

April 24, 1956

G. F. TURECHEK
GUN PERFORATORS

2,742,857

Filed Jan. 12, 1950

2 Sheets-Sheet 1

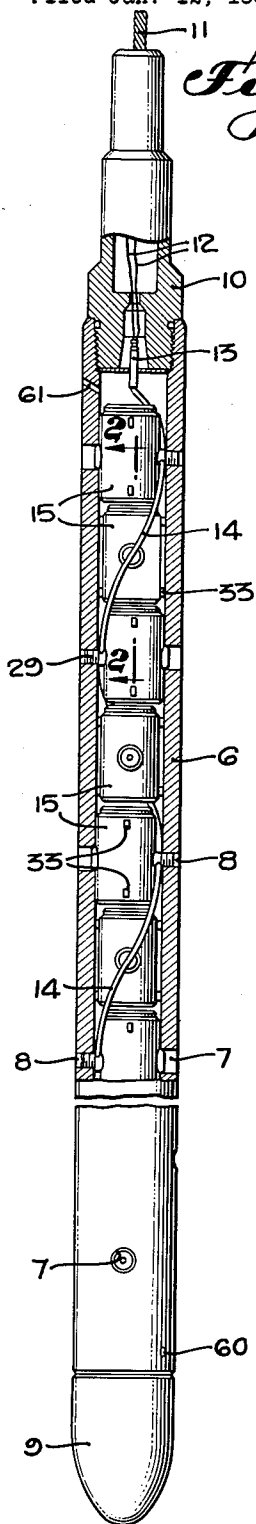


Fig. 1.

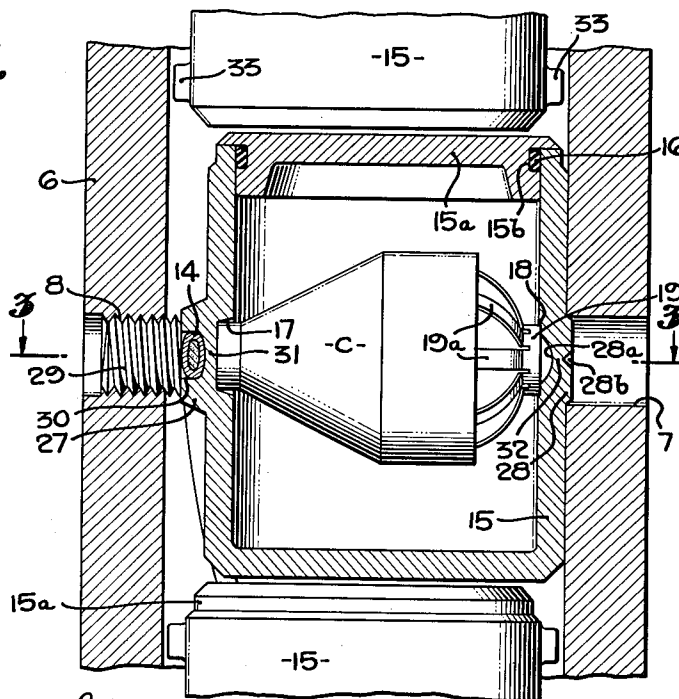


Fig. 2.

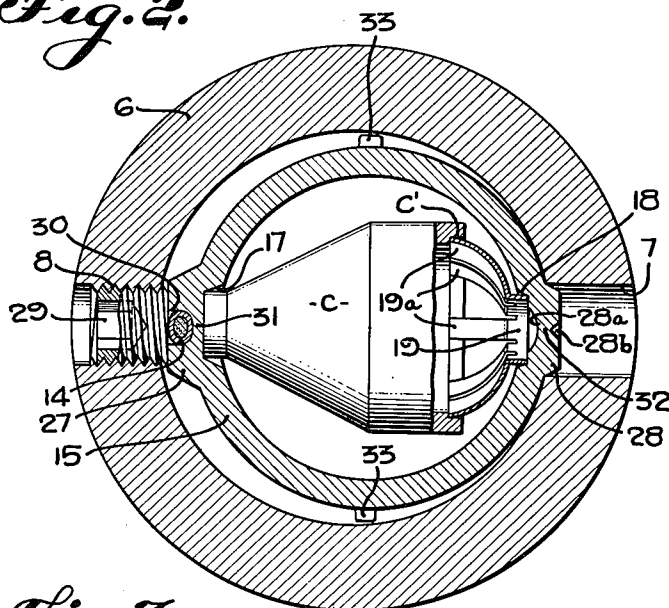


Fig. 3.

GEORGE F. TURECHEK,
INVENTOR.

BY

Lyle Dillon
ATTORNEY

April 24, 1956

G. F. TURECHEK

2,742,857

GUN PERFORATORS

Filed Jan. 12, 1950

2 Sheets-Sheet 2

Fig. 4.

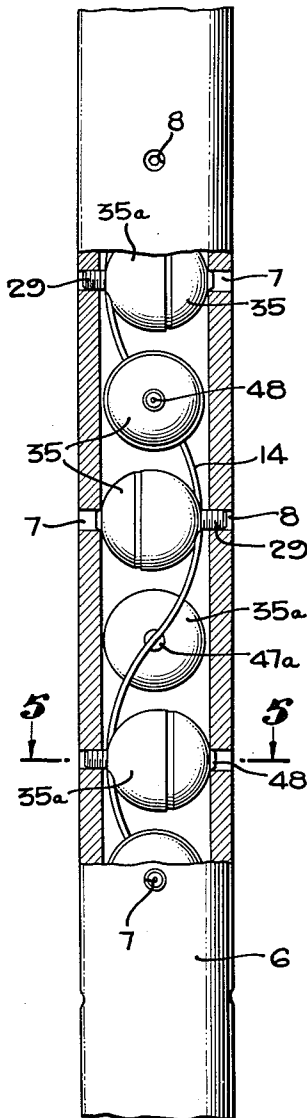
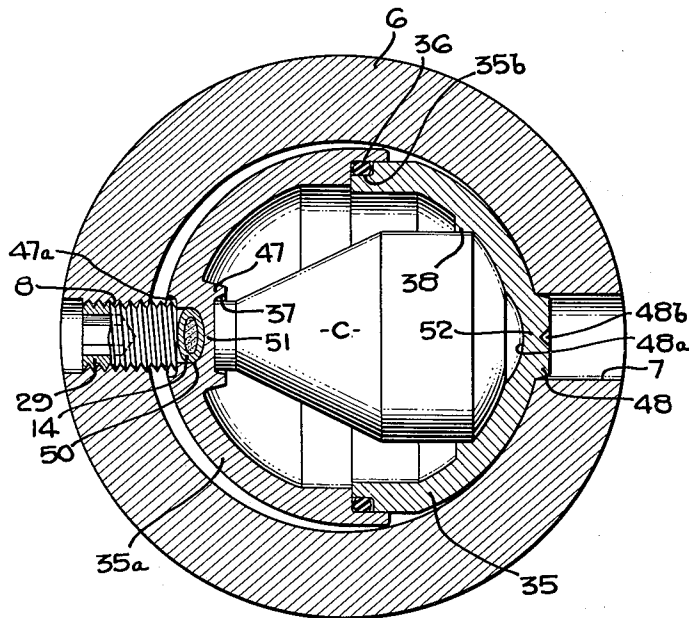


Fig. 5.

GEORGE F. TURECHEK,
INVENTOR.

BY

Lyle Dillon
ATTORNEY

1

2,742,857

GUN PERFORATORS

George F. Turechek, Los Angeles, Calif., assignor, by mesne assignments, to Lane-Wells Company, Los Angeles, Calif., a corporation of California

Application January 12, 1950, Serial No. 138,215

14 Claims. (Cl. 102—20)

This invention relates to gun perforators for use in deep wells to bring in the latter by perforating the well casings and the surrounding formations. More particularly it has to do with methods and apparatus for mounting explosive charges in gun bodies and in protecting the latter against damage and deformation from the firing of the same. It is particularly adapted for use with high explosive shaped charges of the type disclosed in the copending United States application of Will H. Lindsay, Jr. and Robert A. Phillips, Serial No. 106,567, filed July 25, 1949, now Patent No. 2,707,917, dated May 10, 1955.

Heretofore in the use of shaped detonating charges of the cone type in which the charge is contained in a casing or shell of plastic, such as Bakelite, Lucite, cellulose acetate or other such material, it has been the practice to exclude well fluid from the interior of the gun body by sealing the lateral ports through which the blasts or jets from the shaped charges are projected. This has resulted in many instances in leaving debris from sealing discs and the like in the well bore or wedged between gun body and well casing. Moreover, after several firings, the gun ports may become enlarged and distorted, the sealing discs no longer make a fluid tight fit and more and more repairs are required to keep the gun body in condition for further use. Moreover, it has been found that serious damage to the interior of the gun tube has been produced due to the violent impinging thereon of particles of the plastic casing or shell of the charges when the charges are fired.

It is a principal object of the present invention to avoid entirely, or greatly, to minimize the difficulties and disadvantages of prior methods of using shaped charge in gun perforators.

Another object is to devise ways and means to utilize shaped charges without sealing the gun body as a whole against entrance of well fluid.

Another object is to eliminate the need for repair of gun ports.

Another object is to protect the interior of the gun body against the impinging action of particles of the plastic or envelope of the detonating charges.

Another object is to distribute the pressure of the detonating charges over a greater area and to cushion the same in a manner to prevent localized damage or rupture of the gun body.

Still another object is to prevent displacement of the detonating charge and deforming of the perforating jet therefrom by reason of interference therewith of the explosive wave or surge in the gun body caused by adjacent shaped charges and by the detonation cord which fires the detonating charges.

Other objects, advantages and features of novelty will be apparent from the detailed description which follows:

According to the present invention each detonating charge is mounted in an individual fluid tight container which is insertable within the axial bore of the gun body and is rigidly centered and supported in line with a gun port. The container may be positioned by a projection or boss which seats in the gun port and may be held in place

2

there by a set screw engaging the container at a point opposite the projection or boss. Suitable means within the container fixed the position of the detonating charge so that its firing end is directed to and centered upon the projection or boss seated in the gun port while the priming end of the charge is adjacent the set screw. The portion of the wall of the container which is engaged by the set screw is reduced in thickness to a relatively thin web by a groove in which a Primacord may be seated to detonate the charge, and the wall of the projection or boss is also of reduced thickness to facilitate passage of the blast or jet therethrough when the charge is detonated. By preference the containers are constructed of brittle and readily frangible material and since they are fluid-tight the interior of the gun body around the containers is permitted to fill with well fluid which serves to cushion and to equalize pressures within the gun body at the time of detonation. Moreover, the inner walls of the gun body are protected from the full effect of blast of the detonating charges by the frangible containers and by the intervening body of well fluid.

In order to illustrate the invention and the manner of its use, preferred embodiments thereof are shown in the accompanying drawings, in which:

Figure 1 is an elevational view, partly in longitudinal section of a gun perforator ready to be lowered into a well bore to perforate the casing thereof;

Figure 2 is a longitudinal sectional view, on an enlarged scale, through one of the fluid-tight containers shown in Figure 1, parts of adjacent containers being shown in elevation, the section being on the line 2—2 of Figure 1;

Figure 3 is a cross-sectional view taken substantially on line 3—3 of Figure 2, certain parts being shown in plan view;

Figure 4 is a partial longitudinal sectional view of a gun body showing a modified form of fluid-tight container; and

Figure 5 is a cross-sectional view on an enlarged scale taken on line 5—5 of Figure 4, the shaped charge unit being shown in plan view.

Figure 1 shows a perforating gun according to the present invention, fully loaded and ready to be lowered into a well to perforate the casing thereof and the surrounding formation. The gun comprises an elongated hollow or tubular gun body 6 having a series of longitudinally spaced laterally directed firing ports 7 through the walls thereof, such ports being arranged spirally of the gun body as illustrated or in any other desired arrangement. Diametrically opposite each of the firing ports 7 is a smaller threaded port 8. The lower end of gun body 6 is closed by a plug 9 and its upper end is closed by a cable head 10 to which is attached a suspension conductor cable 11 containing an insulated conductor wire. An electrical conductor 12, attached at the top within the cable head to the conductor wire in the conductor cable, extends from within the cable head 10 to a blasting cap 13 from which a detonating cord, such as, for example, Primacord 14 leads to a series of fluid tight containers 15. These fluid tight containers are disposed in superposed relation with respect to one another within the axial bore of a gun body 6, each container 15 supporting therein a shaped detonating charge C as best shown in Figures 2 and 3, in position to be fired through an adjacent gun port 7.

Figures 2 and 3 show the details of a container 15 which is constructed preferably of brittle or highly frangible material. Cast iron is a preferred material but glass, glazed ceramic and some forms of die casting pot metal may also be utilized. The container 15 as illustrated is cup-shaped and is provided with a removable top cover 15a which makes a fluid tight seal by the provision of an

O ring 16 of rubber or other suitable resilient material which seats in an annular groove 15b in the cover. On its interior, container 15 is formed with diametrically opposed recesses for the support of its shaped charge unit C, the rear or priming end of which seats in recess 17, as indicated, while its forward or firing end is supported by a retainer ring member 19 seated in recess 18. The retainer ring member 19 is provided with a plurality of flared spring fingers 19a which extend into and engage the inner surface of an annular groove C' (Figure 3) formed in the forward end of the shell of the shaped charge C. Spring retainer 19 may be formed from cylindrical spring stock by slitting it lengthwise making a plurality of fingers 19a and then bending and flaring the fingers 19a to the extent shown. The shaped charge unit C is mounted in container 15 by placing spring retainer 19 in the forward end of the charge unit and then pressing the latter inwardly sufficiently to permit charge C and retainer 19 to be inserted into the open end of container 15, and moving the charge downwardly until charge and retainer snap into recess 17 and 18 respectively.

Container 15 is formed with external projections or bosses 27 and 28, boss 28 being of a size to fit and seat within one of the lateral firing ports 7 of gun body 6. Whereupon rearward boss 27 is engaged by diametrically opposite plug or set screw 29 which is screwed into the threaded port 8 opposite the firing port to secure the container rigidly in place. Plug 29 also serves to retain Primacord 14 seated in a groove 30, provided therefor in boss 27, this groove also serving to reduce the thickness of the wall of container 15 between Primacord 14 and the rear end of charge C to a relatively thin web 31. Boss 28 on the forward side of the container 15 is also reduced in thickness, internally at 28a and externally at 28b, to weaken it at its central portion and thereby to form a relatively thin web 32 to be broken through by a blast or jet from the shaped charge unit C which is thus directed centrally through gun port 7. Small guide bosses 33 may be formed on the exterior of containers 15 to assist in properly positioning and centering the containers within the gun body 6 during the loading.

In the alternative embodiment of the invention shown in Figures 4 and 5, the fluid tight containers are approximately spherical in shape when assembled as shown at 35, 35a and occupy less space within the gun body 6 than the cylindrical containers 15, 15a shown in Figures 1-3. Each spherical container is made up of a rearward body part 35 and a forward body part 35a, both parts being hemispherical in shape, with the rearward part 35a partially telescoping over the forward part 35 to form an overlapping fluid-tight seal at the telescoped joint where an O ring sealing 36 is seated in a groove 35b in part 35. In this form of the invention shaped charge unit C is mounted between and within parts 35 and 35a of the container without the intermediary of any retainer member. The front or firing end of the shaped charge unit C is received in a large circular recess formed by an inwardly projecting annular ridge 38 spacing and centering the charge at the proper distance from projection or boss 48 on part 35, which, in turn, seats in gun port 7. The small rear or priming end of charge unit C is received in a cylindrical recess 37 formed at boss 47 which in this instance is on rear part 35a and projects inwardly instead of outwardly as in the form of invention herein first described. Set screw 29 in threaded opening 8 in the gun body, engages cover part 35a to securely hold container 35, 35a in place. In this instance set screw 29 seats in a recess 47a which opens into groove 50 provided for Primacord 14, the latter being separated from charge C merely by the relatively thin wall or web 51 as in the first form of the invention. Boss 48 is also reduced in thickness, internally at 48a and externally at 48b to weaken it at its central portion forming the relatively thin web 52 which will give way to the blast or jet from charge C and will direct the same centrally through

its gun port 7. In the form of the invention shown in Figures 4 and 5 external guide bosses such as 33 shown in Figure 3 are not required since the overlap of cover part 35a at the joint between parts 35 and 35a serves this general purpose.

In loading the gun perforator, a series of containers 15, 15a or 35, 35a are first assembled with a detonating charge C properly positioned and mounted in each. The end of a detonating cord or Primacord 14 is secured in groove 30 or 50 of the first of the containers to be introduced into the gun body, and then in the grooves of the other containers at proper intervals. The string of containers is then inserted in the open end of gun body 6 in proper relative position to line up projections or bosses 28 or 48 with the gun ports 7. By fishing through the lowest gun port 7 and its opposite threaded port 8 the bottom container 15, 15a or 35, 35a, is positioned so as to seat its boss 28 or 48 in the gun port 7 whereupon screw plug 29 is threaded into port 8 and set up against boss 27 or 47 over groove 30 or 50 containing Primacord 14, thereby securely wedging and holding the container in firing position within the gun body. The other containers of the string are mounted and secured in place progressively in the same manner. Primacord 14 is then attached to blasting cap 13 as shown in Figure 1, cable head 10 is attached to gun body 6 and the assembled gun perforator is ready to be lowered into a well. During lowering well fluid will seep into the bore of gun body 6 through gun ports 7 and around bosses 28 or 48. However, to insure that the gun body 6 is filled with well fluid over and around all the fluid tight containers therein, a lower fluid entrance port 60 and an upper vent port 61 (Figure 1) may be provided in gun body 6.

When the gun perforator is at the desired level in the well, electrical cable 12 will be energized to fire blasting cap 13 and detonate Primacord 14 which will blow through webs 31 or 51 substantially simultaneously to detonate all charges C. The blasts or jets from the shaped charge units will break through the webs 32 or 52 of bosses 28 or 48 to issue through gun ports 7 and perforate adjacent casing and formations. Frangible containers 15, 15a or 35, 35a will intercept the flying bits of material from the envelopes encasing the shaped charge units and together with the well fluid surrounding the containers will absorb and distribute the expanding gases and pressures from the explosions thus protecting the gun body against local rupture and deformation and greatly prolonging its useful life. The debris from the containers remains within the gun body and is emptied out when the gun perforator is hoisted to the surface. After cleaning out, the gun body is ready to be reloaded for further use.

From the above it will be apparent that the present invention marks an important and highly practical advance in the art of perforating well casings and formations by the shaped charge method. By the use of the individual fluid-tight containers 15, 15a or 35, 35a for the detonating charges, as hereinbefore described, it is no longer necessary to exclude well fluid from the gun body. In fact, its admission serves to cushion and to equalize the explosive forces and pressures within the gun body thus minimizing damage thereto. The spherical form of container shown in Figures 4 and 5 occupies less space than the cylindrical form shown in Figures 1-3 and so permits a larger body of well fluid within the gun body. Deformation and jet cutting of the gun ports 7 do not interfere with the use of the fluid tight containers, with the result that expensive and time consuming repairs are infrequent. The Primacord is separated from each explosive charge but is clamped tightly against the wall of the container by the heavy set screw or plug 29 which secures the container rigidly in place. By this means detonation of the charge is insured and displacing or misdirecting of the jet by reason of so-called "interference" by the explosive wave resulting from the cord detonation or adjacent shaped charge

units is avoided. Hence the cord retaining and back up properties of set screw 29 are of great importance.

While the invention has been herein disclosed in what are now considered to be preferred forms, it is to be understood that the invention is not limited to the specific details thereof but covers all changes, modifications and adaptations within the scope of the appended claims.

What is claimed is:

1. In apparatus for perforating well casings, the combination comprising: a hollow body having a central bore and a lateral port extending from said bore; a separate fluid tight container for insertion within said bore of said body, said container having a separate shaped charge unit therein directed toward a relatively thin walled portion of said container; and means for supporting said container within the bore of said body with said thin walled portion and said shaped charge unit centered upon and directed toward said port so that the charge of said shaped charge unit when detonated will fire through said relatively thin walled portion of said container and through said port.

2. In a perforator for well casings, the combination comprising: an elongated hollow body having lateral ports and a fluid inlet port through the walls thereof; a series of separate, closed, fluid-tight containers within said hollow body, each container having an outwardly projecting portion with a transverse relatively thin walled portion to extend within one of the lateral ports of said body; means for securing each container in place within said body with its projecting portion centered in one of said ports; a shaped charge unit in each of said containers; and means for supporting and maintaining each said charge shaped unit directed toward the said relatively thin walled portion of said projecting portion of its said container.

3. In a perforator for well casings, the combination comprising: an elongated hollow body having spaced lateral ports through the walls thereof and threaded openings through said walls opposite said ports; a series of separate, fluid-tight containers within said hollow body, each container having an outwardly projecting portion with a relatively thin transverse walled portion to extend and seat within one of the lateral ports of said body; a screw plug in each of the said threaded openings opposite each of said ports for engaging said containers to secure them in place; a notch in the exterior of the wall of each container adjacent the point of engagement therewith of said plug to receive a continuing portion of a detonating cord and to weaken the wall of said container at said point; a shaped charge unit in each container; and means for mounting and maintaining each said charge unit between and in axial alignment with the said notched and thin walled portions of the wall of its container and with the shaped charge therein directed toward the port in which the said projecting portion thereof is seated.

4. In a perforator for well casings, the combination comprising: an elongated hollow body having longitudinally spaced, laterally directed ports through the walls thereof and a threaded opening through said walls opposite each of said ports; a series of separate, fluid-tight containers within said hollow body, each container having an outwardly projecting portion with a weakened transverse wall to extend and seat within one of the said ports of said body; a screw plug in each of the said threaded openings opposite each of said ports for engaging one of said containers to secure it in place; a notch in the exterior of the walls of each container adjacent the point of engagement therewith of said plug to receive a detonating cord and to weaken the wall of said container at said point; a separate shaped charge unit in each of said containers and having a jet end; and a resilient retainer in each of said containers engaging the jet end of said shaped charge unit and the inside of the container to position the shaped charge unit with the jet end thereof in alignment with said port in which said projecting por-

tion is seated and to hold the opposite end of said charge unit securely against the inside surface thereof opposite said notched portion of said container.

5. In combination: an elongated hollow body having longitudinally spaced, laterally directed ports through the walls thereof and a threaded opening through said wall opposite each of said ports; fluid-tight containers within said hollow body in superposition, each of said containers having external, outwardly protruding bosses on opposite sides thereof, one of said bosses of each said container extending into one of said ports and the other of said bosses being engaged by a screw plug in one of the said threaded openings opposite said port, the walls of each said container being weakened at both said bosses; a separate shaped charge unit in each of said containers; means supporting said shaped charge unit in each of said containers with the forward jet end of the charge unit directed toward the port into which one of the said bosses thereof extends; and detonating means for each of said charge units comprising a detonating cord held against the exterior of the opposite weakened boss of each of said containers by one of said screw plugs.

6. A fluid tight container of frangible material for insertion and mounting within the bore of a tubular perforator body, said container having an external projection to seat in a lateral port in the perforator body wall and said projection having a weakened transverse wall portion; an external recess for a detonating cord in the wall of said container diametrically opposite said projection; and means within said container for mounting and centering a shaped charge unit therein so that when fired its jet will be directed through the said weakened wall portion of said projection and out through the said lateral port in the perforator body.

7. A fluid tight container of frangible material for insertion and mounting within the bore of a tubular perforator body, said container comprising: a cup and a cover therefor; bosses extending from diametrically opposite parts of said cup; a notch in one of said bosses to receive a detonating cord and to form a thin section or web in the wall of said cup, the wall of the other boss being also weakened by thinning; and means within said cup for mounting a shaped charge unit between said bosses and for maintaining said charge unit centered so that when detonated by said cord its jet will be directed through the thinned section of said other boss.

8. A fluid tight container of frangible material for insertion and mounting within the bore of a hollow perforator body, said container comprising: a cup and a cover therefor; bosses extending from diametrically opposite parts of said cup; a notch in one of said bosses to receive a detonating cord and to form a thin section or web in the wall of said cup, the wall of the other boss being also weakened by thinning; and means including a retainer for mounting a shaped detonating charge unit within said cup with the base of the charge unit against the inside surface thereof opposite the thin section or web of the said notched boss for the detonating cord and with the jet end of the charge centered and directed toward the weakened wall of said other boss.

9. A container for a detonating charge to be mounted within the bore of a hollow perforator body comprising: a container formed of hemispherical parts of frangible material which interfit with a fluid tight joint, one of said parts having an exterior projection to seat in a lateral port in the wall of the perforator body and the other part having an external socket diametrically opposite said projection, said other part having a notch through and forming an inward extension of said socket to receive a detonating cord and to reduce the thickness of the wall of said other part to a relatively thin web, said projection also being reduced in thickness to form a weakened central portion; and means on both said parts to engage and support a shaped detonating charge unit within said container with the base of the charge against the inside surface of the

7

thin web adjoining the notch for the detonating cord and with the jet end of the charge centered and directed toward the weakened central portion of said projection.

10. Structure, as set forth in claim 6 wherein a wall portion of said container is formed with an internal recess to receive the priming end portion of said charge unit and align said charge unit with said projection.

11. Structure as set forth in claim 6 wherein the wall portion of the container adjacent said weakened wall is formed with an internal recess to seat a means for mounting and centering the jet end of said charge.

12. Structure as set forth in claim 6 wherein the wall of said container is formed with a pair of internal recesses for respectively seating the opposite ends of said charge unit and align said charge unit with said projection.

13. Structure as set forth in claim 6 wherein diametrically opposite internal wall portions of said container are each formed with an internal recess for respectively seating the rear end of said shaped charge unit and supporting means for the jet end thereof.

14. In apparatus for perforating well casings, the combination comprising: an elongated hollow body adapted to be lowered into a well borehole, said body having a plurality of lateral ports and a fluid inlet extending through the wall thereof; a plurality of separate, closed, fluid-tight containers within said body, said containers each having a separate shaped charge unit fixed

8

therein with space for expansion therein surrounding a substantial portion of said shaped charge unit and said shaped charge unit being directed toward a walled portion thereof; means for supporting said containers within said body with each of said shaped charge units therein centered upon and directed toward one of said ports so that the charges of said shaped charge units when detonated will fire through the walls of said containers and through said ports.

References Cited in the file of this patent

UNITED STATES PATENTS

2,139,104	Wells	Dec. 6, 1938
2,266,345	Turechek	Dec. 16, 1941
2,295,634	Collins	Sept. 15, 1942
2,399,211	Davis	Apr. 30, 1946
2,402,153	Elliott	June 18, 1946
2,494,256	Muskat	Jan. 10, 1950
2,530,966	Huber	Nov. 21, 1950
2,565,788	Tow	Aug. 28, 1951

OTHER REFERENCES

Article entitled, Casing Perforating With Shaped Explosive Charges by R. H. McLemore, published in The Oil and Gas Journal issue of December 28, 1946.