(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 278 052 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
25.12.2019 Bulletin 2019/52

(21) Application number: **16774375.6**

(22) Date of filing: **01.04.2016**

(51) Int Cl.:
F42B 1/028 *(2006.01)* ***E21B 7/00*** *(2006.01)*
E21B 29/02 *(2006.01)* ***E21B 43/117*** *(2006.01)*
F42B 1/02 *(2006.01)* ***F42B 1/036*** *(2006.01)*
F42B 3/08 *(2006.01)* ***E21B 43/119*** *(2006.01)*

(86) International application number:
PCT/US2016/025725

(87) International publication number:
WO 2016/161376 (06.10.2016 Gazette 2016/40)

(54) **SNAP-ON LINER RETENTION DEVICE**

EINRAST-RÜCKHALTEVORRICHTUNG FÜR AUSKLEIDUNG

DISPOSITIF DE RETENUE DE REVÊTEMENT ENCLIQUETABLE

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **02.04.2015 US 201562142099 P**

(43) Date of publication of application:
07.02.2018 Bulletin 2018/06

(60) Divisional application:
19208507.4

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Description

BACKGROUND OF THE INVENTION

[0001] Generally, when completing a subterranean well for the production of fluids, minerals, or gases from underground reservoirs, several types of tubulars are placed downhole as part of the drilling, exploration, and completions process. These tubulars can include casing, tubing, pipes, liners, and devices conveyed downhole by tubulars of various types. Each well is unique, so combinations of different tubulars may be lowered into a well for a multitude of purposes.

[0002] A subsurface or subterranean well transits one or more formations. The formation is a body of rock or strata that contains one or more compositions. The formation is treated as a continuous body. Within the formation hydrocarbon deposits may exist. Typically a wellbore will be drilled from a surface location, placing a hole into a formation of interest. Completion equipment will be put into place, including casing, tubing, and other downhole equipment as needed. Perforating the casing and the formation with a perforating gun is a well-known method in the art for accessing hydrocarbon deposits within a formation from a wellbore.

[0003] Explosively perforating the formation using a shaped charge is a widely known method for completing an oil well. A shaped charge is a term of art for a device that when detonated generates a focused explosive output. This is achieved in part by the geometry of the explosive in conjunction with a liner in the explosive material. Generally, a shaped charge includes a metal case that contains an explosive material with a concave shape, which has a thin metal liner on the inner surface. Many materials are used for the liner; some of the more common metals include brass, copper, tungsten, and lead. When the explosive detonates the liner metal is compressed into a super-heated, super pressurized jet that can penetrate metal, concrete, and rock.

[0004] A perforating gun has a gun body. The gun body typically is composed of metal and is cylindrical in shape. Within a typical gun tube is a charge holder, which is a tube that is designed to hold the actual shaped charges. The charge holder will contain cutouts called charge holes where the shaped charges will be placed.

[0005] A shaped charge is a term of art for a device that when detonated generates a focused explosive output. This is achieved in part by the geometry of the explosive in conjunction with a liner in the explosive material. Many materials are used for the liner; some of the more common metals include brass, copper, tungsten, and lead. When the explosive detonates the liner metal is compressed into a super-heated, super pressurized jet that can penetrate metal, concrete, and rock.

[0006] Within a typical gun tube is a charge holder, which is a tube that is designed to hold the actual shape charges. The charge holder will contain cutouts called charge holes where the shape charges will be placed. A typical shaped charge is carried in a cylindrical perforating gun.

[0007] Typically, the liner is held within the shaped charge case using an adhesive material. Adhesives present issues during the manufacturing process that incur additional costs and have environmental issues. A need exists for a means of cheaply retaining a liner and explosive material within the shaped charge case without using adhesives. Additionally, it is desirable to place an insulating and non-sparking material on the shaped charge cases for a variety of reasons including safety. From e.g. US 7,752,971 B2 a shaped charge apparatus is known, comprising a shaped charge case, a liner and an explosive material.

SUMMARY OF EXAMPLES OF THE INVENTION

[0008] The present invention provides a shaped charge apparatus according to claim 1. Further embodiments of the shaped charge apparatus are described in the dependent claims.

[0009] In accordance with independent claim 1 a shaped charge apparatus has a shaped charge case with an axis, an inner surface, an outer surface, and a top surface, and at least one circumferential groove on the outer surface. An L-shaped inner retainer ring with an inner radial surface, an outer radial surface, a lower axial surface, and an upper axial surface is attached to the shaped charge case. The lower axial surface of the inner retainer ring is adjacent to the top surface of the shaped charge and the outer radial surface is adjacent to the inner surface of the shaped charge. A L-shaped outer retainer ring having an upper axial surface, a lower axial surface, an inner radial surface, and an outer radial surface, may be attached to the top of the L-shaped inner ring. The inner radial surface of the outer retainer ring may include at least one circumferential groove interfaced with the shaped charge outer surface circumferential groove. The shaped charge includes a liner with an inner surface and an outer surface. The liner is restrained axially by the inner retainer ring and the outer retainer ring. An explosive material is located between the outer surface of the liner and the inner surface of the shaped charge case.

[0010] A variation may include the one circumferential groove on the outside surface of the shaped charge case being a plurality of circumferential grooves. At least one circumferential groove on the inner radial surface of the outer retainer ring may be a plurality of circumferential grooves. The inner retainer ring may be composed of plastic. The outer retainer ring may be composed of plastic. The outer retainer ring and the inner retainer ring may be integrally formed into a single retainer ring. The inner retainer ring may be rated to function up to 400 degrees Fahrenheit. The outer retainer ring may be rated to function up to 400 degrees Fahrenheit. The inner retainer ring may have a low electrical conductivity. The outer retainer ring may have a low electrical conductivity. The inner

retainer ring may be manufactured using an additive manufacturing process. The outer retainer ring may be manufactured using an additive manufacturing process.

[0011] The shaped charge may include the rim of the open end of the case being substantially circular. It may have a substantially cylindrical inner surface and a substantially cylindrical outer surface and the insulating ring being substantially circular and a substantially cylindrical inner surface and a substantially cylindrical outer surface. The inner surface of the insulating ring may have a smaller diameter than the inner surface of the open end of the case. The outer surface of the rim of the case may have a retention feature. The retention feature may include a raised circumferential ridge, a plurality of raised circumferential ridges, a circumferential groove, or a plurality of circumferential grooves. The inner surface of the rim of the case may have a retention feature that may include a raised circumferential ridge, a plurality of raised circumferential ridges, a circumferential groove or a plurality of circumferential grooves.

[0012] Further variations of the shaped charge may include the inner surface of the insulating ring with a retention feature. The retention feature may include a raised circumferential ridge, a plurality of raised circumferential ridges, a circumferential groove, or a plurality of circumferential grooves.

[0013] Further variations of the shaped charge may include the outer surface of the insulating ring having a retention feature of a raised circumferential ridge, a plurality of raised circumferential ridges, a circumferential groove, or a plurality of circumferential grooves.

[0014] Further variations of the shaped charge disclosed may include the rim of the open end of the case being substantially circular and having a substantially cylindrical inner surface. It may also have a substantially cylindrical outer surface. It may also have the insulating ring having a substantially circular end face, a substantially cylindrical inner wall extending axially from the end face, and a substantially cylindrical outer wall extending axially from the end face. The outer wall of the insulating ring may be adapted to fit outside the outer surface of the rim of the case. The outer wall of the insulating ring may include a retention feature adapted to engage a retention feature on the outer surface of the rim of the case. The inner wall of the insulating ring may be adapted to fit inside the inner surface of the rim of the case. The inner wall of the insulating ring may have a retention feature adapted to engage a retention feature on the inner surface of the rim of the case.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] For a thorough understating of the present invention, reference is made to the following detailed description of the preferred embodiments, taken in conjunction with the accompanying drawings in which reference numbers designate like or similar elements throughout the several figures. Briefly:

FIG. 1 is cross section of an example perforating gun.

FIG. 2 is a cross section view of a shaped charge with an inner retainer ring and an outer retainer ring.

FIG. 3 is a cross section view of a shaped charge with a single retainer ring.

DETAILED DESCRIPTION OF EXAMPLES OF THE INVENTION

[0016] In the following description, certain terms have been used for brevity, clarity, and examples. No unnecessary limitations are to be implied therefrom and such terms are used for descriptive purposes only and are intended to be broadly construed. The different apparatus, systems and method steps described herein may be used alone or in combination with other apparatus, systems and method steps. It is to be expected that various equivalents, alternatives, and modifications are possible within the scope of the appended claims.

[0017] Referring to FIG. 1, a typical perforating gun 10 includes a gun body 11 that houses the shaped charges 12. The gun body 11 contains end fittings 16 and 20 which secures the charge tube 18 into place. The charge tube 18 has charge holes 23 that are openings where shaped charges 12 may be placed. The gun body 11 has threaded ends 14 that allow it to be connected to a series of perforating guns 10 or to other downhole equipment depending on the job requirement. Other design variations may use ends that are bolted together. In FIG. 1, a 60 degree phase gun is shown where each shaped charge 12 is rotated about the center axis by 60 degrees from one shaped charge to the next. Each shaped charge 12 has a corresponding scallop 21 milled into the gun body 11. Other embodiments of this design are possible including zero degree phase guns, where all the shaped charges are aligned. Other end fittings or connections could be used in lieu of threaded fittings, such as bolted fittings.

[0018] Referring to FIG. 2, an example embodiment is a shaped charge 116 with a shaped charge case 111 having an axis 117, an inner surface 108, an outer surface 118, and a top surface 107. Shaped charge case 111 has circumferential groove 103 on the outer surface 118. An L-shaped inner retainer ring 115 with an inner radial surface 109, an outer radial surface 119, a lower axial surface 120, and an upper axial surface 106 is attached to the top surface 107 of the shaped charge case 111. The lower axial surface 120 is adjacent to the top surface 107 of the shaped charge case 111. The outer radial surface 119 is adjacent to the inner surface 108 of the shaped charge case 111. A L-shaped outer retainer ring 102 having an upper axial surface 122, a lower axial surface 121, an inner radial surface 104, and an outer radial surface 105 engages with the shaped charge case 111. Its inner radial surface 104 includes at least one circumferential groove 123 that is interfaced with the shaped

charge outer surface circumferential groove 103. The shaped charge 116 includes a liner 113 with an inner surface 124 and an outer surface 125. The liner 113 is restrained axially by the inner retainer ring 115 and the outer retainer ring 102. An explosive material 112 is located between the outer surface 125 of the liner 113 and the inner surface 108 of the shaped charge case 111. The shaped charge case 111 has an apex end 126.

[0019] Another example embodiment may include the shaped charge case 111 having an axis 117, an inner surface 108, an outer surface 118, and a top surface 107 and at least one circumferential retaining feature 103 for retaining a ring on the outer surface. The retaining feature 103 may be a circumferential groove, a plurality of circumferential grooves, a thread, a buttress thread, a plurality of ridges, a plurality of detents, a lip, or some other retaining means that is well known in the art.

[0020] A variation of the example embodiment may include a plurality of circumferential grooves 103 on the outside surface 118 of the shaped charge case 111. The inner retainer ring 115 may be composed of plastic. The outer retainer ring 102 may be composed of plastic. The inner retainer ring 115 may be rated to function up to 400 degrees Fahrenheit. The outer retainer ring 102 may be rated to function up to 400 degrees Fahrenheit. The inner retainer ring 115 probably has a low electrical conductivity. The outer retainer ring 102 probably has a low electrical conductivity. The inner retainer ring 115 may be manufactured using an additive manufacturing process. The outer retainer ring 102 may be manufactured using an additive manufacturing process.

[0021] Another example embodiment includes a method for making a shaped charge by forming explosive material 112 inside of a shaped charge case 111, forming a liner 113 over the explosive material 112, and installing a first retainer ring 115 onto the shaped charge case 111. The retainer ring 115 prevents axial movement of the liner 113 and the explosive material 112 within said shaped charge case 111.

[0022] A variation of the example embodiment includes installing a second retainer ring 102 to the shaped charged case 111. It could also include installing the shaped charge 116 in a charge tube 18. The second retainer ring 102 may prevent axial movement of the first retainer ring 115. The forming of a liner 113 may result in a substantially frusto-conical shape. The forming explosive material 112 may result in a substantially frusto-conical shape. The example embodiment may further include electrically isolating the shaped charge 116. It may include manufacturing the first retainer ring 115. It may further include manufacturing the second retainer ring 102. The manufacturing of the first retainer ring 115 may include an additive manufacturing process. The manufacturing of the second retainer ring 102 may include an additive manufacturing process.

[0023] The outer retainer ring 102 and the inner retainer ring 115 may be integrally formed into a single retainer ring 215 as shown in FIG. 3. Such an embodiment may include a shaped charge 216 with a case 211 having an apex end 226, an open end 208 having a rim 230, and a cavity extending into case from the open end 208. A liner 213 is fitted into the open end of the case. An electrically insulating ring 215 is fitted over the rim 230 of the open end 208 of the case 211. Explosive material 212 is located between the liner 213 and the charge case 211

[0024] A variation of the embodiment may include the rim 230 of the open end 208 of the case 211 being substantially circular and having a substantially cylindrical inner surface 214. It have include a substantially cylindrical outer surface 218. The insulating ring 215 may be substantially circular. It may include a substantially cylindrical inner surface 231 and a substantially cylindrical outer surface 232. The inner surface 231 of the insulating ring 215 may have a smaller diameter than the inner surface 214 of the open end 208 of the case 211. The outer surface 218 of the rim 230 of the case 211 may include a retention feature 203 such as a raised circumferential ridge, a plurality of raised circumferential ridges, a circumferential groove, or a plurality of circumferential grooves.

[0025] In other examples of the embodiment of figure 3 the inner surface 214 of the rim of the case may include a retention feature 203 such as a raised circumferential ridge, a plurality of raised circumferential ridges, a circumferential groove, or a plurality of circumferential grooves. Further variations of the embodiment may include the inner surface 231 of the insulating ring 215 having a retention feature. The retention feature may include a retention feature 203 such as a raised circumferential ridge, a plurality of raised circumferential ridges, a circumferential groove, or a plurality of circumferential grooves.

[0026] Further variations of the embodiment may include the outer surface 232 of the insulating ring 215 has a retention feature 233. The retention feature 233 may include a retention feature 203 such as a raised circumferential ridge, a plurality of raised circumferential ridges, a circumferential groove, or a plurality of circumferential grooves.

[0027] Further variations of the embodiment disclosed may include the rim 230 of the open end 208 of the case 211 being substantially circular. It may have a substantially cylindrical inner surface 214 and a substantially cylindrical outer surface 218. The insulating ring 215 may have a substantially circular end face 202, a substantially cylindrical inner wall 235 extending axially from the end face 202, and a substantially cylindrical outer wall 234 extending axially from the end face 202. The outer wall 234 of the insulating ring 215 may be adapted to fit outside the outer surface of the rim 230 of the case 211. The outer wall 234 of the insulating ring 215 may include a retention feature 233 adapted to engage a retention feature 203 on the outer surface 218 of the rim 230 of the case 211. The inner wall 235 of the insulating ring 215 may be adapted to fit inside the inner surface 214 of the rim 230 of the case 211. Alternatively, the inner wall 235

of the insulating ring 215 may include a retention feature adapted to engage a retention feature on the inner surface of the rim 230 of the case 211.

[0028] Although the invention has been described in terms of particular embodiments which are set forth in detail, it should be understood that this is by illustration only and that the invention is not necessarily limited thereto. Alternative embodiments and operating techniques will become apparent to those of ordinary skill in the art in view of the present disclosure. Accordingly, modifications of the invention are contemplated which may be made without departing from the scope of the claimed invention.

Claims

1. A shaped charge apparatus (116; 216) comprising:

a shaped charge case (111; 211) with an axis (117; 217), an inner surface (108; 214), an outer surface (118; 218), and a top surface (107; 230) and at least one circumferential retaining means (103; 203) for retaining a ring on the outer surface (118; 218);
a liner (113; 213) with an inner surface (124) and an outer surface (125);
an explosive material (112; 212) located between the outer surface (125) of the liner (113) and
the inner surface (108; 214) of the shaped charge case (111; 211);
a L-shaped inner retainer ring (115) attached to the top surface (107; 230) of the shaped charge case (111; 211) and with an inner radial surface (109), an outer radial surface (119), a lower axial surface (120), and an upper axial surface (106), wherein the lower axial surface (120) is adjacent to the top surface (107; 230) of the shaped charge case (111; 211) and the outer radial surface (119) is adjacent to the inner surface (108) of the shaped charge case (111; 211); and
a L-shaped outer retainer ring (102) engaging with the shaped charge case (111; 211) and having an upper axial surface (122), a lower axial surface (121), an inner radial surface (104), and an outer radial surface (105), wherein the inner radial surface (104) includes at least one other retaining means that is interfaced with the shaped charge case (111; 211) outer surface (118; 218) circumferential retaining means (103; 203),
wherein the inner retaining ring (115) and the outer retainer ring (102) are separate rings or are integrally formed into a single retainer ring (215); and
wherein the liner (113; 213) is restrained axially by the inner retainer ring (115) and the outer retainer ring (102).

2. The apparatus (116; 216) of Claim 1, wherein the at least one retaining means (103; 203) on the outside surface (118) of the shaped charge case is a circumferential groove.

3. The apparatus (116; 216) of Claim 2, wherein the at least one retaining means is a plurality of circumferential grooves (103; 203).

4. The apparatus (116; 216) of Claim 1, wherein the retaining means (103; 203) is a thread.

5. The apparatus (116; 216) of Claim 4, wherein the thread is a buttress thread.

6. The apparatus (116; 216) of Claim 1, wherein the retaining means (103; 203) is a plurality of ridges.

7. The apparatus (116; 216) of Claim 1, wherein retaining means (103; 203) is a plurality of detents.

8. The apparatus (116; 216) of Claim 1, wherein retaining means (103; 203) is a lip.

Patentansprüche

1. Eine Hohlladungsvorrichtung (116; 216), aufweisend:

ein Hohlladungsgehäuse (111; 211) mit einer Achse (117; 217),
einer Innenfläche (108; 214), einer Außenfläche (118; 218) und
einer oberen Fläche (107; 230) und zumindest einem Umfang-Rückhaltemittel (103; 203) zum Rückhalten eines Rings an der Außenfläche (118; 218),
eine Auskleidung (113; 213) mit einer Innenfläche (124) und einer Außenfläche (125),
einen Explosivstoff (112; 212), welcher zwischen der Außenfläche (125) der Auskleidung (113) und der Innenfläche (108; 214) des Hohlladungsgehäuses (111; 211) angeordnet ist,
einen L-förmigen, inneren Rückhaltering (115), welcher an der oberen Fläche (107; 230) des Hohlladungsgehäuses (111; 211) befestigt ist, und mit einer inneren Radialfläche (109), einer äußeren Radialfläche (119), einer unteren Axialfläche (120) und einer oberen Axialfläche (106), wobei die untere Axialfläche (120) zur oberen Fläche (107; 230) des Hohlladungsgehäuses (111; 211) benachbart ist und die äußere Radialfläche (119) zur Innenfläche (108) des Hohlladungsgehäuses (111; 211) benachbart ist, und

einen L-förmigen, äußeren Rückhaltering (102), welcher mit dem Hohlladungsgehäuse (111; 211) eingreift und eine obere Axialfläche (122), eine untere Axialfläche (121), eine innere Radialfläche (104) und eine äußere Radialfläche (105) hat, wobei die innere Radialfläche (104) zumindest ein weiteres Rückhaltemittel aufweist, welches mit dem Umfang-Rückhaltemittel (103; 203) der Außenfläche (118; 218) des Hohlladungsgehäuses (111; 211) verbunden ist,
wobei der innere Rückhaltering (115) und der äußere Rückhaltering (102) separate Ringe sind oder als ein einzelner Rückhaltering (215) einstückig geformt sind, und
wobei die Auskleidung (113; 213) durch den inneren Rückhaltering (115) und den äußeren Rückhaltering (102) axial zurückgehalten wird.

2. Die Vorrichtung (116; 216) gemäß Anspruch 1, wobei das zumindest eine Rückhaltemittel (103; 203) an der Außenfläche (118) des Hohlladungsgehäuses eine Umfangsnut ist.

3. Die Vorrichtung (116; 216) gemäß Anspruch 2, wobei das zumindest eine Rückhaltemittel eine Mehrzahl von Umfangsnuten (103; 203) ist.

4. Die Vorrichtung (116; 216) gemäß Anspruch 1, wobei das Rückhaltemittel (103; 203) ein Gewinde ist.

5. Die Vorrichtung (116; 216) gemäß Anspruch 4, wobei das Gewinde ein Sägezahngewinde ist.

6. Die Vorrichtung (116; 216) gemäß Anspruch 1, wobei das Rückhaltemittel (103; 203) eine Mehrzahl von Erhöhungen ist.

7. Die Vorrichtung (116; 216) gemäß Anspruch 1, wobei das Rückhaltemittel (103; 203) eine Mehrzahl von Vertiefungen ist.

8. Die Vorrichtung (116; 216) gemäß Anspruch 1, wobei das Rückhaltemittel (103; 203) eine Lippe ist.

Revendications

1. Appareil de charge creuse (116 ; 216) comprenant :

un boîtier de charge creuse (111 ; 211) avec un axe (117 ; 217), une surface interne (108 ; 214), une surface externe (118 ; 218), et une surface supérieure (107 ; 230) et au moins un moyen de retenue circonférentiel (103 ; 203) pour retenir un anneau sur la surface externe (118 ; 218) ;
un revêtement (113 ; 213) avec une surface interne (124) et une surface externe (125) ;
un matériau explosif (112; 212) positionné entre la surface externe (125) du revêtement (113) et la surface interne (108 ; 214) du boîtier de charge creuse (111 ; 211);
un anneau de retenue interne en forme de L (115) fixé sur la surface supérieure (107 ; 230) du boîtier de charge creuse (111 ; 211) et avec une surface radiale interne (109), une surface radiale externe (119), une surface axiale inférieure (120) et une surface axiale supérieure (106), dans lequel la surface axiale inférieure (120) est adjacente à la surface supérieure (107 ; 230) du boîtier de charge creuse (111 ; 211) et la surface radiale externe (119) est adjacente à la surface interne (108) du boîtier de charge creuse (111 ; 211) ; et
un anneau de retenue externe en forme de L (102) se mettant en prise avec le boîtier de charge creuse (111 ; 211) et ayant une surface axiale supérieure (122), une surface axiale inférieure (121), une surface radiale interne (104) et une surface radiale externe (105), dans lequel la surface radiale interne (104) comprend au moins un autre moyen de retenue qui est interfacé avec le moyen de retenue circonférentiel (103 ; 203) de la surface externe (118 ; 218) du boîtier de charge creuse (111 ; 211),
dans lequel l'anneau de retenue interne (115) et l'anneau de retenue externe (102) sont des anneaux séparés ou sont formés de manière solidaire en un seul anneau de retenue (215) ; et
dans lequel le revêtement (113 ; 213) est retenu de manière axiale par l'anneau de retenue interne (115) et l'anneau de retenue externe (102).

2. Appareil (116 ; 216) selon la revendication 1, dans lequel le au moins un moyen de retenue (103 ; 203) sur la surface externe (118) du boîtier de charge creuse est une rainure circonférentielle.

3. Appareil (116 ; 216) selon la revendication 2, dans lequel le au moins un moyen de retenue est une pluralité de rainures circonférentielles (103 ; 203).

4. Appareil (116 ; 216) selon la revendication 1, dans lequel le moyen de retenue (103 ; 203) est un filetage.

5. Appareil (116 ; 216) selon la revendication 4, dans lequel le filetage est un filetage trapézoïdal.

6. Appareil (116 ; 216) selon la revendication 1, dans lequel le moyen de retenue (103 ; 203) est une pluralité de crêtes.

7. Appareil (116 ; 216) selon la revendication 1, dans lequel le moyen de retenue (103 ; 203) est une pluralité de détentes.

8. Appareil (116 ; 216) selon la revendication 1, dans lequel le moyen de retenue (103 ; 203) est une lèvre.

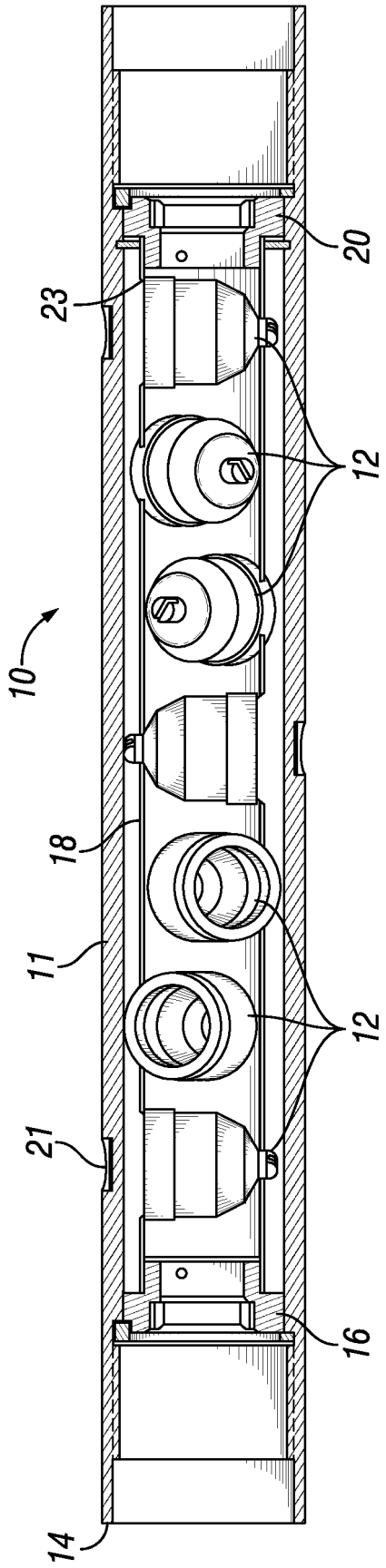

FIG. 1

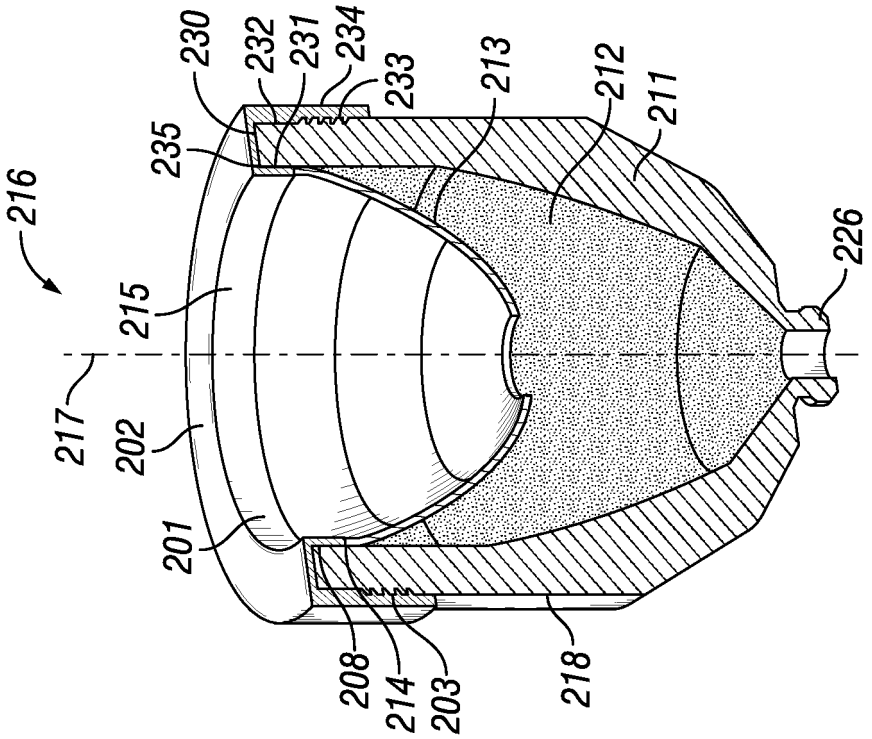
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FIG. 3

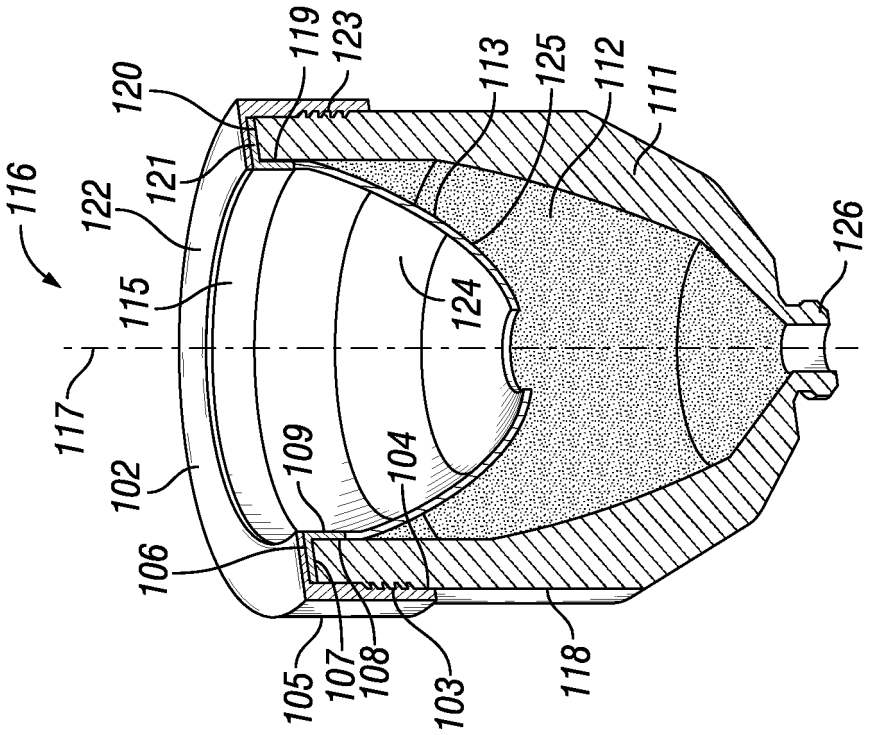
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FIG. 2

REFERENCES CITED IN THE DESCRIPTION

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