Aug. 2, 1960 H. H. MOHAUPT 2,947,250

SHAPED CHARGE ASSEMBLY AND GUN

Filed Sept. 24, 1951 2 Sheets-Sheet 1

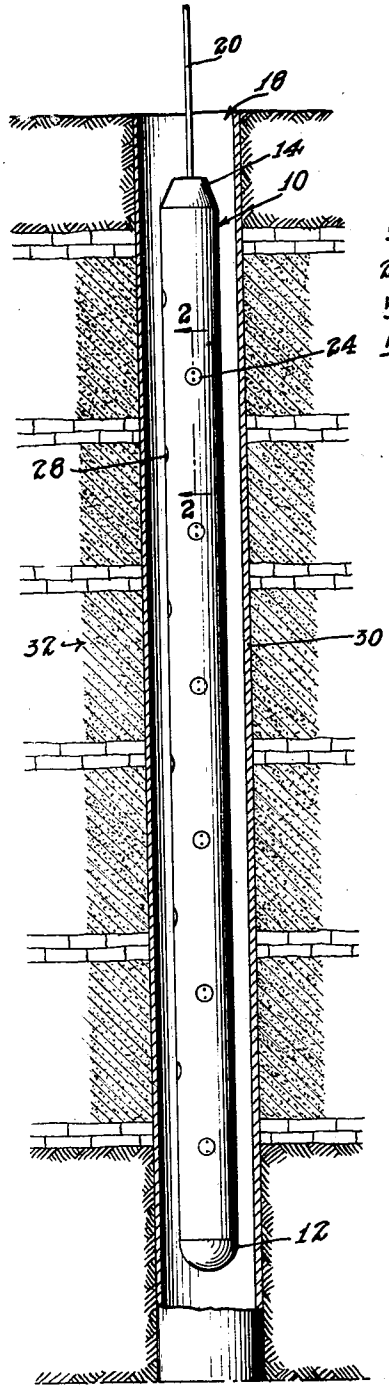


FIG. 1

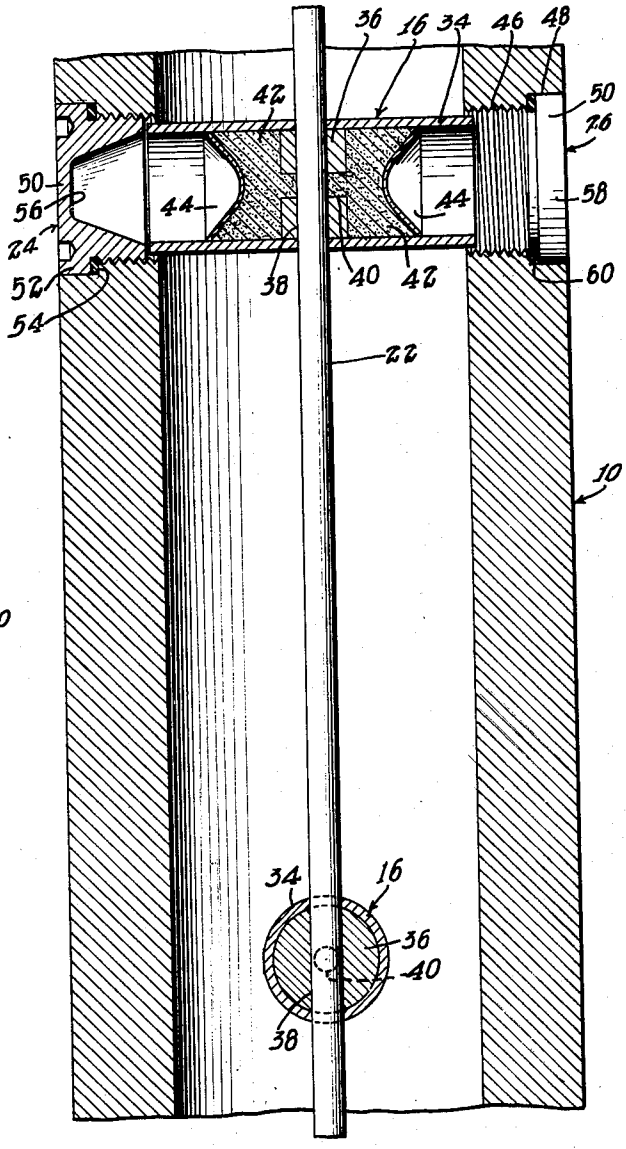


FIG. 2

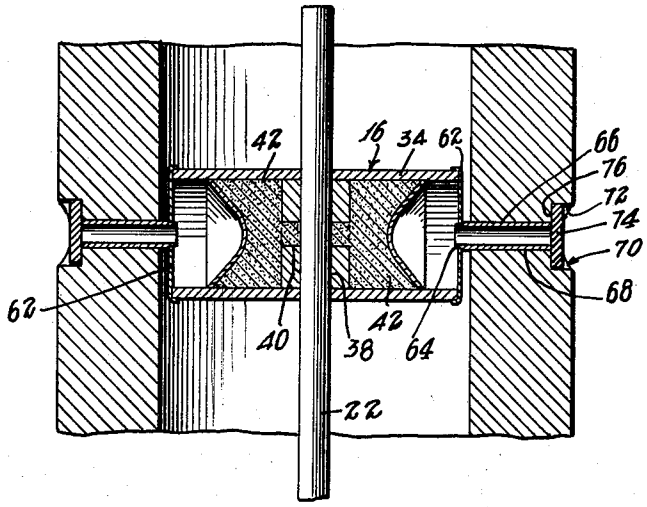
INVENTOR.
HENRY H. MOHAUPT
BY
Lyon & Lyon
ATTORNEYS

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FIG. 3



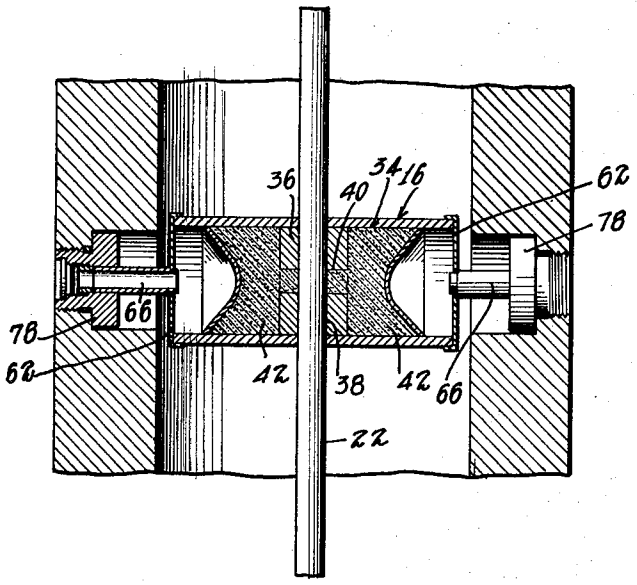


FIG. 4

INVENTOR.
HENRY H. MOHAUPT
BY Lyon & Lyon
ATTORNEYS

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SHAPED CHARGE ASSEMBLY AND GUN

Henry H. Mohaupt, Swampscott, Mass., assignor, by mesne assignments, to Welex, Inc., Fort Worth, Tex., a corporation of Delaware

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2 Claims. (Cl. 102—20)

This invention relates to improvements in means for perforating casing in wells and for perforating and fracturing earth formations around well bores.

In the perforating of oil wells by the use of shaped charges, i.e., explosive charges provided with surface cavities lined with an inert material such as metal, it has been the general practice to lower into the well a carrier for the charges, such carrier providing a gun body in which is placed a multiplicity of the charges which are detonated adjacent the formation at which perforation through the casing and into the formation is desired. This means of perforating has replaced to a substantial extent the earlier methods of perforating wells. However, the gun assemblies and charges heretofore used in the aforesaid shaped charge perforator are somewhat more expensive than the equipment used for the older type perforating, and it has been by reason of the increased efficiency and more effective results of shaped charge perforating that such new method has been able to replace to a large extent the older method. Obviously, any means for decreasing the cost and expense of shaped charge perforating would be of advantage to the newer method in competing with the older and would constitute a considerable contribution to the oil industry. It is with such a means that the instant invention is concerned.

One of the difficulties attendant upon prior shaped charge perforating has been occasioned in the assembly of the charges within the gun prior to running the gun into the well. Thus, in standard practice, a number of charges are placed laterally within the gun facing radially in different directions. Since the charge must be detonated rearwardly of the cavitied end of the explosive, it has been difficult to insert the various charges within the gun and at the same time efficiently provide the firing means, usually a detonating fuse, such as Primacord, adjacent the rearward end of each charge. Similarly, effective means for placing and securing the charges in their proper positions within the gun body have been difficult of achievement.

Consequently, an object of the instant invention is to provide a novel charge assembly adapted for combination with the gun in such a way as to provide an easy positioning of the detonating fuse in its proper proximity to the charges upon their positioning within the gun.

Similarly, it is an object of this invention to provide the charge assemblies themselves adapted for cooperative positioning within the gun in such manner as to make easier such positioning. In this there is provided a double ended charge assembly whereby the center of the charge is substantially filled with explosive and two cavitied ends provided, the charge thus firing in two directions. Double ended charges of this type are not new in the art, but this particular charge assembly and its adaptability to easy positioning within the gun body is believed to be novel.

Another expense attendant upon this type perforator lies in the nature of the charges themselves, such charges

including in the main a high density explosive difficult of initial detonation. Heretofore it has been the practice to use booster charges of lesser density, which booster charges are set off by the initial firing means and which in turn set off the higher density main charge. It is an object of this invention to provide means within the charge itself for doing away with the necessity of such a booster charge whereby again to decrease the cost of this type perforator.

Again an expense attendant upon shaped charge perforating lies in gun life problems. Upon use and reuse of a particular gun eventually such gun will outlive its usefulness. One of the principal causes of this is damage occasioned to the ports through which the charges must fire, such damage being occasioned by the force of the explosive against the port. It is an object of this invention to devise a charge assembly whereby such charge assembly inherently affords protection for the gun ports thereby preserving the longevity of the gun.

Further objects of the invention will appear hereinafter.

In the drawings:

Figure 1 shows a side elevtaional view of a gun body incorporating the novel assembly placed within a well;

Figure 2 shows a vertical section view taken on the line 2—2 of Figure 1;

Figure 3 shows in part a similar view to Figure 2, but demonstrates a modification of the invention; and

Figure 4 shows a view similar to Figure 3 demonstrating the same embodiment of Figure 3 in conjunction with a different type gun port sealing plug than is shown in Figure 3.

In essence, the invention of this application consists in the concept of providing a full enclosure within the charge assembly through which the detonating fuse may be strung so that the force of such detonating fuse available to detonate the charge will be enhanced and thus a booster made unnecessary. It likewise consists in the concept of providing bores in the charge assemblies, such bores being aligned upon positioning of the charges within the guns, so that the Primacord may be easily, efficiently and rapidly threaded through the said bores. A specific feature of the invention lies in the provision of a rigid housing for the charge assembly whereby the housing is of such a length as to extend at either end into the gun ports so that the charge may be inserted into the gun ports and retained in its proper position therein. Additionally, such extended housing provides a protection for the gun port against the force of the exploding charge.

Referring to the drawings and particularly to Figures 1 and 2, a gun body 10 preferably cylindrical is shown having a round closure 12 on its lower end and a frusto-conical cap 14 at its upper end. The upper cap encloses a detonating mechanism for the shaped charge assembly 16, and the gun is lowered into the well 18 by a conductor cable 20, which connects to the detonating mechanism which in turn fires a detonating fuse 22 which sets off the shaped charge assemblies 16. The shaped charge assemblies fire jets through the gun ports, such as 24, 26 and 28, which jets penetrate the well casing 30 and on into the formation 32.

Each shaped charge assembly includes a rigid housing 34, preferably cylindrical. Such housing encompasses a solid fuse-confining medial member 36, which medial member is provided with a transverse passageway 38 to receive the detonating fuse 22 and with an intersecting axial bore 40 communicating the detonating fuse with two main explosive charges 42. In the absence of booster charges, the explosive charges 42 fill their respective explosive chambers and also the axial bore 40. The explosive charges 42 are cavitied and provided with

liners 44 which are in retracted disposition with respect to the extremities of the housing 34 and which are directed outwardly through the gun ports 24 and 26.

The gun ports 24 and 26 are shown having interiorly threaded inner portions 46 and counterbored portions 48 of increased diameter. A threaded sealing plug 50 is shown for the gun port 24, having a flange 52 adapted to seat against the shoulder 54 of the gun body 10, there being a sealing ring interposed between said flange and said shoulder. Such sealing plug does not extend entirely through the gun port 24 and the said gun port 24 provides a retaining seat for the extremity of the housing 34. The sealing plug is dished as at 56 whereby but a thin metal wall provides the only obstruction for the passage of the jet through the said plug and through the well casing.

Instead of the sealing plug 50, there is shown for the port 26 a sealing disk 58, which sealing disk may be hammered into the counterbore 48 of the gun port 26 in tight fit atop the sealing ring 60. It will be understood that while two different sealing means are shown in this embodiment of the invention, such sealing means are not a part of the invention but are merely exemplified for brevity and to show the adaptability of the invention to a variety of such sealing plugs.

By the aforedescribed invention it may easily be seen that effective reduction in the cost of the shaped charge perforating method, both in the matter of material cost and in the matter of operational cost, is effected. The provision of the confining medial portion 36 enables the full explosive force of that portion of the detonating fuse within the charge assembly to be directed into the respective main explosive charges, thus avoiding the necessity of booster charges. The provision of a transverse passage in each charge assembly for receiving the detonating fuse and the aligned position of the passageways of the various charges upon assembly of the gun permits a simple threading of the detonating fuses through the charge assemblies after insertion of said assemblies within the gun. First, the charge assemblies are merely inserted through the gun ports, the sealing plugs or disks being removed. Next, the sealing plugs or disks may be placed in position. The closure 12 and cap 14 being removed, a needle attached to the detonating fuse may be inserted into the top or bottom of the gun and threaded through the passageways 38, the detonating fuse following therethrough. The closure 12 may be replaced, the fuse connected with the detonating mechanism in the cap 14, and the cap 14 replaced. Thereafter, the gun may be lowered into the well and the perforating accomplished in the usual manner. Upon use and reuse of the gun, it will be seen that the extremities of the housing 34 protect the bores of the gun ports 24 and 26 to a substantial extent from the deleterious effect of direct exposure to the explosive blast of the charge assembly.

Figure 3 shows a modification of the invention in that the length of the housing 34 is less than the interior diameter of the gun body. Instead of seating in the gun ports therefore the housing is provided with disks 62 having upturned retaining flanges, which disks are holed to receive the extremities 64 of retaining tubes 66. The retaining tubes 66 extend through the small bores 68 of the gun ports 70, which gun ports have large counterbores 72 to receive in close fit the sealing disks 74, such sealing disks being adapted to be hammered into the said counterbores against the shoulders 76 of the gun ports. O-rings or other sealing means may be provided between the disks and shoulders if found necessary.

It will be seen that in this modification of the invention, the shaped charge assembly may not be inserted through the gun ports. On the contrary, the charge assemblies must be inserted endwise into the gun and held in position by a suitable tool while the retaining tubes 66 are inserted into the gun ports into the engagement with the disks 62. Upon their positioning, however, the detonating fuse may be threaded through the passages 38 as before. It will be noted that in this embodiment of the invention, the charge assembly may have more than two extremities. For example, a charge assembly may have three extremities adapted to be directed outwardly through three gun ports circumferentially spaced 120° about the gun.

The departure of the adaptation of the invention shown in Figure 4 from the assembly shown in Figure 3 is only in the provision of the particular interiorly flanged sealing plugs 78. They include the retaining tubes 66 which are used to engage the disks 62 and thus secure the charge assembly 16 in proper position. Such sealing plugs are fully described and claimed in a copending application Serial No. 207,924, filed January 26, 1951, by Henry H. Mohaupt and Bruce Gilbert, entitled "Jet Carrier Sealing Plug," now U.S. Patent No. 2,765,739, issued October 9, 1956.

While there has been described what is at present considered a preferred embodiment of the present invention, it will be apparent to those skilled in the art that various modifications and changes may be made without departing from the essence of the invention, and it is intended to cover herein all such modifications and changes as come within the true scope and spirit of the appended claims.

I claim:

1. A shaped charge gun assembly for perforating well pipe comprising an elongated cylindrical gun body providing a coaxial cylindrical chamber therein, the side wall of said gun body providing therein longitudinally spaced groups of pairs of diametrically opposed cylindrical ports of the same diameter; plugs inserted in said ports; a plurality of shaped charge assemblies each positioned in said chamber at one of said port groups, each said shaped charge assembly comprising an open-ended cylindrical housing having an outside diameter smaller than the diameter of said ports and a length greater than the diameter of said chamber and less than the outside diameter of said gun body with its extremities extending into and seated in the ports of its associated port group, explosive within said housing, said explosive having a pair of lined cavities each facing outwardly of an end of said housing and through one of said ports, and means providing a transverse passage through said housing medially thereof and communicating with said explosive, said shaped charge assemblies being positioned to dispose said transverse passages in alignment axially of said chamber; and a detonation fuse threaded through said passages in detonating relation to the explosive in said shaped charge assemblies; whereby the extension into and seating of the extremities of each said housing in the ports of its associated port group interposes the extremities of said housing between said explosive and said ports to protect said ports to a substantial extent from the deleterious effect of direct exposure to the explosive blast of the charge assembly.

2. A shaped charge assembly as defined in claim 1 wherein said gun body has removable end closures, facilitating threading of said detonation fuse through said passages.

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