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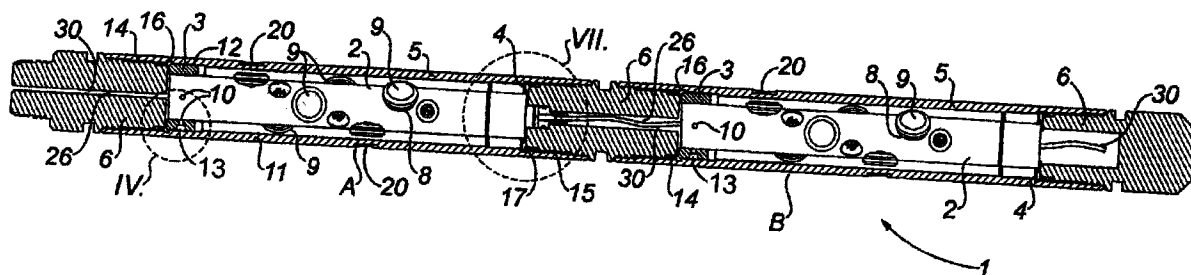
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(54) Titre : STRUCTURES DE RETENUE ET D'ORIENTATION D'UN TUBE DE CHARGEMENT DANS UN CANON DE PERFORATION

(54) Title: CHARGE TUBE RETAINING AND ORIENTING STRUCTURES FOR A PERFORATING GUN



(57) Abrégé/Abstract:

Structure is provided to circumferentially and longitudinally position a charge tube within a carrier tube, so that the charge tube charges are aligned with the carrier tube scallops. A top collar, having an external key, is secured to the top of the charge tube. A vertical groove is machined through the top threads of the carrier tube. When the key enters the groove the carrier tube is circumferentially oriented. Preferably, an externally threaded steel disc is screwed into the internal bottom threads of the carrier tube, to longitudinally position the charge tube when it is inserted into the carrier tube and abuts the disc. The disc further functions to support and retain the charged tube in the carrier tube when a gun section is in an upstanding position without a bottom tandem plug in place to perform these functions.

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ABSTRACT OF THE DISCLOSURE

Structure is provided to circumferentially and longitudinally position a charge tube within a carrier tube, so that the charge tube charges are aligned with the carrier tube scallops. A top collar, having an external key, is secured to the top of the charge tube. A vertical groove is machined through the top threads of the carrier tube. When the key enters the groove the carrier tube is circumferentially oriented. Preferably, an externally threaded steel disc is screwed into the internal bottom threads of the carrier tube, to longitudinally position the charge tube when it is inserted into the carrier tube and abuts the disc. The disc further functions to support and retain the charged tube in the carrier tube when a gun section is in an upstanding position without a bottom tandem plug in place to perform these functions.

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**Title: CHARGE TUBE RETAINING AND ORIENTING
STRUCTURES FOR A PERFORATING GUN**

Field Of The Invention

The invention relates to perforating guns and more particularly to guns having structures for retaining and orienting the charge tube within the carrier tube.

5 Background Of The Invention

Perforating guns are commonly used to bring oil and gas wells into production. The guns contain shaped charges which can be detonated to form perforations in the well casing wall.

10 A perforating gun usually is formed by a string of one or more sections, each typically comprising:

- 15 • An outer steel tube referred to as the carrier tube. The tube is relatively thick-walled. It has "scallops" formed in its outer surface. These are indentations or thinned and weakened wall areas. These scallops are usually spaced longitudinally and circumferentially from one another in a spiral pattern;
- 20 • A steel charge tube positioned within the carrier tube in concentric, inwardly spaced relationship. The charge tube is relatively thin walled. It has a series of side wall openings into which the shaped charges are fitted. These openings are arranged along an identical spiral path so as to coincide or register with the scallops;
- 25 • The carrier tube is internally threaded at each of its ends so that externally threaded connection subs may be threaded thereinto. The subs function to connect sequential gun sections together and, at the top section, to connect it to the tubing string or cable on which it is commonly run;

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- The subs and charge tubes have central connected vertical passageways through which a detonating cord assembly extends. At the base of each charge tube and the top of the adjacent sub, the detonating cord of an upper gun section is electrically connected with the detonating cord of the next lower gun section by a pair of boosters separated by a narrow air gap.

As previously indicated, it is necessary to accurately orient the charges so that they are in register with or positioned directly opposite to the scallops.

Also, when two gun sections are being connected together at the wellsite, there is a stage where the bottom sub may not form part of one of the sections. For example, assume that a gun is being assembled to be run into the well bore on tubing by a service rig. One section of the gun may be suspended in the top of the well, with its top sub protruding. The next section will only have a sub at its top end, until connected with the section already in the well. As a result, the risk exists that the charge tube and its charges could slip out the bottom of the carrier tube in the course of raising it vertically to connect it with the first section.

So there needs to be some means used to retain the charge tube within the carrier tube so that it cannot drop out.

In the prior art, these two concerns are dealt with by providing two collars that attach to the charge tube, one at the base and one at the top. The bottom collar is then attached to the carrier tube. More particularly, the top and bottom collars are attached to the charge tube before it is inserted into the carrier tube. The top collar is attached by means of screws. One of the screws is only partially threaded in, so that it protrudes outwardly and radially. When the charge tube is inserted into the carrier tube, the protruding screw engages a vertical groove formed by the interior surface of the carrier tube, thereby ensuring correct circumferential orientation. The bottom collar attaches to the bottom of the charge tube with screws as well. Once the

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charge tube is inserted into the carrier tube, the bottom collar must then be secured to the carrier tube by means of screws, so that the charge tube does not drop through the bottom of the carrier tube. However this is awkward to do.

5 It is therefore one object of the invention to provide an improved system for orienting the charge tube so that its charges are circumferentially aligned with the scallops.

 In accordance with an embodiment of the invention, it is another object to provide a means for simultaneously retaining the charge tube in the
10 carrier tube, when no bottom sub is in place, and for positioning the charge tube so that its charges are longitudinally aligned with the scallops.

Summary Of The Invention

 In a preferred form of the invention, two modifications are made to the conventional perforating gun. More particularly:

- 15 • A top collar having an external vertical key and three screw holes is provided. The key and holes are equidistantly located around the collar. The charge tube will have been provided with three holes corresponding with the collar holes. A vertical groove is formed in the side wall of the carrier tube,
20 through the upper internal threads so as to extend below the threads. Screws are inserted through the collar holes to penetrate the charge tube holes. This fixes the location of the key. The locations of the screw holes, key and groove have been coordinated and arranged so that the charges are
25 automatically circumferentially aligned with the scallops when the key is dropped into the groove;
- Preferably, an annular steel disc having external threads is also provided. The disc is screwed up to the top of the lower threads of the carrier tube. It functions to support the charge
30 tube at its bottom end. The location of the thread end is

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coordinated and arranged so that the charges are automatically longitudinally aligned with the scallops. When the bottom sub is threaded in, it serves to support the disc in retaining the charge tube.

5 Most preferably, the disc has a relatively thick outer annular portion (to enable threads to be cut in its circumferential surface) and a relatively thin inner portion (to minimize the air gap between the bottom booster of the top gun section and the top booster of the bottom gun section).

10 As a result of the foregoing, a perforating gun assembly is provided which can more easily be assembled. There is automatic orientation and positioning of the charges opposite the scallops. And the charge tube is prevented from dropping out of the carrier tube when the bottom sub is not in place.

15 In accordance with an embodiment of the invention, there is provided a perforating gun assembly comprising: a charge tube carrying a plurality of charges that are spaced longitudinally and circumferentially from one another; a carrier tube having upper and lower internal threads at its upper and lower ends, said carrier tube containing the charge tube in concentric, inwardly spaced relationship, said carrier tube having scallops
20 formed in its side wall, for registering with the charges; an annular alignment collar secured to the top of the charge tube; the collar having first orienting means formed by its outer surface; the carrier tube having second orienting means formed by its inner surface; said first and second orienting means being engaged and causing the carrier tube to be positioned with its charges
25 aligned circumferentially with the scallops; an externally threaded, annular disc, positioned at the upper end of the carrier tube's lower threads, said disc supporting the charge tube so that its charges are aligned longitudinally with the scallops, said disc preventing the charge tube from dropping out of the carrier tube; whereby the charge tube is retained in the carrier tube with the
30 scallops in register with the charges.

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Description Of The Drawings

Figure 1 is a cross-sectional side view of an assembled perforating gun having two sections in accordance with an embodiment of the invention;

5 Figure 2 is a sectional plan view of the upper alignment collar;

Figure 3 is a perspective view of the collar of Figure 2;

Figure 4 is an expanded cross-sectional side view of the collar structure shown in circle IV of Figure 1;

Figure 5 is a perspective view of the retainer disc;

10 Figure 6 is a cross-sectional side view of the retainer disc;

Figure 7 is an expanded cross-sectional side view of the disc in the gun, shown in circle VII of Figure 1;

Figure 8 is a perspective view of the upper end of the carrier tube with part of the side wall broken away, showing an orienting groove
15 extending down into the unthreaded portion of the side wall; and

Figure 9 is a sectional side view showing a tandem sub connecting two gun sections.

Description Of The Preferred Embodiment

20 An embodiment of the invention will first be described in connection with the fully assembled perforating gun assembly 1 shown in Figure 1.

The assembly 1 comprises two sections A, B, each comprising a charge tube 2, an upper alignment collar 3, a charge tube retainer disc 4, a carrier tube 5 and connecting subs 6.

25 Each charge tube 2 has a series of charge openings 8 spaced circumferentially and longitudinally relative to one another. A shaped charge 9 is fitted into the uppermost opening 8. Usually there will be a plurality of charges mounted in the charge tube.

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At its upper end, three openings 10 are formed in the side wall 11 of the charge tube 2. The openings 10 are spaced apart equidistantly at 1/4, 1/2 and 3/4 of the circumferential extent.

The collar 3 is mounted on the end of the charge tube 2. The collar 3 is annular in configuration and has an outwardly protruding key 12 and three side openings 13. The key 12 and openings 13 are equidistantly spaced around the collar 3. It also has an internal upper lip 19 for positioning the openings 13 at the desired elevation on the charge tube 2.

The carrier tube 5 is internally threaded at its upper and lower ends. The upper and lower threads 14, 15 terminate at 16, 17 respectively. A vertical groove 18 extends down through the threads 14 into the non-threaded side wall 11, as shown in Figure 8.

The carrier tube 5 has a series of scallops 20 formed in its side wall 21. The scallops 20 are areas where the side wall 21 is weakened by thinning it. The scallops 20 are spirally arranged so that they are circumferentially and longitudinally spaced one from another.

In assembling the assembly 1, the collar 3 is seated on the upper end of the charge tube 2. The collar side openings 13 are aligned with the charge tube openings 10. Screws 23 are screwed into the aligned openings 13, 10 to fix the collar 2 on the charge tube 2.

An annular, externally threaded steel disc 4 is screwed into the carrier tube 5 from its bottom end. When the disc 4 reaches the top 17 of the lower threads 15, it is in position to control the longitudinal location of the charge tube 2.

When the charge tube 2 is dropped into the carrier tube 5, engagement of the key 12 and groove 18 orients the charge(s) 9 with the scallops 20 with respect to circumferential location. Simultaneously, the charge tube 2 bottoms on the disc 4, which fixes the longitudinal positioning of the charges 9. In this way, the charges 9 are located opposite to the scallops 20.

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As shown in Figures 5-7, the disc 4 is constructed with a thinned inner portion 4a and a thickened outer portion 4b. The thickened outer portion 4b provides strength and enables cutting of the threads 25 in the circumferential edge surface of the disc 4. The purpose of thinning the portion 4a is explained below.

As shown in Figures 1 and 9, the connecting subs 6 have axial passageways or bores 26 through which detonator cords 30a, 30b extend. At the bottom end of the top charge tube 2 an internal insert 31 is positioned. Insert 31 is connected with detonator cord 30a. At the top end of sub bore 26, a second insert 32 is positioned. The two inserts 31, 32 each comprise boosters 33, 34 for transmitting energy from the upper gun section A to the lower gun section B through an air gap 35. The disc 4 is thinned to minimize the air gap 35.

In summary then, the embodiment of the invention described above provides means which facilitate the assembling of the gun sections and ensure retention of the charge tube when the bottom sub 6 is not in the assembly.

The scope of the invention is defined by the claims now following.

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Claims:

1. A perforating gun assembly comprising:
 - a) a charge tube having a plurality of openings that are spaced longitudinally and circumferentially from one another;
 - 5 b) a shaped charge fitted into each one of said charge tube openings;
 - c) a carrier tube containing said charge tube in concentric inwardly spaced relationship, said carrier tube having a plurality of scallops formed in its side wall for registering with the charges;
 - 10 d) an alignment collar connected to the charge tube, the collar having a first orienting means and protruding therefrom;
 - e) a second orienting means positioned on an inner surface of the carrier tube, wherein the first orienting means and second orienting means are configured to align the charges with the scallops; and,
 - 15 f) a longitudinal alignment means positioned in the carrier tube such that the charge tube is movable within the carrier tube toward the longitudinal alignment means and when the charge tube bottoms on said longitudinal alignment means, the charges are longitudinally aligned with the scallops.
- 20 2. The perforating gun assembly as defined in claim 1 wherein said longitudinal alignment means comprises a member attached to the inside of the carrier tube.
- 25 3. The perforating gun assembly as defined in claim 2 wherein said member comprises an annular surface for supporting the charge tube.
4. The perforating gun assembly as defined in claim 2 wherein
30 said member is detachable from the inside of the carrier tube.
5. The perforating gun assembly as defined in claim 1 wherein

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said longitudinal alignment means comprises an annular member on which the charge tube bottoms to prevent the charge tube from dropping out of the carrier tube.

6. A perforating gun assembly comprising:

- 5 a) a charge tube having a plurality of openings that are spaced longitudinally and circumferentially from one another;
- b) a shaped charge fitted into each one of said charge tube openings;
- c) a carrier tube containing said charge tube in concentric
10 inwardly spaced relationship, said carrier tube having a plurality of scallops formed in its side wall for registering with the charges;
- d) a first orienting means protruding from the charge tube;
- e) a second orienting means positioned on an inner surface of the carrier tube, wherein the first orienting means and second orienting
15 means are configured to align the charges with the scallops; and,
- f) a longitudinal alignment member attached to the inside of the carrier tube;

wherein the charge tube is movable within the carrier tube toward the annular member such that when the charge tube bottoms on the
20 annular member, the charges are longitudinally aligned with the scallops.

7. A method for assembling a perforated gun assembly including a charge tube having a plurality of openings that are spaced longitudinally and circumferentially from one another, a carrier tube having a plurality of scallops formed in its side wall for aligning with the plurality of openings and a
25 longitudinal alignment means, the method comprising:

a) fitting a shaped charge into at least one charge tube opening in the plurality of charge tube openings in the charge tube;

b) providing a first orienting means and a second orienting means positioned on the charge tube and the carrier tube for circumferentially aligning the charge tube openings with the scallops;

c) attaching the longitudinal alignment means to a bottom end of the carrier tube; and,

d) dropping the charge tube into a top end of the carrier tube such that the first orienting means and the second orienting means cooperate to circumferentially align the charge tube openings with the scallops, and when the charge tube bottoms on the longitudinal alignment means, the charge tube openings are longitudinally aligned with the scallops.

8. The method as defined in claim 7 wherein the second orienting means is positioned on an inner surface of the carrier tube, and an alignment collar is connected to the charge tube, the alignment collar having the first orienting means protruding therefrom, and the method further comprises inserting the charge tube into the carrier tube such that the first orienting means and the second orienting means engage, thereby bringing the charge tube openings into circumferential alignment with the scallops.

9. The method as defined in claim 7 wherein the carrier tube has lower internal threads at the bottom end, and step c) comprises threading an externally threaded annular disk into the lower internal threads of the carrier tube.

10. A perforating gun assembly for containing shaped charges that can be detonated to form perforations in a well casing wall, comprising:

a) a charge tube having a plurality of openings that are spaced longitudinally and circumferentially from one another, at least one of the plurality of openings being formed to receive a shaped charge;

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b) a carrier tube containing said charge tube in concentric inwardly spaced relationship, said carrier tube having a plurality of scallops formed in its side wall for registering with the plurality of openings, the scallops being weakened wall areas;

c) an alignment collar connected to the charge tube, the collar having a first orienting means and protruding therefrom;

d) a second orienting means positioned on an inner surface of the carrier tube, wherein the first orienting means and second orienting means are configured to align the plurality of openings with the scallops; and,

e) a longitudinal alignment means positioned in the carrier tube such that the charge tube is movable within the carrier tube toward the longitudinal alignment means and when the charge tube bottoms on said longitudinal alignment means, the plurality of openings are longitudinally aligned with the scallops.

11. The perforating gun assembly as defined in claim 10 wherein said longitudinal alignment means comprises a member attached to the inside of the carrier tube.

12. The perforating gun assembly as defined in claim 11 wherein said member comprises an annular surface for supporting the charge tube.

13. The perforating gun assembly as defined in claim 11 wherein said member is detachable from the inside of the carrier tube.

14. The perforating gun assembly as defined in claim 10 wherein said longitudinal alignment means comprises an annular member on which the charge tube bottoms to prevent the charge tube from dropping out of the carrier tube.

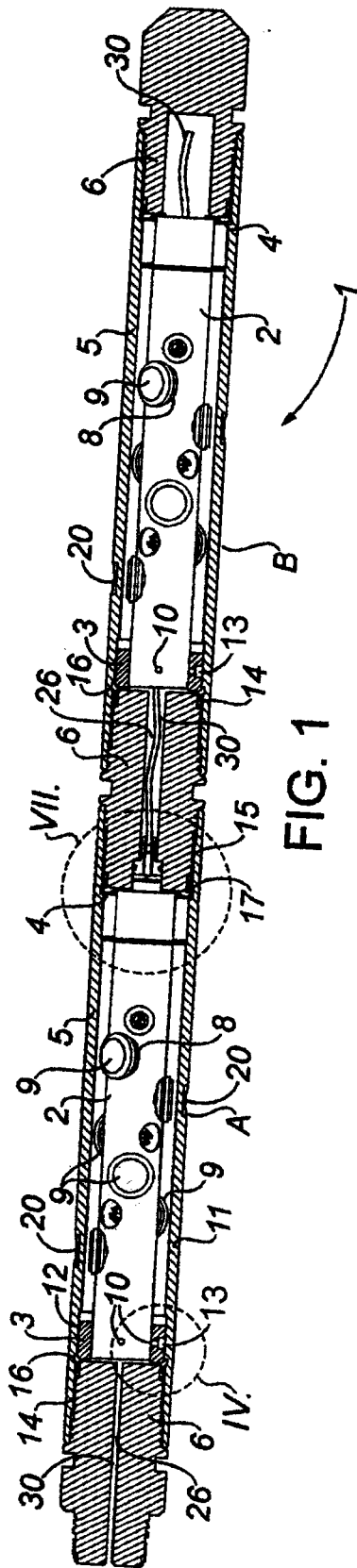


FIG. 1

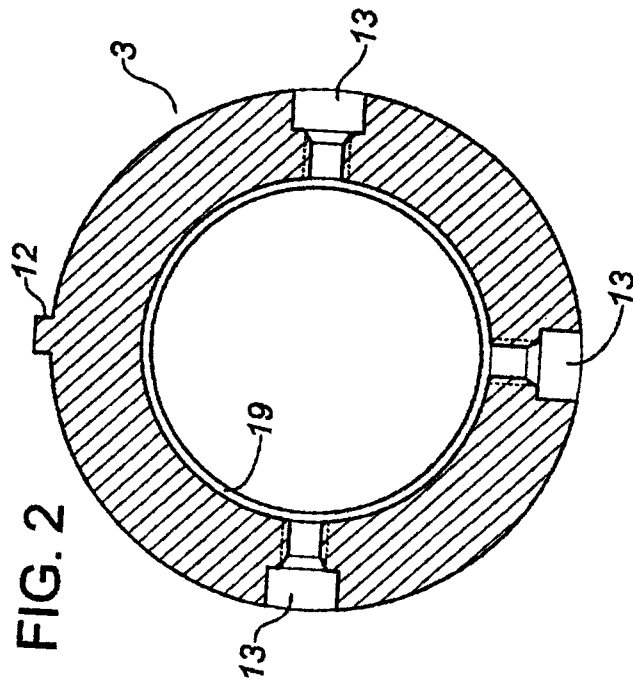


FIG. 2

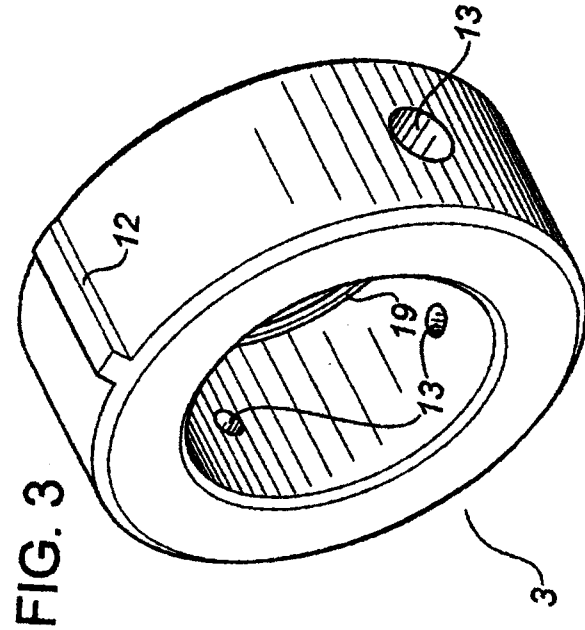


FIG. 3

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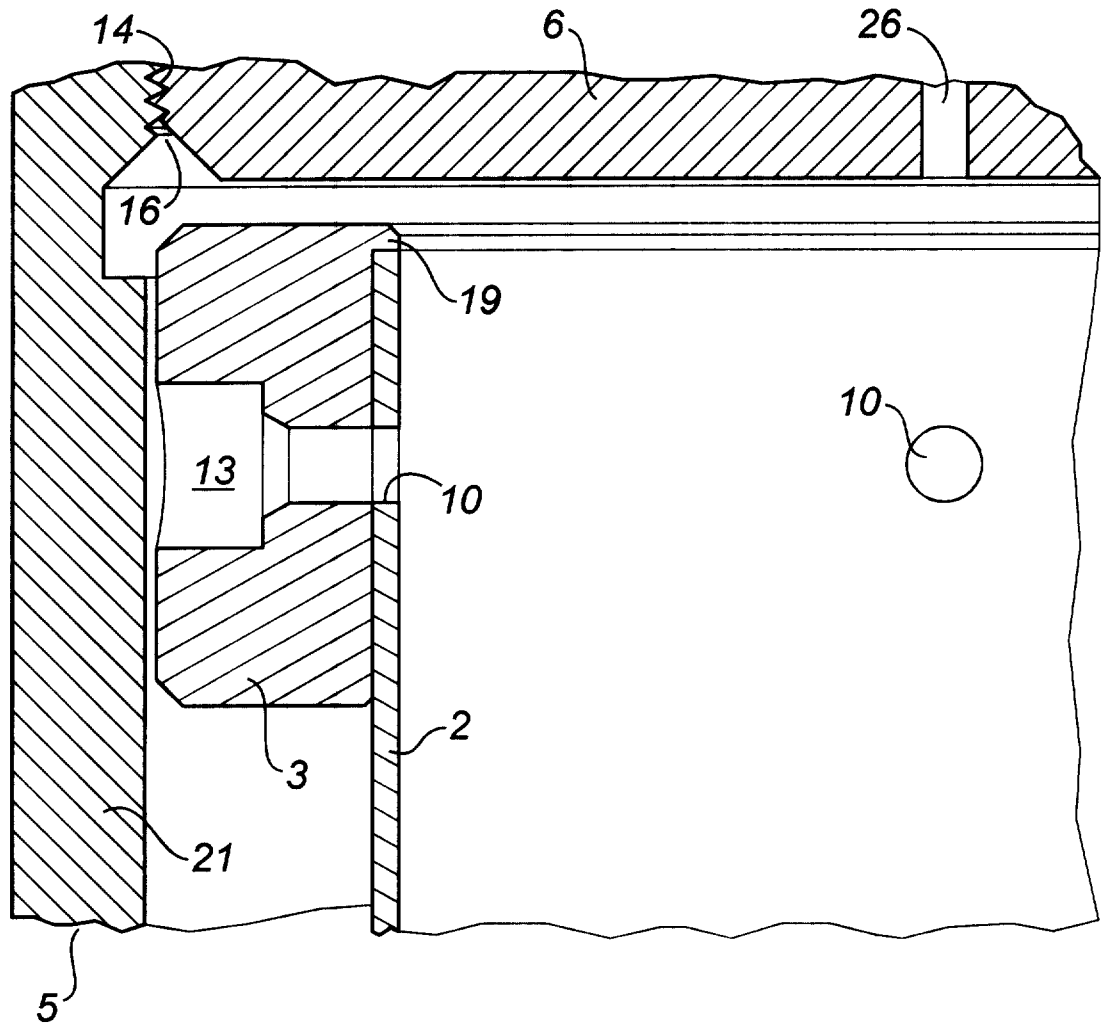


FIG. 4

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FIG. 5

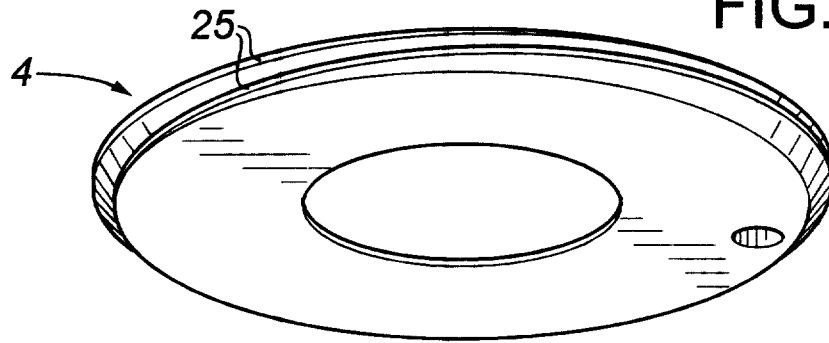


FIG. 6

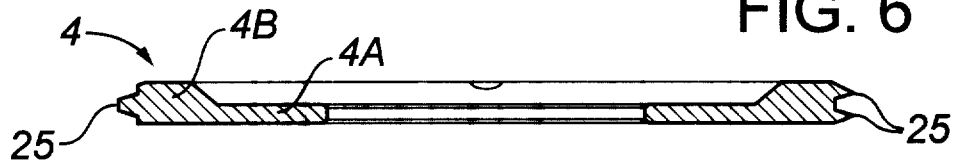
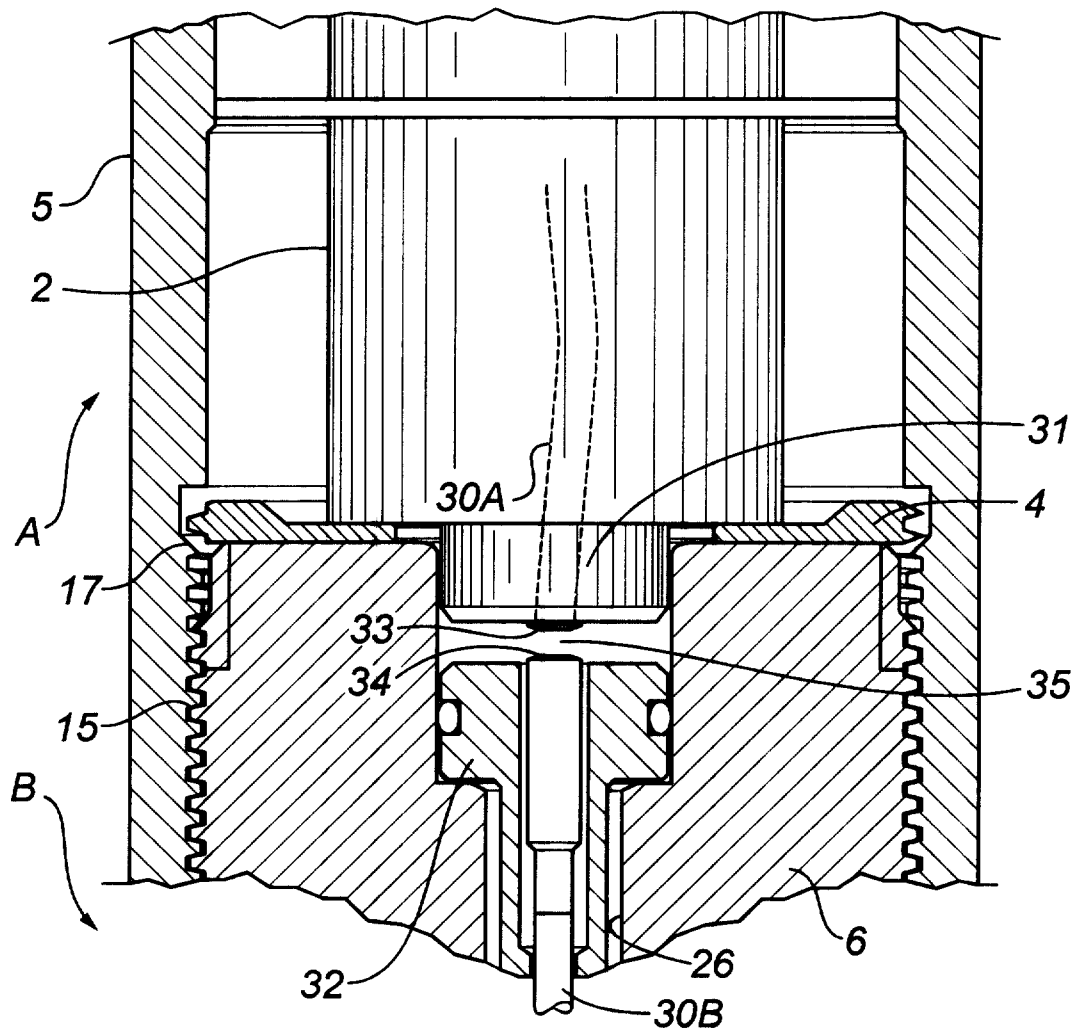


FIG. 7



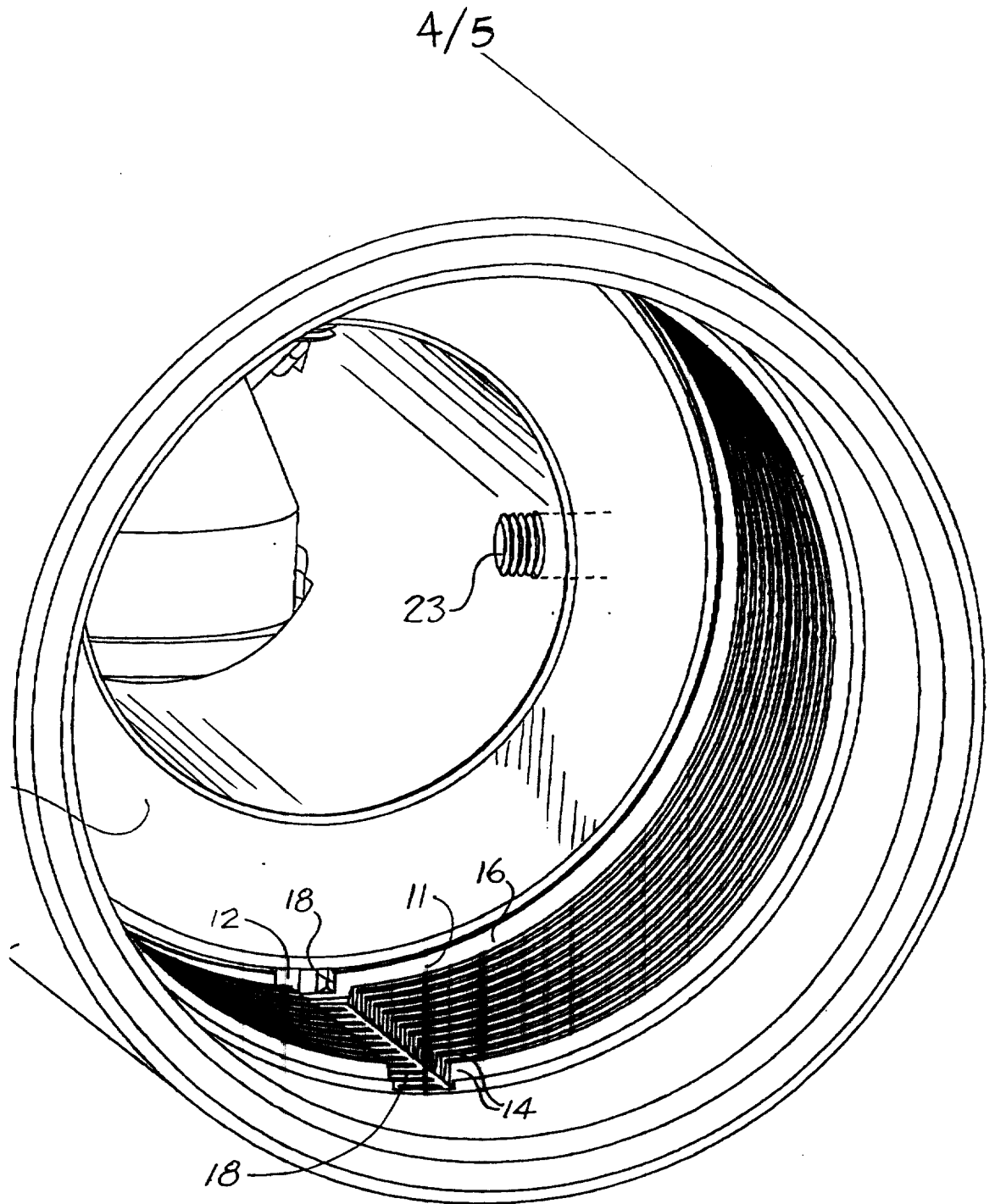


Fig. 8

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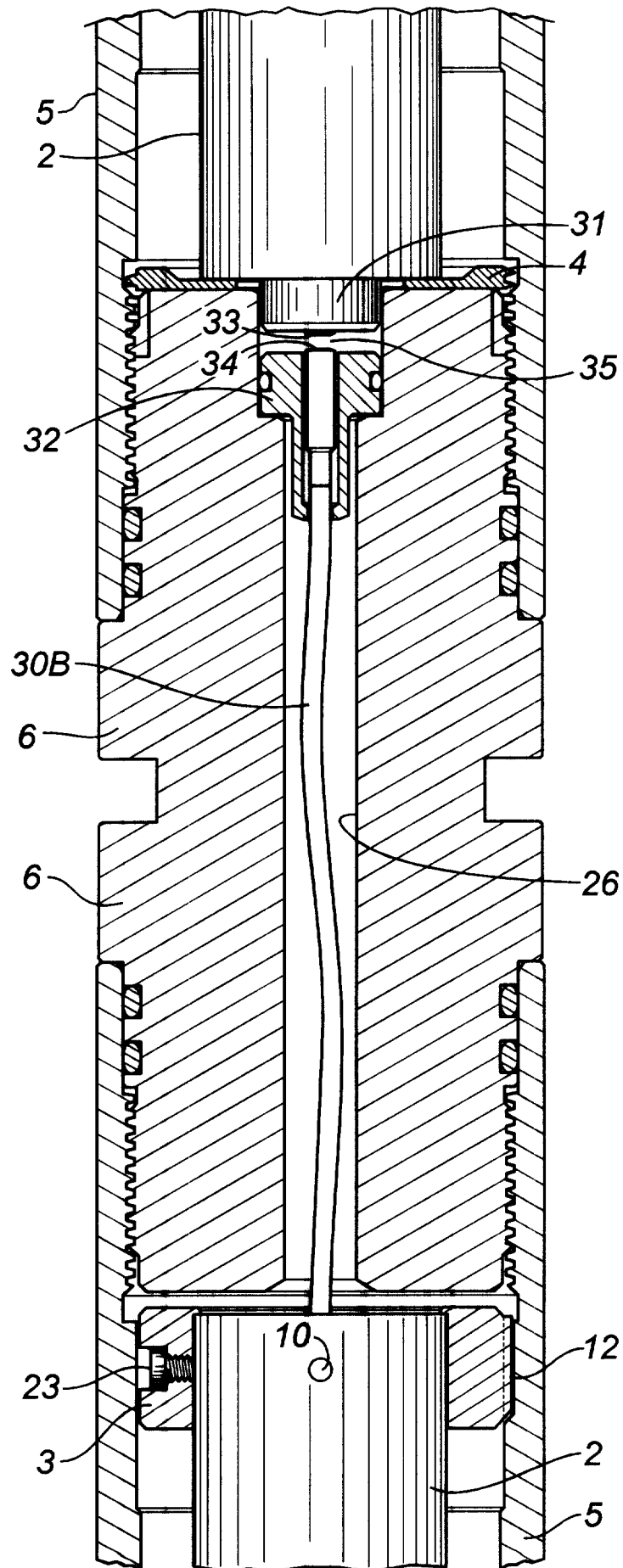


FIG. 9

