An integral shaped charge has a liner portion and a case portion, the liner portion forming a cavity extending from a face to an apex. An explosive is disposed in the chamber.
SHAPED CHARGE WITH AN INTEGRAL LINER AND CASE

TECHNICAL FIELD

[0001] The present specification relates in general to wellbore operations and more specifically to shaped charges.

BACKGROUND

[0002] A perforating device or perforating gun may be utilized in a subterranean well to perforate a well casing and surrounding formation. For example, once a well is drilled, a well casing may be inserted into the well and cemented into place. A perforating gun may be inserted into the well and shaped charges may be detonated to punch holes in the well casing and surrounding formation. A shaped charge may include a liner surrounded by a case to enclose explosive materials. When the explosive materials are detonated in shaped charges, the liner portion forms a slug and a jet that is propelled through the well casing and into the formation and may create a perforation tunnel. Therefore, the liner and the case for the shaped charges are manufactured separately utilizing two or more different non-integral or non-unitary parts for the case and the liner.

SUMMARY

[0003] An embodiment of a shaped charge includes a shaped charge comprising: a body comprising a liner portion and a case portion; the case portion and the liner portion together being a single unitary piece of shaped charge material; the case portion and the liner portion defining a chamber between the case portion and the liner portion; and an explosive material disposed within the chamber.

[0004] The foregoing has outlined some of the features and technical advantages of embodiments in order that the detailed description of the embodiments that follow may be better understood. Additional features and advantages will be described hereinafter which form the subject of the claims herein.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] The foregoing and other features and aspects of embodiments will be best understood with reference to the following detailed description of specific embodiments, when read in conjunction with the accompanying drawings, wherein:

[0006] FIG. 1 is a schematic illustrating a perforating gun disposed in a wellbore;

[0007] FIG. 2 is a cross-sectional view of an illustrative embodiment of a shaped charge;

[0008] FIGS. 3 and 4 are partial cross-sectional views of an embodiment of a shaped charge at stages of a process of forming a shaped charge; and

[0009] FIG. 5 is a cross-sectional view of another embodiment of a shaped charge utilizing multiple explosive materials.

DETAILED DESCRIPTION

[0010] Refer now to the drawings wherein depicted elements are not necessarily shown to scale and wherein like or similar elements are designated by the same reference numeral through the several views.

[0011] FIG. 1 is a well schematic illustrating an embodiment of a perforating gun 5 disposed in a wellbore 7. Perforating gun 5 is disposed in wellbore 7 on a conveyance 9 at subterranean formation 11. Perforating gun 5 includes one or more shaped charges 10 adapted for forming perforations and fluid communication between wellbore 7 and formation 11. The conveyance 9 can be coiled tubing, wireline, slickline, or production tubing, for example. Further, the conveyance could be absent in a case where the perforating device is integrated with a completion.

[0012] FIG. 2 is a cross-sectional view of an illustrative embodiment of a shaped charge 10. Shaped charge 10 includes a body 12 and an explosive 14. Shaped charge body 12 is constructed of a shaped charge material and includes a liner portion 16 and a case portion 18. The liner portion 16 and the case portion 18 can be formed of a single unitary piece of material of construction. For example, in the embodiment illustrated in FIG. 2, shaped charge body 12 is an integral shaped charge having a liner portion 16 and a case portion 18 formed from a single unitary part of the shaped charge material.

[0013] Liner portion 16 is a generally bowl, or coned, shaped section that may shape the perforating jet of the detonated explosive 14. For purposes of description, liner portion 16 forms a cavity 20 extending from a face 22 of shaped charge 10 to a tip 24 or apex 24. Case portion 18 is the portion of body 12 that extends around from face 22 proximate to apex 24. Explosive 14 is disposed in a chamber 26 formed between liner portion 16 and case portion 18.

[0014] A hole 28 may be formed through case portion 18 into chamber 26. Hole 28 may be utilized, for example, for disposing explosive 14 in chamber 26 and for positioning and/or exposing a primer 30 (FIGS. 4 and 5). In the embodiment illustrated in FIG. 2, liner portion 16 and case portion 18 are formed from a single unitary piece of material. The single unitary piece of material can begin as a substantially flat planar shape, and can preferably begin as a flat circular disk shape.

[0015] An embodiment of a method of constructing a shaped charge 10 of the present invention is described with reference to FIGS. 3 and 4. In FIG. 3, a single piece of unitary material 32, referred to herein as shaped charge material, is provided. Liner portion 16 and case portion 18 may be constructed of various types of material without departing from the scope of embodiments described herein. For example, in this embodiment, material 32 may be formed of various materials, including without limitation, metals, barite, metal alloys, metal powders, ceramics, metal filled resins, and the like. Barite can also be used when combined with a densifying agent such as ceramics, glass, steel, lead etc or other metal powder. As will be further understood, material 32 may include explosive material 14.

[0016] In this embodiment, material 32 is provided as a substantially planar member that is a single unitary part and is circular in shape. In a first step, liner portion 16 is formed from the material 32 into substantially the desired profile and dimensioned to achieve the desired liner portion 16 shape. For example, in this embodiment, liner portion 16 is formed to have a triple radius formed as it extends down from a face 22 down to its tip 24. For example, there can be at least three distinct radii of curvature from the face 22 to the tip 24, possibly as part of a progressive change of curvature; akin to
tapering. Ballistic characteristics can be affected from varying the shape of the liner portion. Further, as in this embodiment liner portion 16 can have a progressively changing thickness, e.g., tapering, wherein its thickness decreases as it extends from about face 22 toward tip 24. Similarly, the thickness of the liner will affect ballistic characteristics. Material 32 may then be drawn down and around the liner portion 16 to form a case portion 18 to define chamber 26 as shown in FIG. 4.

[0017] Explosive 14 may be provided prior to or after shaped charge body 12 is formed and shaped into the desired liner portion 16 and case portion 18 configuration. For example, in some embodiments, explosive 14, such as plastic bonded explosive (PBX), may be injected or extruded into chamber 26. In the embodiment of FIG. 3, explosive material 14 is illustrated as being disposed with material 32 along the portion forming liner portion 16 prior to forming case portion 18. Thereby, when case portion 18 is formed (FIG. 4) explosive 14 is positioned in chamber 26. A liner insert 34 may be disposed in liner cavity 20.

[0018] Shaped charge body 12 may be formed in various manners associated with the composition of material 32. For example, if shaped charge material is a metal, liner portion 16 may be formed from the sheet of material by stamping, drawing, casting, machining, molding, or by any suitable manufacturing method. However, in other embodiments, the materials may be provided in any suitable form for the particular manufacturing method utilized, such as a liquefied material for casting, a solid block of material for machining, and the like. Further, the material utilized to form the shaped charge may be a metal or a combination of metals, a metal filled resin, a ceramic, glass, barite, refractory material, any other suitable materials, or a combination thereof. Barite can also be used when combined with a densifying agent such as ceramics, glass, steel, lead etc or other metal powder.

[0019] FIG. 5 is a cross-sectional view of another embodiment of a shaped charge 10 having an integral shaped charge body 12 (a liner portion 16 and a case portion 18) and multiple explosive materials 90a and 90b. In the illustrated embodiment, shaped charge 10 includes a first explosive material 90a and a second explosive material 90b. For example, second explosive 90b may have a higher velocity of detonation (VOD) than first explosive 90a. In some embodiments, explosives 90a and 90b may be injected or extruded into chamber 26 after shaped charge body 12 is formed. In other embodiments, explosives 90a and 90b may be disposed with shaped charge material 32 (FIG. 3) prior to forming shaped charge body 12. Shaped charge 10, illustrated in FIG. 5, further includes an inert resin spider 36 and a primer 30 disposed in chamber 26. The primer 30 can extend along the inside of the case portion 18 outward and upward from the hole 28, and end with a primer ring 31 at the rim of the primer 30.

[0020] From the foregoing detailed description of specific embodiments, it should be apparent that apparatuses, systems, and methods of manufacturing shaped charges that are novel have been disclosed. Although specific inventive embodiments have been disclosed herein in some detail, this has been done solely for the purposes of describing various inventive features and aspects, and is not intended to be limiting with respect to the scope of the claims herein. It is contemplated that various substitutions, alterations, and/or modifications, including but not limited to those embodiment variations which may have been suggested herein, may be made to the disclosed embodiments without departing from the spirit and scope of the specification and the claims herein.

1. A shaped charge comprising:
   a liner portion and a case portion formed by one of the group of stamping, drawing and machining, wherein the case portion and the liner portion are a single unitary piece of shaped charge material;
   the case portion and the liner portion defining a chamber between the case portion and the liner portion; and
   an explosive material disposed within the chamber.

2. The shaped charge of claim 1, wherein the shaped charge material comprises barite.

3. The shaped charge of claim 1, wherein the shaped charge material comprises at least one selected from the group consisting of: a metal, a glass, and a ceramic.

4. The shaped charge of claim 1, wherein the explosive material comprises a first explosive material and a second explosive material, the first and second explosive materials having different explosive characteristics from one another.

5. The shaped charge of claim 1, wherein the shaped charge material includes an explosive material.

6. The shaped charge of claim 1, wherein the liner portion extends from a face of the shaped charge to an apex and comprises at least three distinct radii of curvature.

7-8. (canceled)

9. The shaped charge of claim 1, wherein the explosive material comprises a first PBX explosive material and a second PBX explosive materials, the first and the second explosive materials having different explosive characteristics.

10. The shaped charge of claim 1, wherein the explosive material is PBX explosive.

11. The shaped charge of claim 1, wherein a liner insert is disposed in a cavity defined by the liner portion.

12. The shaped charge of claim 1, wherein the liner insert comprises a material selected from a group consisting of a metal, a glass, a ceramic and barite.

13. The shaped charge of claim 11, wherein the liner insert comprises sintered tungsten.

14. A method for constructing a shaped charge, the method comprising the steps of:
   providing a single unified piece of shaped charge material;
   forming the shaped charge material into a shaped charge body comprising a liner portion and a case portion;
   wherein forming comprises one selected from a group consisting of stamping, drawing, and machining; and
   disposing an explosive material in the shaped charge.

15. The method of claim 14, wherein the step of forming comprises drawing the shaped charge material from a face around the case portion to form the liner portion.

16. The method of claim 14, wherein the step of forming includes:
   creating a generally conical shaped liner portion extending from a face to an apex; and
   creating a case portion extending down and around from the face proximate to the apex.

17. The method of claim 16, wherein the step of creating the generally conical shaped liner portion precedes the step of creating the case portion.

18. The method of claim 16, wherein the explosive material is disposed with the perforating material before the shaped charge body is formed.

19. The method of claim 16, wherein the explosive material is disposed in a chamber defined by the liner and the case.
20. The method of claim 14, wherein the single unified piece of shaped charge material is provided in a substantially flat planar shape.

21. The method of claim 14, wherein the single unified piece of shaped charge material is provided in a substantially flat planar shape.

22. A method for constructing a shaped charge for a perforating gun, comprising:
providing a substantially planar, disk shaped unitary piece of shaped charge material having a face;

forming a conically shaped liner portion extending from the face to an apex, the liner portion having a cavity;
drawing the shaped charge material down from the face and around the liner portion to form a case portion and a chamber between the liner portion and the case portion; and

disposing an explosive material in the chamber.

23. The method of claim 22, wherein the liner portion comprises at least three distinct radiiuses of curvature.

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