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CASELESS SHAPED CHARGES FOR OIL-PRODUCING BOREHOLES

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Fig. 1

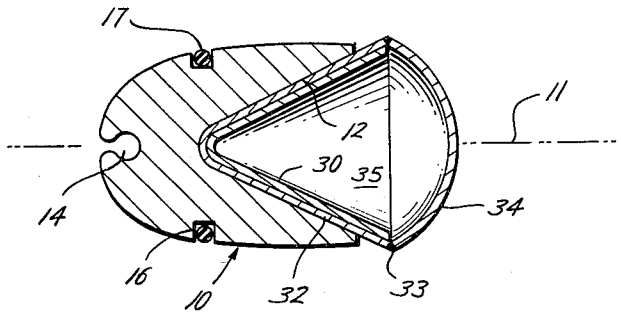
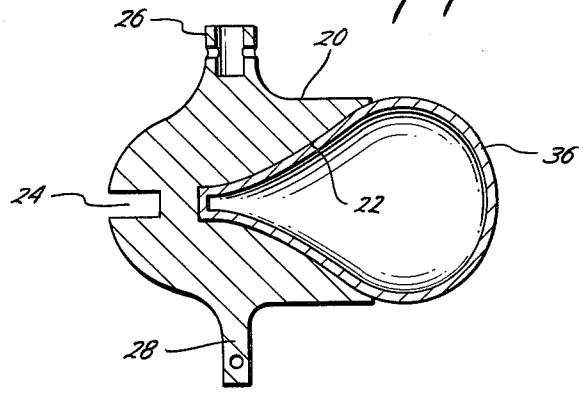


Fig. 2



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CASELESS SHAPED CHARGES FOR OIL-PRODUCING BOREHOLES

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4 Claims. (Cl. 102—24)

This invention relates to shaped charges for use in completing oil wells, and more particularly, shaped charges for perforating the casing of a well bore to place earth formations in fluid communication with the interior of the casing.

Shaped charges used heretofore, typically consist of an explosive carried inside a pressure-resistant and fluid-impermeable capsule case made of a material such as metal or glass. The explosive has a generally conical recess which receives a thin metal liner. The capsule case typically is a two piece construction with fluid-tight sealing means between the two pieces, when assembled. Each of the above elements forming the shaped charge, heretofore, has been considered essential for the operation of a capsule-type shaped charge which is disposed in a well bore containing mud or other control fluids.

The pressure-resistant and fluid-tight capsule case has heretofore been considered essential for three reasons: (1) it has attaching parts which permit the capsules to be connected to one another in an assembly; (2) since the explosive material is only compressed, the case provides mechanical protection; and (3) the casing protects the hydroscopic explosive material against fluid disensitizing.

To detonate the explosive in the case, the thickness of the rear section of the casing is made sufficiently thin so that a detonating primer or blasting cord disposed in contact with the casing can be used to detonate the explosive in the case.

The sealing means fluid-tightly secured between the two case parts also keep the inside of the recess formed between the liner and case free of fluids so that a volume of air under a reduced pressure is disposed in front of the liner providing a stand-off space which improves the performance of the charge when fired.

One of the major drawbacks of the above type of shaped charge is that the case is broken up upon firing forming considerable amounts of debris which is not easily removed from the well bore. The debris can also adversely affect subsequent completion operations and production from the well bore.

Furthermore, although the case provides confinement of the explosive pressures when the explosive material is detonated, it also reduces the volume of explosive of a given charge. Hence, if the case can be replaced with explosive material, the performance of the shaped charge can be greatly improved.

The present invention relates to secondary explosives which are compounded in a solid state with good mechanical properties and imperviousness to fluids. These secondary explosives also can be handled and subjected to considerable shock without detonating. An explosive of this type, for example, is "Holtex" which is described in French Patent No. 1,146,818 and German Patent No. 1,147,159.

A hollow charge according to the invention is characterized by the fact that it is constituted essentially by a block of a secondary explosive of a type appearing in a solid state, which is impervious to liquids, while a recess is provided to the front of the solid block and liner means are provided for forming a shaped charge.

Accordingly, it is an object of the present invention to provide a novel type of shaped charge consisting only of a fluid-impervious, mechanically stable explosive without need of a container case.

According to a second object of the present invention, the recess in a shaped charge is provided with a liner incorporated in a fluid-tight hollow body with thin walls to resist pressure and provide a low-pressure stand-off recess in front of the liner.

According to a third object of the present invention, a secondary explosive is provided with a rearward recess for a detonating primer.

The novel features of the present invention are set forth with particularity in the appended claims. The present invention, both as to its organization and manner of operation together with further objects and advantages thereof, may best be understood by way of illustration and example of certain embodiments when taken in conjunction with the accompanying drawings in which:

FIGS. 1 and 2 illustrate in cross-section different embodiments of the present invention.

FIG. 1 illustrates an explosive block **10** made of a suitable fluid-impervious secondary explosive which is formed as a shaped charge. Block **10** is formed by moulding the explosive under pressure and has symmetry about an axis of revolution **11**. In the forward end of the block **10** is a conical recess **12** while the rearward end has a transverse slot **14** adapted to receive a detonating or blasting cord (not shown). Intermediate the length of the block **10** is an annular groove **16**. Parallel, longitudinally extending wire members **17** (shown in cross-section) can be received in the groove to carry the charges into a well bore.

Block **10** has a liner adapted to be fitted within the conical recess **12**. The liner includes a first inner copper cone **30** and a second outer cone **32** (next to the explosive) made of zinc. The second outer cone is welded along its base at **33** to a hemispherically shaped metal cap **34** so as to form a fluid-tight hollow member. The thickness of the cap **34** and the type of material used are selected so that the cap resists the pressures encountered in the well bore. The interior **35** of the cap is, of course, at atmospheric pressure.

FIG. 2 illustrates another type of shaped charge. Block **20** similarly is provided with a forward, tulip-shaped recess **22** and a rearward slot **24** for the explosive blasting cord (not shown). Block **20** is also formed with diametrically opposed male and female pin and socket attaching means **26** and **28** for connecting successive individual shaped charges to one another.

A hollow body **36** is adapted to engage the wall of the recess **22** in the shaped charge of FIG. 2. The material forming the liner **36**, for example, may be glass or metal and can be formed to a thickness suitable for resisting the pressures it encountered in a well bore.

In addition to the advantages defined hereinabove, it may be stated that the fact of providing a direct contact between the secondary explosives **10** and **22** and the detonating primers constituted by the blasting cords allows resorting to blasting cords of a smaller diameter while ensuring reliably the firing of the shaped charge.

The liners illustrated in FIGS. 1 and 2 may be secured inside the recesses **12** and **22** through numerous means such as gluing, application of cement, screwing, fitting with a force fit and the like.

The advantages of the liners according to the invention are obvious since said liner may be made and separately inspected before assembly and after inspection of the explosive block.

It is possible to imagine as a modification of the shaped charges according to the invention, the application on the

outer wall of the explosive masses **10** and **20** of a thin coating or layer of a combustible material. Such a coating or layer may be made, for instance, of magnesium or a combustible thermoplastic material so that no waste material is obtained when firing. It is possible to design the charge in a manner such that the projections **26** and **28** which allow forming of strings of shaped charges, may be made with the combustible material, which would allow producing more readily the explosive blocks which would then assume a shape of revolution.

The shapes of the explosive blocks, of the recesses, of the housings provided for the detonating primers, and of the securing means have obviously been shown solely by way of example and they may be entirely different from those disclosed without departing from the scope of the present invention. The same is obviously the case for the various methods of execution of the elements forming the shaped charge according to the invention.

As to the nature of the materials forming the liners in FIGS. 1 and 2, they may be quite different from those disclosed. It is possible, for instance, to use in the case of FIG. 1 an outer coat **32–34** of a reacting metal such as titanium or misch-metal with a suitable thickness and an inner cone **30** of copper.

On the other hand, although they are chiefly intended for a direct lowering inside the borehole, it is obviously possible to house the shaped charges according to the invention in retrievable casing guns, which would allow positioning in chambers of a predetermined size, shaped charges the performances of which are clearly improved as a consequence of the elimination of the metal casing used hitherto for the mere mechanical protection of the explosive during the handling of the latter.

While particular embodiments of the present invention have been shown and described, it is apparent that changes and modifications may be made without departing from this invention in its broader aspects and, therefore, the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of this invention.

What is claimed is:

1. A shaped charge for perforating earth formations traversed by a well bore having fluids therein and consisting of: a compressed body of a fluid-imprevious secondary explosive uniformly disposed about a central axis and having integral extensions of said explosive projecting laterally therefrom adapted for connection to a support and a generally frusto-conical recess in one end thereof diverging outwardly from the central axis of said compressed body, and a complementary, hollowed thin-walled liner element received within said recess and adapted to develop a perforating jet along said central axis.

2. The shaped charge of claim **1** wherein said liner element is composed of glass.

3. The shaped charge of claim **1** wherein said liner element is a fluid-tight enclosed body extending beyond said one end of said explosive bore.

4. The shaped charge of claim **1** wherein said explosive body has a layer of combustible material coating the exterior surfaces.

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