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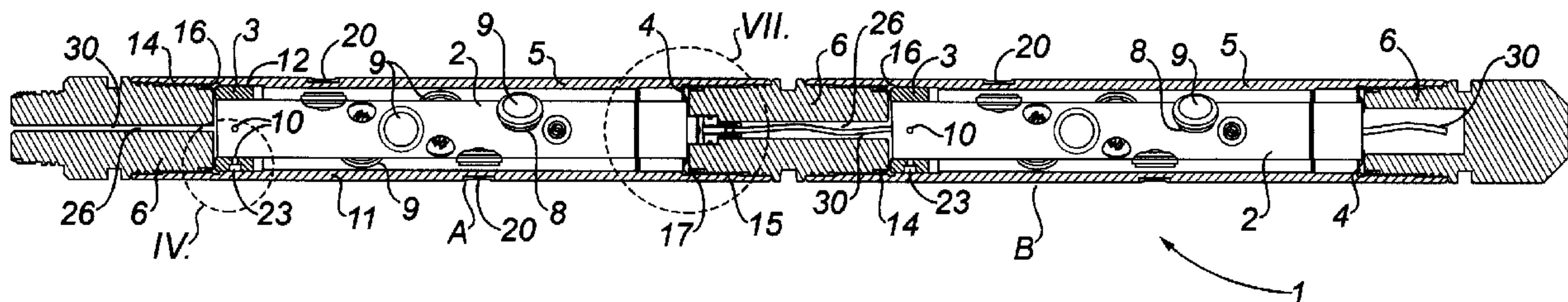
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(54) Titre : STRUCTURES DE RETENUE ET D'ORIENTATION D'UN TUBE DE CHARGEMENT DANS UN CANON DE PERFORATION

(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. 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.

1 **“CHARGE TUBE RETAINING AND ORIENTING STRUCTURES**
2 **FOR A PERFORATING GUN”**
3

4 **ABSTRACT OF THE DISCLOSURE**

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

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FIELD OF THE INVENTION

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

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BACKGROUND OF THE INVENTION

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

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

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- 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;
- 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;

- 1 • The carrier tube is internally threaded at each of its ends so that
2 externally threaded connection subs may be threaded thereinto.
3 The subs function to connect sequential gun sections together and,
4 at the top section, to connect it to the tubing string or cable on
5 which it is commonly run;
- 6 • The subs and charge tubes have central connected vertical
7 passageways through which a detonating cord assembly extends.
8 At the base of each charge tube and the top of the adjacent sub,
9 the detonating cord of an upper gun section is electrically
10 connected with the detonating cord of the next lower gun section by
11 a pair of boosters separated by a narrow air gap.

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

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

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

1 In the prior art, these two concerns are dealt with by providing two
2 collars that attach to the charge tube, one at the base and one at the top. The
3 bottom collar is then attached to the carrier tube. More particularly, the top
4 and bottom collars are attached to the charge tube before it is inserted into
5 the carrier tube. The top collar is attached by means of screws. One of the
6 screws is only partially threaded in, so that it protrudes outwardly and radially.
7 When the charge tube is inserted into the carrier tube, the protruding screw
8 engages a vertical groove formed by the interior surface of the charge tube,
9 thereby ensuring correct circumferential orientation. The bottom collar
10 attaches to the bottom of the charge tube with screws as well. Once the
11 charge tube is inserted into the carrier tube, the bottom collar must then be
12 secured to the carrier tube by means of screws, so that the charge tube does
13 not drop through the bottom of the carrier tube. However this is awkward to
14 do.

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

18 It is another object to provide a means for simultaneously retaining the
19 charge tube in the carrier tube, when no bottom sub is in place, and for
20 positioning the charge tube so that its charges are longitudinally aligned with
21 the scallops.

SUMMARY OF THE INVENTION

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

- 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, 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 automatically circumferentially aligned with the scallops when the key is dropped into the groove;
 - 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 tube at its bottom end. The location of the thread end is 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.
- 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

1 bottom booster of the top gun section and the top booster of the
2 bottom gun section).

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

8 Broadly stated, the invention is a perforating gun assembly comprising:
9 a charge tube carrying a plurality of charges that are spaced longitudinally
10 and circumferentially from one another; a carrier tube having upper and lower
11 internal threads at its upper and lower ends, said carrier tube containing the
12 charge tube in concentric, inwardly spaced relationship, said carrier tube
13 having scallops formed in its side wall, for registering with the charges; an
14 annular alignment collar secured to the top of the charge tube; the collar
15 having first orienting means formed by its outer surface; the carrier tube
16 having second orienting means formed by its inner surface; said first and
17 second orienting means being engaged and causing the carrier tube to be
18 positioned with its charges aligned circumferentially with the scallops; an
19 externally threaded, annular disc, positioned at the upper end of the carrier
20 tube's lower threads, said disc supporting the charge tube so that its charges
21 are aligned longitudinally with the scallops, said disc preventing the charge
22 tube from dropping out of the carrier tube; whereby the charge tube is
23 retained in the carrier tube with the scallops in register with the charges.

DESCRIPTION OF THE DRAWINGS

Figure 1 is a cross-sectional side view of an assembled perforating gun having two sections;

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;

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 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

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.

1 Each charge tube 2 has a series of charge openings 8 spaced
2 circumferentially and longitudinally relative to one another. A shaped charge
3 9 is fitted into the uppermost opening 8. Usually there will be a plurality of
4 charges mounted in the charge tube.

5 At its upper end, three openings 10 are formed in the side wall 11 of
6 the charge tube 2. The openings 10 are spaced apart equidistantly at $\frac{1}{4}$, $\frac{1}{2}$
7 and $\frac{3}{4}$ of the circumferential extent.

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

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

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

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

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

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

10 As shown in Figures 5 – 7, the disc 4 is constructed with a thinned
11 inner portion 4a and a thickened outer portion 4b. The thickened outer portion
12 4b provides strength and enables cutting of the threads 25 in the
13 circumferential edge surface of the disc 4. The purpose of thinning the portion
14 4a is explained below.

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

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

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

1 THE EMBODIMENTS OF THE INVENTION IN WHICH AN
2 EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS
3 FOLLOWS:

4 1. A perforating gun assembly comprising:

5 a charge tube carrying a plurality of charges that are spaced
6 longitudinally and circumferentially from one another;

7 a carrier tube having upper and lower internal threads at its upper and
8 lower ends, said carrier tube containing the charge tube in concentric,
9 inwardly spaced relationship, said carrier tube having scallops formed in its
10 side wall, for registering with the charges;

11 an annular alignment collar secured to the top of the charge tube;

12 the collar having first orienting means positioned at its outer surface;

13 the carrier tube having second orienting means positioned at its inner
14 surface;

15 said first and second orienting means being engaged and causing the
16 carrier tube to be positioned with its charges aligned circumferentially with the
17 scallops;

18 an externally threaded, annular disc, positioned by threading it to the
19 upper end of the carrier tube's lower threads, said disc supporting the charge
20 tube so that its charges are aligned longitudinally with the scallops, said disc
21 preventing the charge tube from dropping out of the carrier tube;

22 whereby the charge tube is retained in the carrier tube with the scallops
23 in register with the charges.

1 2. The perforating gun as set forth in claim 1 wherein:

2 the disc is formed of steel and has a relatively thick outer annular
3 portion and a relatively thin inner annular portion.

4

5 3. The perforating gun as set forth in claim 1 wherein:

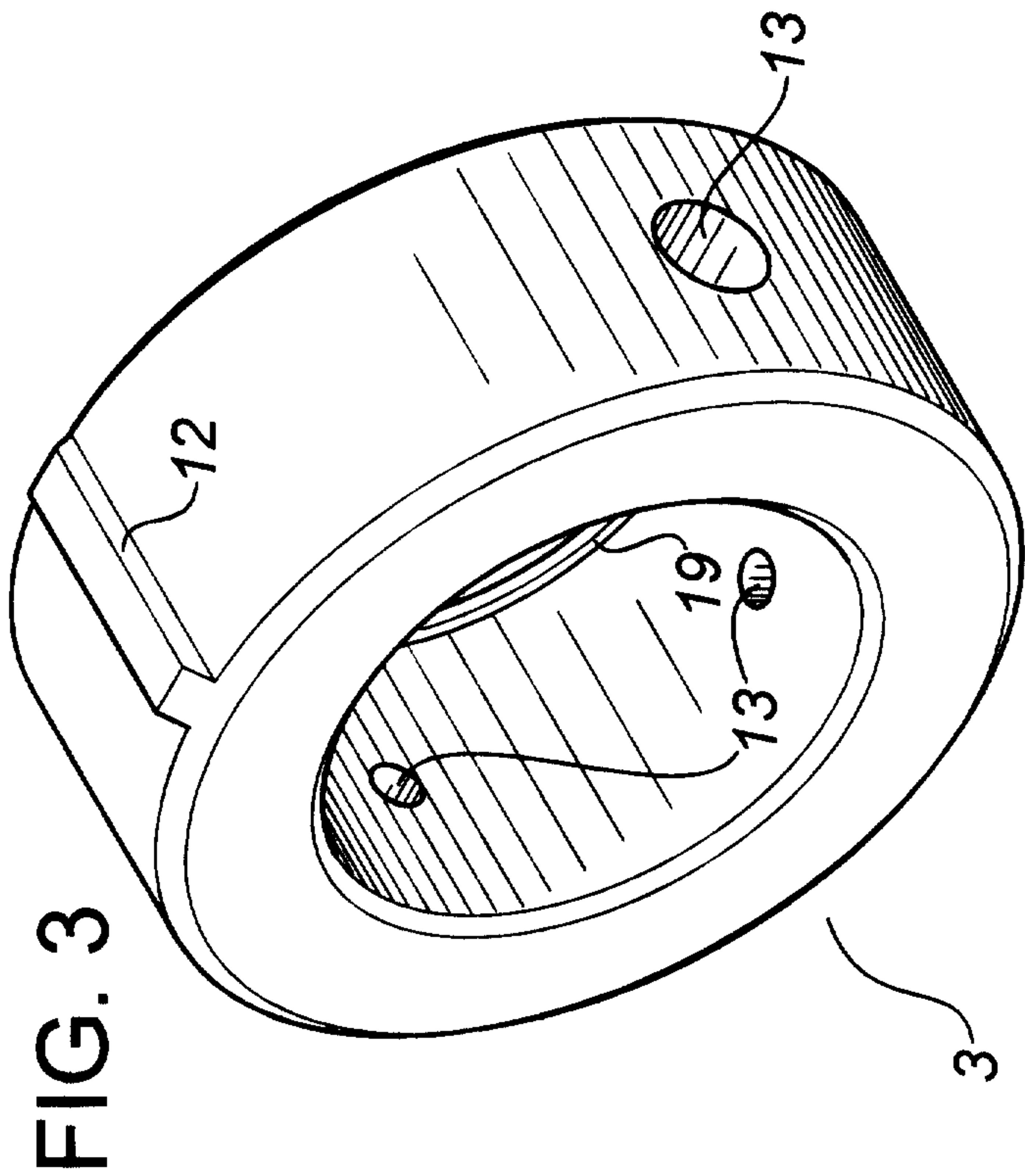
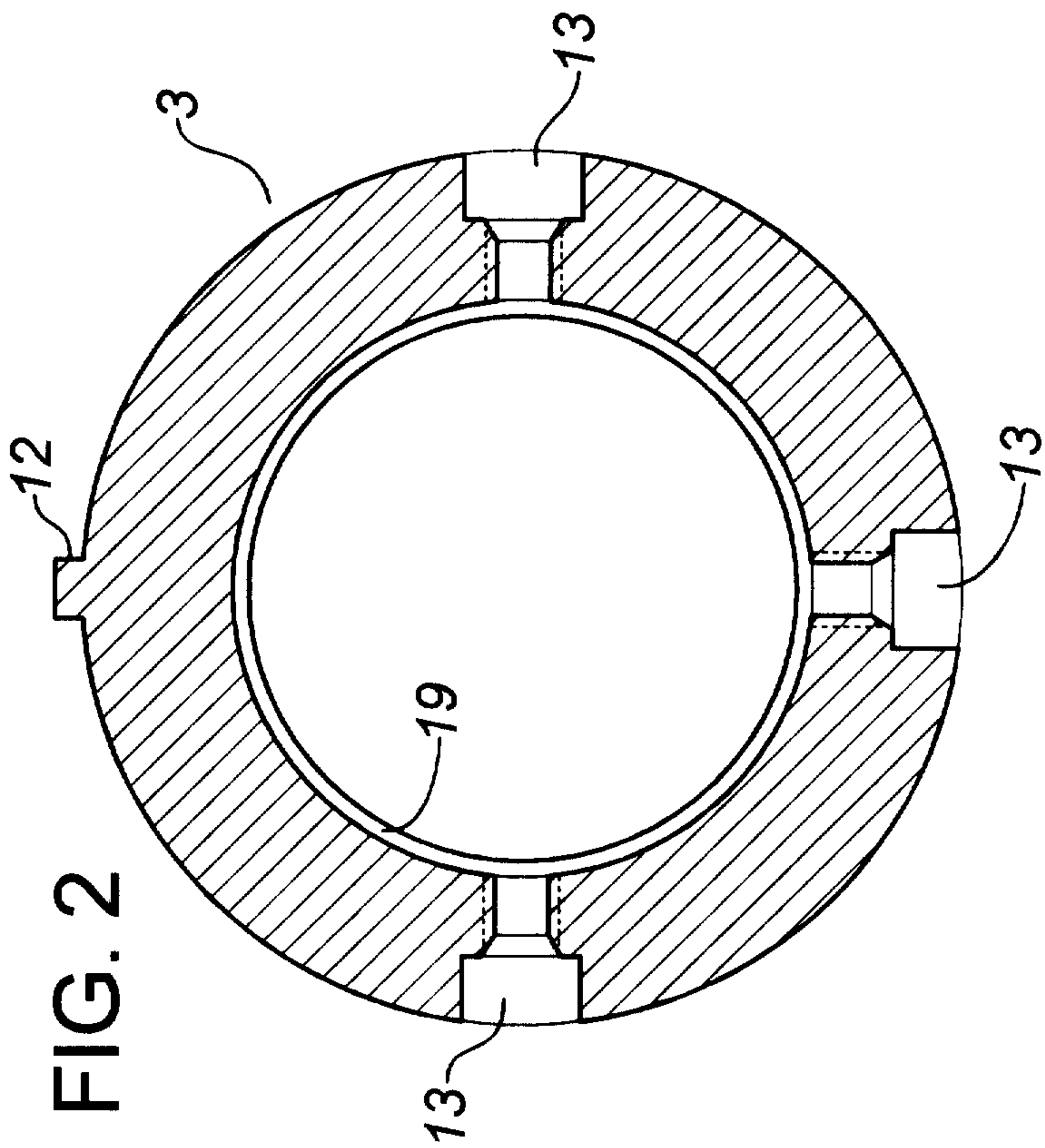
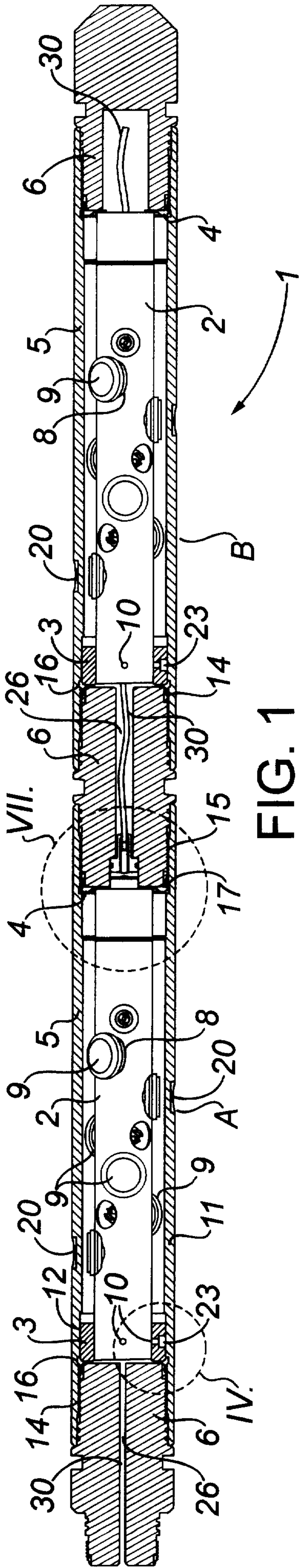
6 the first orienting means is a vertically extending key protruding from
7 the circumferential surface of the collar; and

8 the second orienting means is a vertically extending groove formed
9 through the upper threads of the carrier tube.

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11 4. The perforating gun as set forth in claim 3 wherein:

12 the disc is formed of steel and has a relatively thick outer annular
13 portion and a relatively thin inner annular portion.



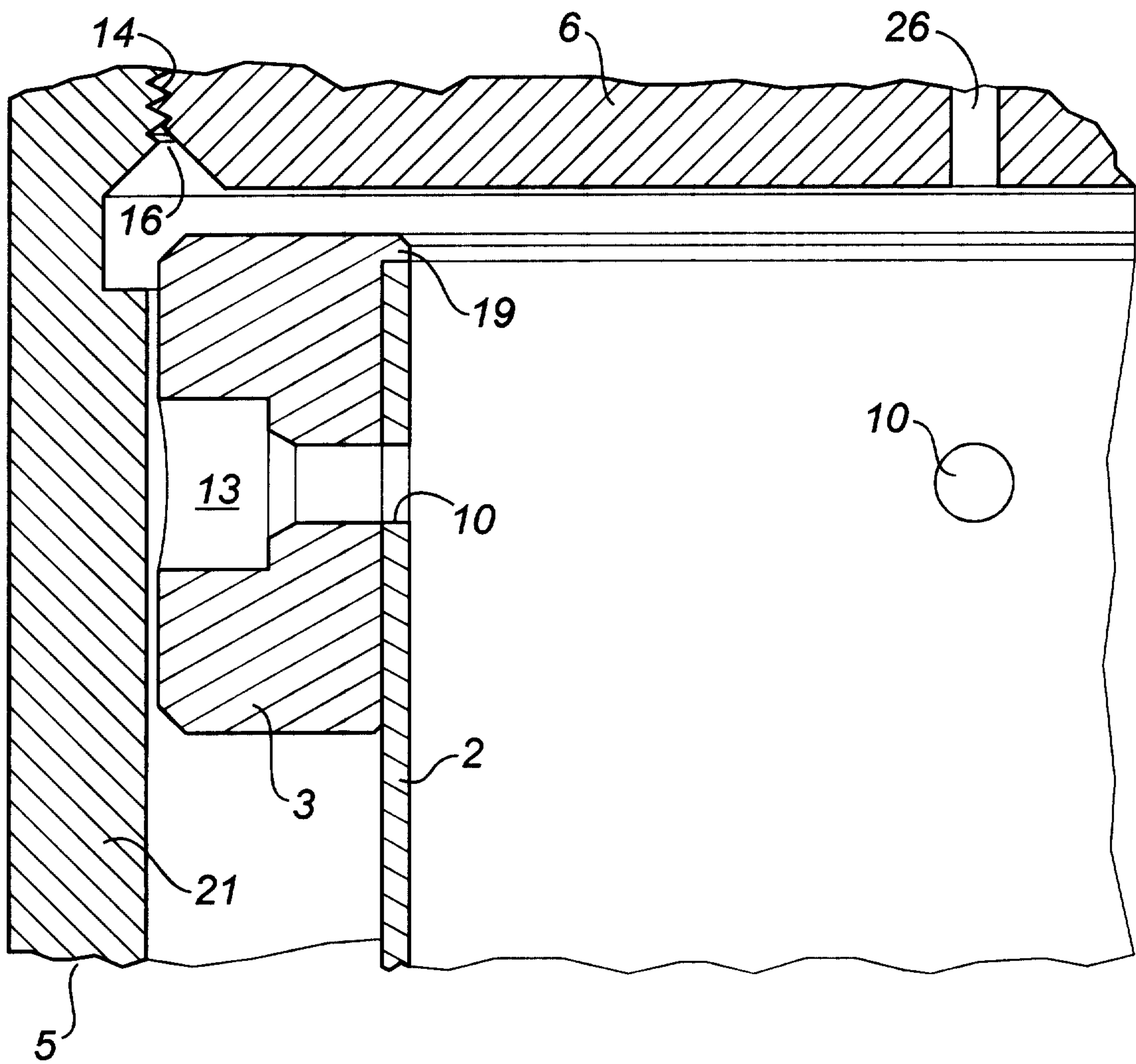


FIG. 4

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FIG. 5

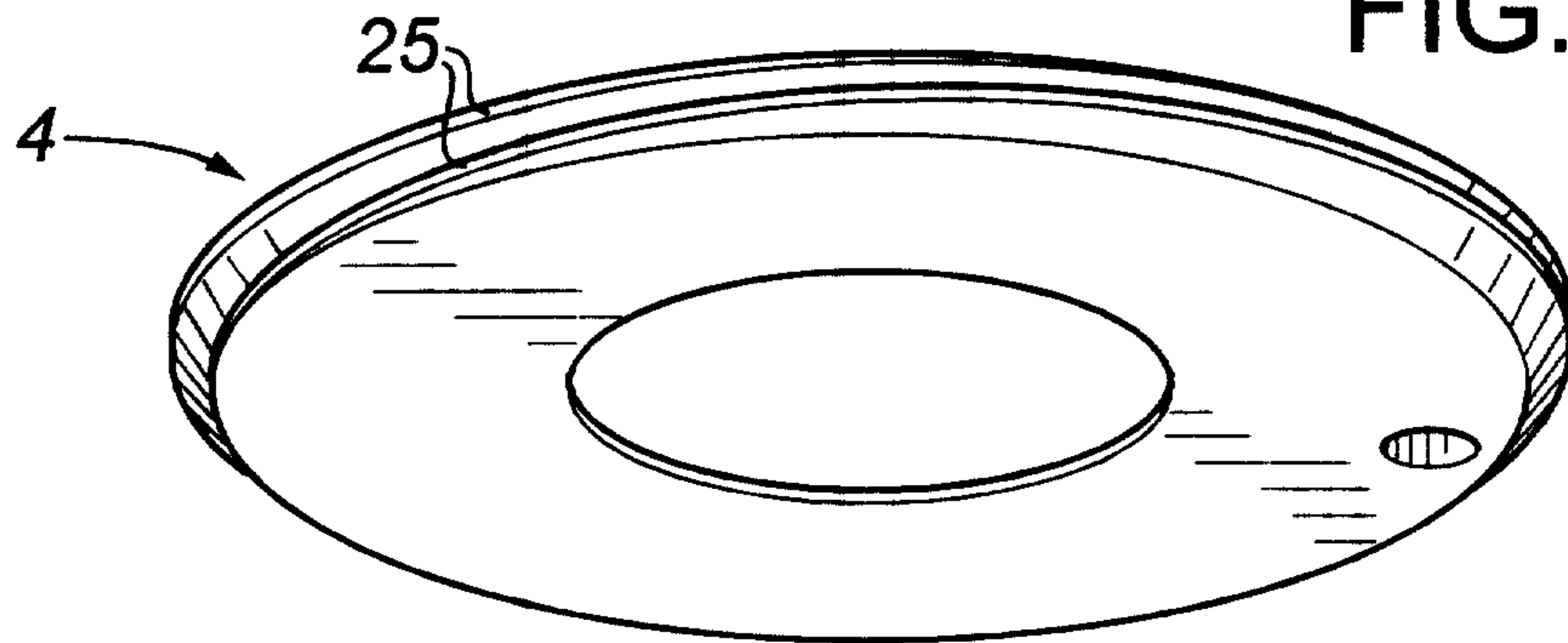


FIG. 6

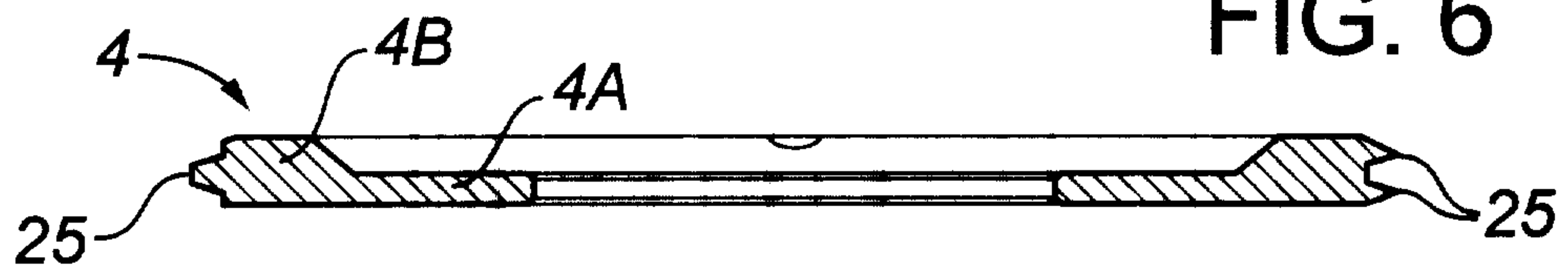
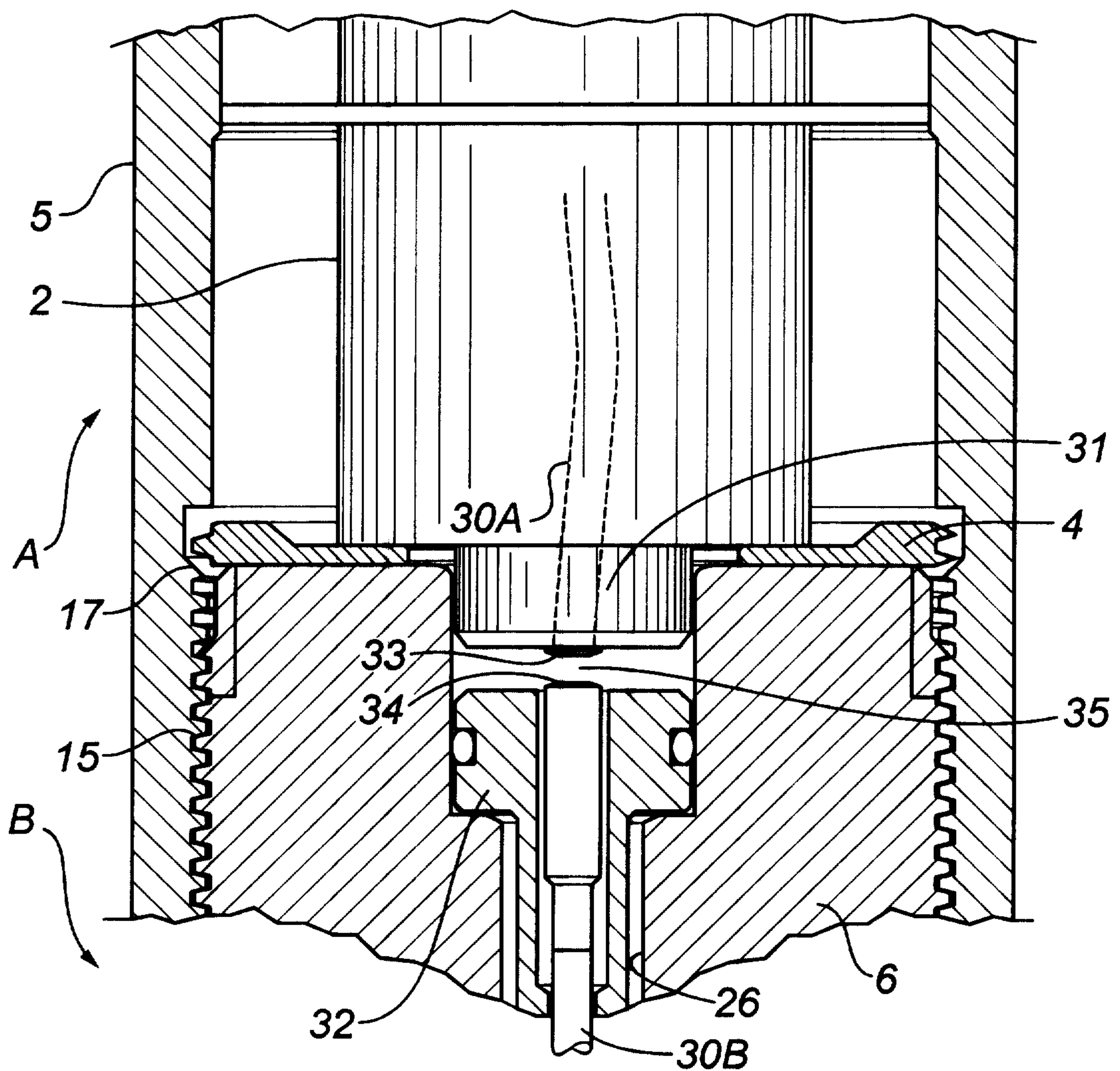


FIG. 7



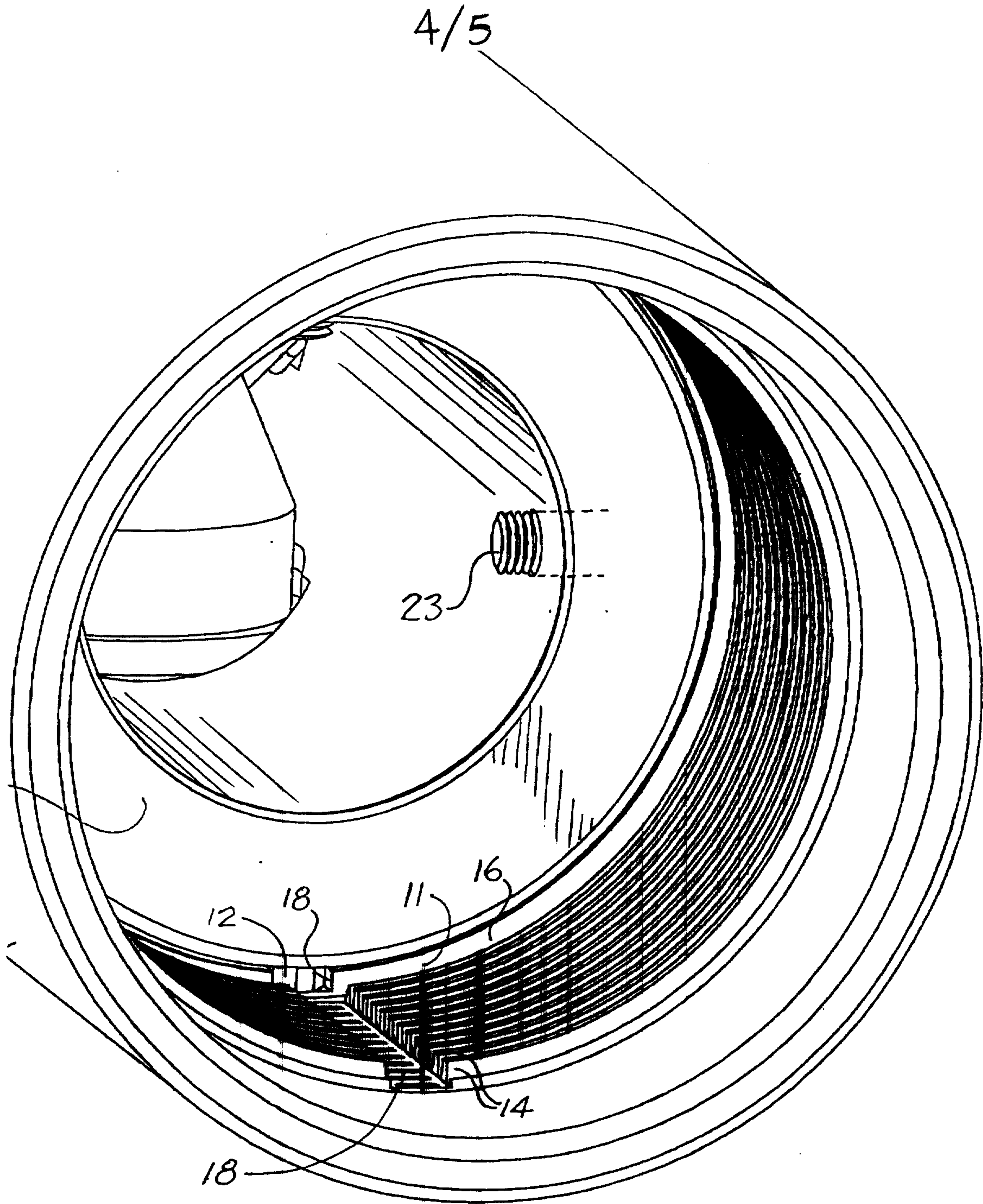


Fig. 8

