

[54] **PERFORATING GUN**  
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 [73] Assignee: **Harrison Jet Guns, Inc.**, Houston, Tex.  
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 [51] Int. Cl. .... **E21b 43/117**  
 [58] Field of Search ..... **102/20; 175/4.6**

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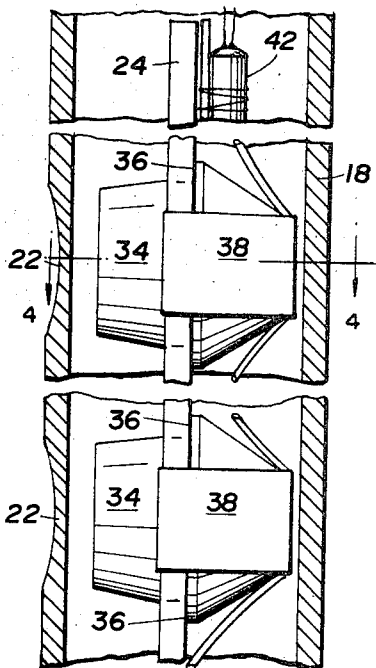
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[57] **ABSTRACT**

A shaped charge assembly for a tubular oil well perforating gun includes a channel member having spaced apertures in the web thereof with shouldered shaped charges extending through the apertures with the shoulders engaging the web of the channel member. A spring clip engages the edges of the channel and the apex of the charge to secure the charge in the aperture and to maintain a ribbon detonator in contact with the apex of the charge.

**10 Claims, 6 Drawing Figures**



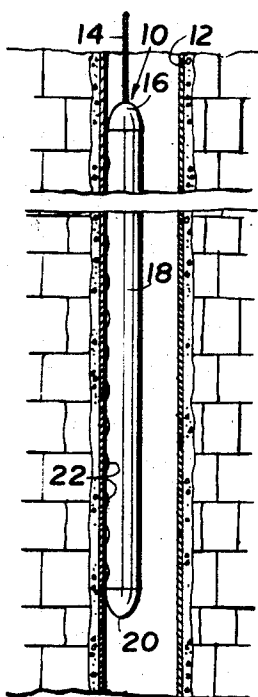


FIG. 1

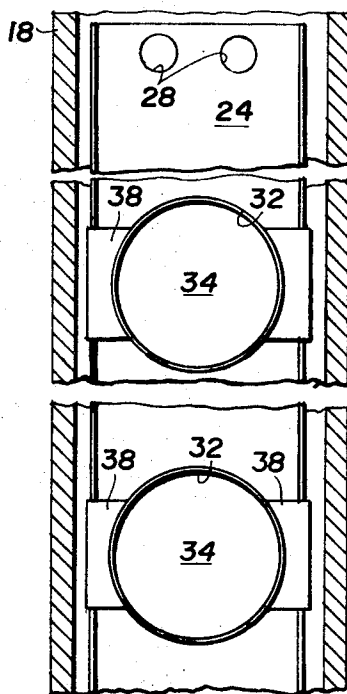


FIG. 2

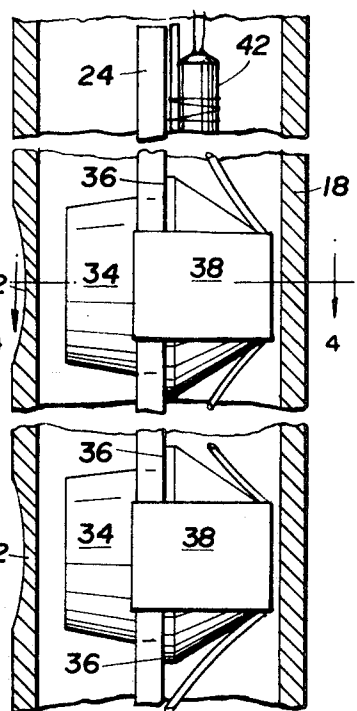


FIG. 3

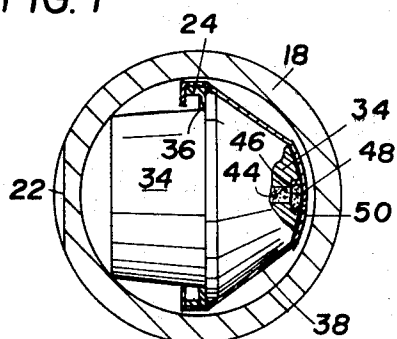


FIG. 4

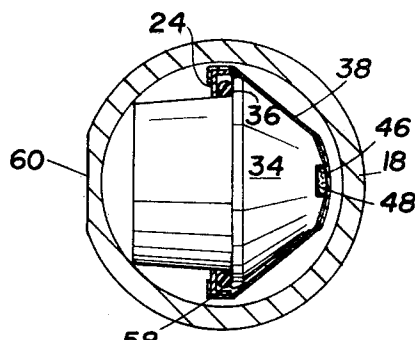


FIG. 6

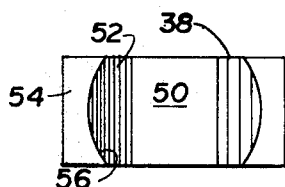


FIG. 5

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## PERFORATING GUN

## BACKGROUND OF THE INVENTION

This invention relates to guns for perforating oil well casings and more particularly to apparatus which facilitates loading and supporting explosive charges in a perforating gun.

Heretofore, shaped explosive charges of the cone type have been employed in an elongated perforating gun barrel. The shaped charges loaded in a gun barrel are directed radially outward from the barrel. In some instances shaped charges are secured in a port in a barrel by force applied through a port closing plug which engages the mouth of a shaped explosive charge. In other cases, shaped charges are positioned in a barrel to face wall sections of the barrel that have been externally thinned. Loading and positioning the charge in such barrels is achieved by this invention. Since the gun barrel and associated apparatus are expendable, minimization of cost while maintaining reliability is essential.

By the present invention shaped charges can be positively and reliably positioned in a perforating gun and at the same time can be interconnected with a detonator.

## SUMMARY OF THE INVENTION

In accordance with the present invention, a perforating gun comprises an elongated hollow casing which receives a charge carrier channel with a plurality of spaced charges secured in apertures therein. Flat spring clips engage the channel edges and the apex of each charge to retain each charge in an aperture along with means for detonating the charges.

## BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention reference may be had to the following description taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is an elevation view of a perforating gun having charges supported therein in accord with the present invention;

FIG. 2 is an enlarged longitudinal sectional view of a portion of the gun of FIG. 1;

FIG. 3 is a view similar to that of FIG. 2 rotated 90° therefrom;

FIG. 4 is a sectional view taken along section line 4-4 of FIG. 3;

FIG. 5 is an elevation view of the retention clip utilized with the present invention; and

FIG. 6 is a sectional view similar to that of FIG. 4 showing an alternate embodiment of the present invention.

## DETAILED DESCRIPTION OF THE INVENTION

The present invention will be described in conjunction with a preferred embodiment. It is to be understood that various changes, alterations and substitutions of equivalents can be made to the embodiments disclosed without departing from the concept of the invention. It is intended that the invention as disclosed be limited only by the definition contained in the appended claims. Where appropriate for clarity, like numerals will be employed in the several FIGURES to indicate the same or similar structure.

Referring first to FIG. 1, a detonator gun 10, in accord with the present invention, is of the jet perforating type. The gun 10 is lowered into a well bore 12, and upon energization of an electrical circuit activated at the ground level, fires a detonator which in turn causes the shaped charges to explode. The gun 10 is attached to a suspension cable 14 via cable head 16. Electrical circuit connections are run along the cable and through the cable head to be connected to a detonator. The gun includes an intermediate gun section or barrel 18 and a bottom closure member 20. The barrel 18 is of hollow construction and contains a plurality of shaped charges. The exterior of the barrel 18 is thinned at regularly spaced zones 22. The purpose of the thinned zones 22 is to provide preselected locations in the barrel 18 through which the blast from the shaped charges can pass. Thinned zones 22 minimize dissipation of projectile energy in breaking out of barrel 18. Burrs on the exterior of the casing 18 extending beyond the perimeter of barrel 18 are minimized thereby aiding removal of the spent gun barrel through lubricators at the well head. Also prevented is total rupture or separation of barrel 18.

Referring to FIGS. 2, 3 and 4, enlarged views of the casing, charge and charge carrying member are shown. FIG. 3 is rotated 90° from FIG. 2. FIG. 4 is a cross sectional view of FIG. 3 taken along section line 4-4. A structural channel 24 is suspended inside barrel 18. The width of the channel 24 is slightly less than the I.D. of barrel 18. The channel member 24 hangs in barrel 18, suspended from head 16 on fasteners (not shown) extending through holes 28 in the upper portion of the channel 24. The upper portion of barrel 18 has internal threads by which it is connected to the head 16. A plurality of spaced apertures 32 are provided in the web of channel 24. A shaped charge 34 extends through the apertures 32. Shaped charge 34 has formed as an integral part thereof an annular shoulder 36 which abuts the outer surface of the web of channel 24.

A spring clip 38 extends around the apex of charge 34 and engages the flanges of channel member 24. The coaction of the clip 38 and the shoulder 36 abutting the channel member 24 retains the shaped charge 34 securely in the apertures 32. The clips 38 are formed from spring steel which has a high shock resistance. In addition, clips 38 have a sufficient width and thickness to withstand the reactive forces generated when the shaped charge 34 is detonated. The clip 38 absorbs retroblast energy to a degree shielding barrel 18 from such reactive forces.

Barrel 18 has a plurality of thinned zones 22 in the outer wall thereof which are adjacent the mouth of each shaped charge 34. Thinned zones 22 are readily formed by grinding the exterior surface of the barrel 18. The thinned zones 22 are located so that the charges will rupture the barrel 18 at desired locations. In addition, the thinned zones 22 will provide less material for the formation of burrs caused by the explosion. Burrs extending beyond the barrel perimeter, rupture of the casing, or inordinate bulging of the barrel 18 will render it difficult, if not impossible, to pass barrel 18 through lubricators employed for entering the gun into the well bore. It should be realized that it is necessary to withdraw the gun including barrel 18 after firing so that the well may be completed.

Retention at the shaped charge 34 is best seen in FIG. 4. The charge 34 is of conventional construction in that

it contains a conical shaped body of explosive with a metallic inside liner of conical shape whose bore faces the gun wall. A passageway 44 is provided in the rear portion of charge 34 communicating with a slot 46 in the rear of the charge 34. The passageway 44 contains 5 detonating material. A ribbon detonator 48 extends through slot 46 in each of the charges 34. The detonator 48 is connected to a cap 42 near the cable head 16 (FIG. 1). The cap 42 is detonated by use of a conventional blaster (not shown). Clip 38 coacts with detona- 10 tor 48 and charge 34 to retain the detonator 48 in intimate contact with the material in passageway 44. The detonator may be of the type sold under the trademark "Primacord". By its use a plurality of charges 34 can be exploded sequentially upon detonation of the cap 15 42.

A preferred form of the spring clip 38 is shown in FIG. 5. The clip 38 has a rounded central portion 50 which engages the apex of charge 34 to force the detona- 20 tor 48 into slot 46. The forwardly extending sides 52 of clip 38 engage the sloping sides of the charge 34. Flanges 54 are provided to engage the channel 34. The flanges 54 have circular indentations 56 therein which engage the cylindrical portion of the wall of charge 34 extending from the bore of the conical portion.

FIG. 6 illustrates an alternate embodiment of the present invention. The shaped charge 34 is the same as in the unit of FIG. 4. There is coaction of the spring clip 38 with the rear portion of the charge 34. In this embodiment, however, the channel 24 has been rotated 180° such that the flanges thereof extend in the direction 25 of the cone apex. The flanges on clip 38 thus engage the outer surface of the web of the channel 24. An "O" ring 58 is interposed between the inner surface of the web of channel 24 and annular shoulder 36 of the charge 34. This form of the invention can be utilized alone or can be utilized in conjunction with the embodiment shown in the previous FIGURES. If, for example, it is desired to direct the explosion from the shaped charges in two different directions, charges are alternately reversed. Half the charges would be mounted in the manner shown in FIG. 4 and half in the manner shown in FIG. 6. Appropriate thinned zones would thus be provided in the opposite side of the barrel 18 to provide selective rupture thereof. It will be noted that the thinned zone 60 provided in the barrel 18 is somewhat different from that shown in previous FIGURES. The thinned zone is provided by grinding away a portion of barrel 18 along an entire longitudinal wall. The direction of the charge is aligned with the flat portion 60 such that the wall can rupture in the flat portion 60, thus providing a minimum of burring, bulging and random rupturing of the casing walls 18.

Gun casings and channel members can be manufactured in uniform relatively short sections which may then be joined if desired to perforate longer sections of the bore hole. It has been found that sections 10 feet long are convenient for transport storage and use. The apertures 32 in the channel 24, and thus the thinned portions 22 in the wall of casing 18 have been provided on 3 inch centers. The length of the gun can be increased by multiples of the 10 foot sections by utilizing suitable connectors for the casings and the longitudinally disposed web members. It is, of course, to be understood that the gun of the present invention can be 65 manufactured in any desired length and can be tailored to fit a particular application.

The advantages of the present invention are apparent to those of ordinary skill in the art. Among these advantages are easy loading, minimum time consumption in loading and operating the gun, relatively simple manufacturing procedures for the component parts thereof and simple and efficient interconnection of a plurality of charges with a detonator.

What is claimed is:

1. A perforating gun comprising:
  - an elongated barrel having a passageway there-through,
  - a channel member mounted in said passageway having a plurality of spaced charge receiving apertures through the channel web,
  - a shaped charge positioned in at least one of said apertures, and including a projecting portion engaging the channel member adjacent the aperture,
  - a spring clip for engaging the apex of said charge and said channel member to secure said charge in the aperture of said channel member, and
  - means for detonating said charge.
2. The gun of claim 1 wherein said shaped charge includes a housing having a shoulder thereon for engaging a surface of said channel member surrounding said apertures with a portion of said housing extending through said aperture.
3. The gun of claim 2 wherein said means for retaining said charges in said apertures comprises:
  - a spring clip having flanges engaging said channel member and a strap portion interconnecting said flanges which engages the rear portion of said shaped charge.
4. The gun of claim 1 wherein said elongated barrel has a plurality of thinned portions in the wall thereof at spaced locations aligned with the mouth of said shaped charges.
5. The gun of claim 4 wherein said charge carrier member comprises:
  - an elongate structural channel, the web thereof containing said plurality of spaced charge carrying apertures, said structural channel having reinforcing flanges thereon.
6. The gun of claim 1 wherein the exterior of said housing for said shaped charge and said clip member have cooperative means thereon for forming a first passageway, the gun further comprising:
  - a second passageway containing an explosive leading from said first passageway through said housing to said shaped charge,
  - a charge detonator interconnecting said plurality of said shaped charges through said first passageway.
7. The gun of claim 1 wherein said spring clip has substantial width and thickness to absorb reactive force of explosion of said shaped charge to protect the inner wall of said barrel in the region of the charge apex.
8. A perforating gun comprising:
  - an elongated barrel having a passageway there-through,
  - a channel member mounted in said passageway and including a channel web having a plurality of spaced charge receiving apertures formed through it and flanges extending from the web in a predetermined direction,
  - a shaped charge positioned in at least one of said apertures and having an apex and a mouth facing in the same direction as the channel flanges,

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a spring clip for engaging the apex of said shaped charge and including flanges for retentively engaging the flanges of said channel member to secure said charge in the aperture of said channel member, and

means for detonating said charge.

9. A perforating gun comprising:

an elongated barrel having a passageway there-through,

a channel member mounted in said passageway and including a channel web having a plurality of spaced charge receiving apertures formed through it and a pair of flanges extending in a predetermined direction,

a shaped charge positioned in at least one of said ap-

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ertures and including an apex facing in the predetermined direction,

a spring clip for engaging the apex of said charge and including flanges for engaging the surface of the channel web opposite the flanges to secure the charge in the aperture of the channel member,

spacing means interposed between said shaped charge and the channel web, and

means for detonating the charge.

10. The perforating gun according to claim 9 wherein the shaped charge includes a shoulder and wherein the spacing means comprises a resilient O-ring positioned between the shoulder and the surface of the channel web facing in the direction of the flanges.

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