the hammer spaced from the firing means, means carried by the other member for effecting release of the latching means, means operable by the mandrel to move the members toward each other upon rotation of the mandrel, and means to actuate the hammer to fire the charge upon release of the latching means from the hammer.

6. A well bore perforating apparatus in accordance with claim 5, wherein the means to release the latching means is slidably mounted in the other member.

7. A perforating gun firing apparatus including, a suspending mandrel, a non-rotatable member carried by said mandrel, a rotatable member carried by said mandrel, fluid actuated firing means carried by the rotatable member, latch means carried by the rotatable member for holding the means inoperative, and means for releasing the latch means actuated by the rotation of the mandrel and the rotatable member.

8. A perforating gun firing apparatus set forth in claim 7 wherein the rotatable member is provided with inlets for the well fluid, and means for conducting the admitted well fluid to the firing means.

9. In a well gun firing device, the combination of a gun barrel, a support having means for connecting with said gun barrel and provided with a chamber, a firing hammer disposed and slidable within said chamber above the gun barrel, latch means carried by the support for holding the hammer in its inoperative position, rotatable means for unlocking said hammer, and fluid means for applying fluid pressure so as to actuate said hammer.

10. The method of firing a well bore perforating gun having an explosive responsive media for perforating the well bore and also having firing means to fire the explosive by impact, which resides in disposing the media substantially transversely of the longitudinal axis of the gun, holding the firing means at a point spaced above the media under restraint by engagement therewith to resist actuation thereof, lowering the gun into the well bore to be perforated, releasing the firing means to free the same from restraint when the point of firing in the well bore is reached, and constantly subjecting the firing means to fluid pressure throughout the period of restraint to impact the same against the explosive by movement of said firing means axially of said gun so as to fire the explosive and thereby discharge the media to perforate said well bore.

ARTHUR J. COLLINS.