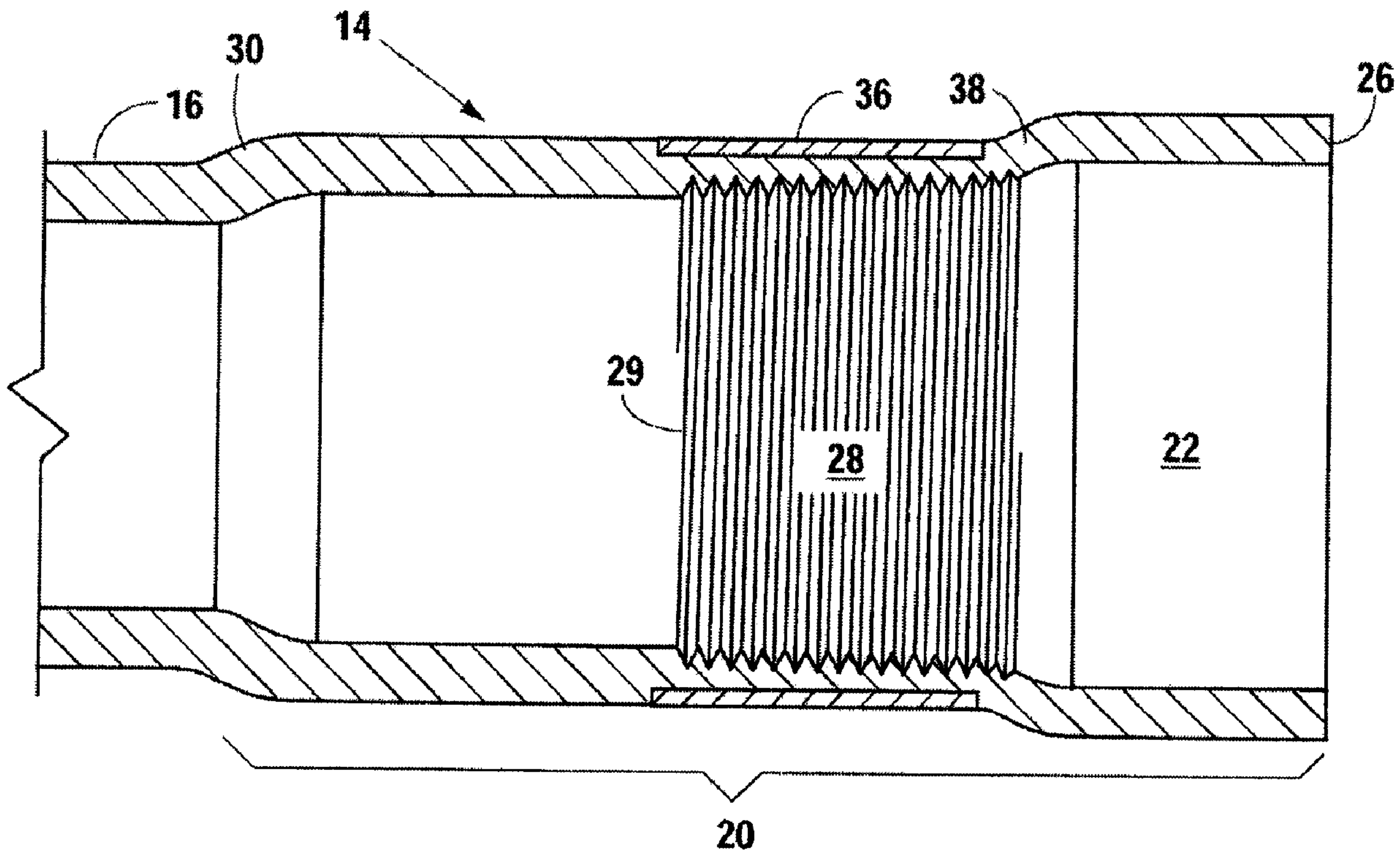




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(54) **Titre :** TUYAU AVEC EXTREMITÉ FEMELLE RENFORCEE
 (54) **Title:** PIPE WITH REINFORCED FEMALE END



(57) **Abrégé/Abstract:**

The present invention relates to a length of pipe with a female end that is reinforced by a band of reinforcing material that extends around the female end. When the pipe and a similar adjacent pipe are threadably connected, the reinforcement material reinforces the female end against failure due to hoop stresses and/or lateral stresses. In this regard, the reinforcing material is any material with a higher resistance to hoop stresses and/or lateral stresses than the material from which the pipe is made. The present invention is also directed to manufacturing processes for manufacturing the pipe of the present invention.

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ABSTRACT

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The present invention relates to a length of pipe with a female end that is reinforced by a band of reinforcing material that extends around the female end. When the pipe and a similar adjacent pipe are threadably connected, the reinforcement material reinforces the female end against failure due to hoop stresses and/or lateral stresses. In this regard, the reinforcing material is any material with a higher resistance to hoop stresses and/or lateral stresses than the material from which the pipe is made. The present invention is also directed to manufacturing processes for manufacturing the pipe of the present invention.

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PIPE WITH REINFORCED FEMALE END

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FIELD OF THE INVENTION

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BACKGROUND OF THE INVENTION

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The present invention relates generally to threaded, submersible pump drop pipe and casing assembly connection and method of manufacture for use in water well and related systems.

Piping systems with threaded connections are well known in the art. Threaded connections connect lengths of pipe using internal threads on the female end of a pipe that interlock with external threads on the male end of a similar adjacent pipe.

During manufacturing of the pipe, external threads are machined into the male end of the pipe and internal threads are machined into the female end of the pipe, typically through automated cutting processes. The shape of the threads, or "thread profile," can vary greatly and often depends on the particular application of the pipe. For example, triangular threads, square threads, rounded threads, and even trapezoidal threads are well known in the art.

Another thread characteristic that depends on the application of the pipe is whether the threads are machined on a pitch as the threads extend away from the leading edge of the pipe. Threads cut on a pitch, called "tapered threads," create a pipe with a gradually changing circumference as the threads extend away from the leading edge of the pipe. As such, for example, the outer circumference of a male end of a pipe with tapered

1 threads increases as the threads extend away from the male leading edge of the pipe, causing
2 the male end of the pipe to be generally shaped as a truncated cone.

3 Pipes with tapered threads are well known in the art and offer certain
4 advantages over pipes with non-tapered threads (*i.e.*, threads not cut on a pitch). For
5 example, specific types of tapered threads such as NPTF threads (also known as Dryseal
6 threads) are used in many piping applications to create watertight (or fluid tight) connections
7 without requiring a sealing compound. The watertight connection is formed through a
8 mechanical seal when the internal threads of the female end of a pipe deform into the
9 external threads of the male end of an adjacent pipe (and vice versa) during tightening of the
10 threaded connection.

11 Tapered threads also have a disadvantage in that care must be taken not to
12 apply too much torque so as to overtighten the connection. Threaded connections with
13 tapered threads are considered “hand-tight” (also known as “finger-tight”) at the point when
14 the male end of the pipe can no longer thread into the female end of an adjacent pipe by
15 hand because the taper on the threads has caused the male end to become jammed within the
16 female end. From hand-tight, a wrench is used to turn at least one of the connected pipes,
17 making the connection “wrench-tight.” Wrench-tight is generally accepted as being a
18 maximum of two turns past hand-tight.

19 If one is not careful the threaded connection can be overtightened past
20 wrench-tight and threaten the integrity of the connection. Overtightening the connection
21 causes hoop stress on the female end of the pipe which, when large enough, will split the
22 female end and cause a failed connection. Hoop stress is a problem with tapered threads that
23 is well known in the art and often occurs near the last internal threads—*i.e.*, the internal

1 threads furthest away from the female leading edge of the pipe—although the failure can
2 occur elsewhere on the female end.

3 Another problem for threaded connections is lateral stress failure of the
4 connection due to lateral forces on the pipe and/or the connection. Although pipes with
5 tapered threads are susceptible to lateral stress failure, this type of failure most frequently
6 occurs on pipes with non-tapered internal threads (*i.e.*, threads that are not cut on a pitch)
7 within the female end of the pipe. Lateral stress failure usually occurs because the
8 manufacturing process for forming the internal threads weakens the pipe wall. Non-tapered
9 internal threads, as well as tapered internal treads, are typically formed in the interior wall of
10 the pipe at the female end by cutting out a portion of the pipe wall. Removing material from
11 the pipe wall decreases the wall thickness and makes the female end of the pipe more prone
12 to lateral stress failure.

13 Lateral stress failure often occurs near the first internal threads—*i.e.*, where
14 the internal threads begin, near the female leading edge of the pipe—but can also occur
15 elsewhere on the female end. In addition, the amount of threads cut into the female end of a
16 pipe can increase its susceptibility to failure from lateral forces and pipes with more threads
17 have a greater tendency to fail. As a result, a need also exists for strengthening pipes that
18 use threaded connections to increase their resistance against lateral stress failure.

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SUMMARY OF THE INVENTION

The present invention is directed to a pipe with a reinforced female end to protect against failure of a threaded connection due to hoop stress and/or lateral stress.

The pipe of the present invention has a female end for receiving a male end of a similar adjacent pipe. At least a portion of the pipe at the female end has a reinforcement band that extends circumferentially around the pipe. The reinforcement band is preferably in the form of a cylinder that extends completely around the circumference of the pipe, although other embodiments with the reinforcement band extending only partially around the circumference of the pipe are contemplated by the present invention. Regardless, the reinforcement band is made from a rigid material or materials that are stronger than the material or materials from which the pipe is made. More specifically, the reinforcement band should have material characteristics which withstand higher hoop stresses and/or lateral stresses than the pipe material.

The present invention is also directed to a manufacturing processes to form the pipe of the present invention. The claimed manufacturing process is for extruded thermoplastic pipe, such as polyvinyl chloride (PVC) pipe or polyethylene pipe, which is belled with a mandrel after extrusion. Prior to belling, the reinforcement band is positioned around the female end of the pipe and when the pipe is enlarged through the belling process, the reinforcement band is embedded into the outer wall of the pipe or at least press fit against the outer wall of the pipe. In addition, a manufacturing process for implementing the reinforcing band into a thermosetting pipe, such as fiber reinforced plastic (FRP) pipe, is also disclosed.

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BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a perspective view of the preferred embodiment of the present invention;

Figure 2 is an exploded perspective view of the preferred embodiment of the present invention, as shown with the female end of one pipe and the male end of a similar adjacent pipe;

Figure 3 is a perspective view of the female end of the preferred embodiment of the pipe of the present invention;

Figure 3A a cross sectional side view taken along the female end of the preferred embodiment of the pipe of the present invention shown in Fig. 3;

Figure 4 is a perspective view of the female end of an alternative embodiment of the pipe of the present invention;

Figure 4A is a cross sectional view taken along the female end of the alternative embodiment of the present invention shown in Fig. 4;

Figure 5 is a perspective view of the female end of another alternative embodiment of the present invention;

Figure 5A is a cross sectional view taken along the female end of the alternative embodiment of the present invention shown in Fig. 5;

Figure 6 is a cross sectional view of the pipe and a perspective view of a mandrel prior to insertion of the mandrel into the pipe, during the preferred manufacturing process for the preferred embodiment of the present invention;

1 Figure 6A is a cross sectional view of the pipe and a perspective view of a
2 mandrel after the mandrel has been initially inserted in the pipe, during the preferred
3 manufacturing process for the preferred embodiment of the present invention;

4 Figure 6B is a cross sectional view of the pipe and a perspective view of a
5 mandrel after the mandrel has been further inserted into the pipe, during the preferred
6 manufacturing process for the preferred embodiment of the present invention;

7 Figure 6C is a cross sectional view of the pipe and a perspective view of a
8 mandrel after the mandrel has been fully inserted into the pipe, during preferred
9 manufacturing process for the preferred embodiment of the present invention;

10 Figure 7 is a cross sectional view of the pipe and a perspective view of a
11 mandrel prior to insertion of the pipe onto the mandrel, during an alternative manufacturing
12 process for an alterative embodiment of the present invention;

13 Figure 7A is a cross sectional view of the pipe and a perspective view of a
14 mandrel after the pipe has been partially inserted over the mandrel, during an alternative
15 manufacturing process for an alternative embodiment of the present invention; and

16 Figure 7B is a cross sectional view of the pipe and a perspective view of a
17 mandrel after the pipe has been fully inserted onto the mandrel, during an alternative
18 manufacturing process for an alternative embodiment of the pipe present invention.

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DETAILED DESCRIPTION OF THE INVENTION

Referring to Figs. 1 through 2A, the preferred embodiment of the present invention is shown with a pipe 10 and a similar adjacent pipe 12. In practice, the pipe 10 has the same structure as the similar adjacent pipe 12 and therefore, a description of structure that is present for the similar adjacent pipe 12 applies equally to a description of the structure for the pipe 10, and vice versa.

Pipe 10 has a female end 14, an intermediate length 16, and a male end 18. The female end 14 has an enlarged exterior diameter 20 with preferably a distinct first cylinder section 22 and a distinct second cylinder section 24. First cylinder section 22 terminates the female end 14 of the pipe 10 at a female leading edge 26. In the preferred embodiment, second cylinder section 24 is between the first cylinder section 22 and the intermediate length 16, and, transitions directly into the intermediate length 16. In this regard, there is preferably an external shoulder 30 between the second cylinder section 24 and the intermediate length 16. The male end 18 of the pipe 10 is opposite the female end 14 and is also adjacent the intermediate length 16. The male end 18 has external threads 32 disposed thereon and terminates the pipe 10 at a male leading edge 34.

Internal threads 28 are formed on the interior surface of at least a portion of the female end 14 (*see* Figs. 1-5A). In the preferred embodiment shown in Figs. 1-3A, the internal threads 28 are formed within the second cylinder section 24.

The form and number of internal and external threads 28, 32 depend on the application and size of the pipe 10. For example, the preferred embodiment of the present invention for one inch diameter PVC drop pipe has internal and external threads 28, 32 that are tapered, have a triangular thread profile, and conform to ASTM Standard F-1498 for the

1 amount of threads. Preferably, the external threads 32 start at a beveled male leading edge
2 34 of the male end 18 and the female end 14 has internal threads 28 within the second
3 cylinder section 24 that begin approximately 0.93 inches from the female leading edge 26
4 and span over slightly more than one inch of pipe length within the second cylinder section
5 24. One with skill in the art will recognize, however, that characteristics like the thread
6 profile, the length of pipe 10 over which the threads span, whether the threads are tapered,
7 and how far the threads start from their respective leading edges, will vary according to the
8 application and size of the pipe 10.

9 Regardless of the thread characteristics and the pipe application, a
10 reinforcement band 36 extends circumferentially around at least a portion of the female end
11 14 of the pipe 10. The reinforcement band 36 is made from a material that has a greater
12 resistance against hoop stress and/or lateral stress than the material from which the pipe 10
13 is made. As discussed in more detail *infra*, the material composition of the reinforcement
14 band 36 and the dimensions of the reinforcement band 36 will largely depend on the
15 manufacturing processes of the pipe 10. Preferably, however, the reinforcement band 36
16 will be made from metal or some sort of metal alloy such as stainless steel.

17 In its preferred embodiment, the reinforcement band 36 is a single, complete
18 cylinder that extends around at least a portion of the enlarged exterior diameter 20 of the
19 female end 14. The edges of the reinforcement band 36 are also preferably embedded in the
20 outer wall of the pipe 10 such that the material from which the pipe 10 is made at least
21 partially covers the edges of the reinforcement band 36. Embedding the reinforcement band
22 36 in this manner prevents the band 36 from becoming axially displaced from its original
23 position around the pipe. However, in alternative embodiments the reinforcement band 36

1 may not be embedded in the outer wall of the pipe 10. Instead, the outer wall of the
2 enlarged diameter 20 may be formed to firmly press against the reinforcement band 36 with
3 enough friction to hold the band 36 in place.

4 Preferably, the reinforcement band 36 is positioned in the outer wall of the
5 female end 14 opposite the internal threads 28 and extending along the length of at least a
6 portion of the internal threads 28. To provide the most protection against failure, at least a
7 portion of the reinforcement band 36 should be placed opposite the last internal thread 29,
8 and preferably extend beyond the last internal thread 29 (*see* Fig. 3A). Likewise, at least a
9 portion of the reinforcement band 36 may be positioned opposite and extend beyond the first
10 internal thread. However, this positioning but may not be desirable, depending on the
11 embodiment of the pipe 10. For example, in the preferred embodiment of the pipe 10 the
12 reinforcement band 36 is not positioned opposite the first internal thread because a shoulder
13 38 is present between the first cylinder section 22 and the second cylinder section 24. In this
14 regard, the preferred embodiment for the one inch PVC drop pipe mentioned above, has a
15 reinforcement band 36 that is 1.53 inches wide and extends along the second cylinder
16 section 24 from beyond the last internal thread 29 up to the shoulder 38, making the
17 reinforcement band 36 positioned opposite substantially all of the internal threads 28 (*see*
18 Fig. 3A).

19 In alternative embodiments, however, the reinforcement band 36 may be
20 positioned so that it extends beyond the first internal thread, or, the reinforcement band 36
21 may be positioned opposite only a smaller portion of the internal threads 28 such as in the
22 embodiment shown in Fig. 4A. In fact, the reinforcement band 36 may not be positioned
23 opposite the internal threads 28 at all. For example, the reinforcement band 36 may extend

1 around the first cylinder section 22 of the female end 14. In another embodiment, the
2 reinforcement band 36 may extend only partially around the circumference of the female
3 end 14. Furthermore, there may be more than one reinforcement band 36 present.
4 Typically, the form of the reinforcement band 36 and whether more than one reinforcement
5 band 36 is present will depend on factors like the application of the pipe 10 and strength of
6 the material from which the reinforcement band 36 is made, as well as the thickness and
7 width of the reinforcement band 36.

8 As mentioned, the preferred embodiment of the present invention has a
9 distinct first cylinder section 22 and a distinct second cylinder section 24 at the female end
10 14 of the pipe 10 (*see* Figs. 1-3A). The first cylinder section 22 and the second cylinder
11 section 24 are separated from one another by the shoulder 38 between the two sections. The
12 interior diameter of the first cylinder section 22 is larger than the interior diameter of the
13 second cylinder section 24 with the interior diameter of the second cylinder section 24 being
14 defined as the diameter at the crest of the last internal thread 29.

15 As the male end 18 of the similar adjacent pipe 12 is inserted into the first
16 cylinder section 22 of the preferred embodiment of the pipe 10 it is funneled to the second
17 cylinder section 24. Preferably the male leading edge 34 of the similar adjacent pipe 12 is
18 beveled to aid such funneling. Once at the second cylinder section 24, the external threads
19 32 of the male end 18 encounter the internal threads 28 of the second cylinder section 24 and
20 turning of the similar adjacent pipe 12 relative to the pipe 10 will cause the threads of the
21 pipes to interlock in a manner well known in the art.

22 The first cylinder section 22 of the preferred drop pipe embodiment is also
23 preferably elongated so that it receives a substantial portion of the engaging external threads

1 32 from the similar adjacent pipe 12 before the external threads 32 begin to thread into the
2 internal threads 28 of the pipe 10. The engaging external threads 32 are only those threads
3 which interlock with the internal threads 28 when tightened. The elongated first cylinder
4 section 22 provides additional lateral strength to the threaded connection once the
5 connection is formed and promotes increased watertightness of the connection. In this
6 regard, pipes connected by threaded connections typically leak at the threads when lateral
7 force is applied to the connected pipes and the elongated first cylinder section 22 protects
8 against these lateral forces, as detailed in U.S. Patent No's. 6,666,480, 7,261,326, 7,470,383,
9 and 7,425,024.

10 Furthermore, the interior diameter of the first cylinder section 22 in the
11 preferred PVC drop pipe embodiment of the present invention mentioned above is only
12 slightly larger than the exterior diameter of the male end 18 of the pipe 10 at the crest of the
13 external threads 32 and minimal clearance exists between the male end 18 of the similar
14 adjacent pipe 12 and the female end 14 of the pipe 10 when the male end 18 is inserted into
15 the first cylinder section 22 of the pipe 10.

16 Other embodiments of the present invention do not have a distinct first
17 cylinder section 22 and a distinct second cylinder section 24. In the alternative embodiment
18 shown in Figs. 4 & 4a the two different interior diameters are the interior diameter at the
19 bevel and the interior diameter at the crest of the last internal thread 29. This alternative
20 embodiment of the pipe 10 has the reinforcement band 36 positioned opposite from the
21 internal threads 28 of the female end 14 and the reinforcement band 36 extends along the
22 length of only a portion of the internal threads 28. In this regard, the reinforcement band 36
23 does not extend beyond the last internal thread 29 or the first internal thread.

1 Further alternative embodiments with no distinct first and second cylinder
2 sections 22, 24 and without distinct interior diameters that differ are also contemplated by
3 the present invention. For example, the alternative embodiment shown in Figs. 4 & 4A
4 could have a non-beveled female leading edge 26 with the internal threads 28 beginning at
5 and extending from the female leading edge 26. In addition, the alternative “flush mount”
6 embodiment of the pipe 10 shown in Figs. 5 & 5A also do not have distinct first and second
7 cylinder sections 22, 24 and do not have differing interior diameters at the female end 14.

8 The alternative flush mount embodiment of the present invention in Figs. 5 &
9 5A illustrates the pipe 10 and the similar adjacent pipe 12 without an enlarged exterior
10 diameter 20 at the female end 14 and without an external, shoulder 30. As such, the female
11 end 14 is flush with the intermediate length 16. Pipes without an enlarged exterior diameter
12 20 are well known in the art and when connected, the pipe 10 and the similar adjacent pipe
13 12 form a so-called “flush mount connection.” As shown in Fig. 5A, the pipe 10 in this
14 alternative embodiment does not have tapered internal and external threads 28, 32, but
15 rather, the internal and external threads 28, 32 are non-tapered threads with a trapezoidal
16 thread profile. Depending on the application, however, the internal and external threads 28,
17 32 could be tapered and have a triangular or other-shaped thread profile.

18 Additionally, the reinforcement band 36 in the flush mount embodiment
19 shown in Figs. 5 & 5A is also not embedded in the pipe wall of the pipe 10. Instead, the
20 reinforcement band 36 is shrink fit on the outer wall of the female end 14 so that it tightly
21 presses against the outer wall of the female end 14 of the pipe 10, as explained *infra*.

22 Turning to the manufacturing processes for the present invention, Figs. 6-6C
23 illustrate the preferred manufacturing method for the preferred embodiment for the pipe 10

1 when the pipe 10 is extruded and belled after such extrusion. As shown, a mandrel 40 is
2 inserted into the pipe 10 after the pipe 10 has been extruded and cut into its desired length.

3 Extruding the pipe and cutting it to the desired length are manufacturing
4 processes that are well known in the art. After extrusion and cutting, the pipe 10 is typically
5 moved to another location in the manufacturing assembly and one end of the pipe 10 is
6 sufficiently heated to render it pliable. Once pliable, the pipe 10 is clamped into place and
7 the mandrel 40 is forced into the heated end of the pipe 10 by a hydraulic cylinder (not
8 shown) to form the contour of the female end 14 of the pipe 10. The mandrel 40 is made of
9 metal and when pressed against the inner circumference of the pliable end of the pipe 10, the
10 mandrel 40 will force the pliable end outward, thereby increasing both the inner and outer
11 circumference of the pipe 10 where the mandrel 40 is inserted. The increase in both inner
12 and outer circumference of the female end 14 creates the enlarged exterior diameter 20 and
13 the external shoulder 30.

14 The reinforcement band 36 is sized so that when the mandrel 40 is inserted
15 into the pliable end of the pipe 10, the outer wall of the pipe 10 comes into contact with—
16 and preferably deforms around—the edges of the reinforcement band 36. The reinforcement
17 band 36 is positioned over the pliable end of the pipe 10 prior to insertion of the mandrel 38.
18 Unlike the heated end of the pipe 10, the reinforcement band 36 is not pliable and as the
19 outer wall of the pipe 10 contacts the reinforcement band 36 the outer wall deforms around
20 the edges of the reinforcement band 36 thereby embedding the reinforcement band 36.

21 The degree or amount of embedding of the reinforcement band 36 into the
22 pliable end of the pipe 10 in the preferred embodiment will depend on the following factors:
23 (1) the size of the reinforcement band 36 relative to the pipe 10 prior insertion of the

1 mandrel 40; (2) the thickness of the reinforcement band 36; (3) the thickness of the outer
2 wall of the pipe 10; and (4) the size of the circumference of the mandrel 40 relative to the
3 pipe 10 prior to insertion of the mandrel 40. With regard to the last factor, the size of the
4 circumference of the mandrel 40 will dictate the amount by which the circumference of the
5 pliable end of the pipe 10 is enlarged. With a one inch extruded PVC drop pipe, for
6 example, the reinforcement band 36 is stainless steel, has an outer diameter of 1.522 inches,
7 and is, at a minimum, 0.020 inches thick.

8 It should be noted that the mandrel 40 shown in Figs. 6-6C is designed to
9 form the preferred embodiment of the present invention. As a result, the reinforcement band
10 36 is positioned over the pliable end of the pipe 10 at a distance that is far enough from the
11 female leading edge 26 so the reinforcement band 36 will embed into the outer wall of the
12 pipe 10 at the second cylinder section 24, opposite where the internal threads 28 will be
13 formed—a step that occurs later in the manufacturing process. As mentioned above, the
14 reinforcement band 36 could be positioned over the pliable end of the pipe 10 so that it
15 embeds in other positions on the outer wall of the pipe 10. It should further be noted that the
16 reinforcement band 36 could be positioned over the end of the pipe 10 prior to heating the
17 end of the pipe 10.

18 Figs. 7-7B show an alternative manufacturing process of the present
19 invention, which in this case, is directed to manufacturing the alternative embodiment of the
20 invention shown in Figs. 4-4A. In this alternative manufacturing process, the mandrel 40
21 stays static and the pliable end of the pipe 10 is urged over the mandrel 40. Again, the
22 reinforcement band 36 is positioned over the pliable end of the pipe 10 and is sized to have
23 the outer wall of the pipe 10 contact it during the enlarging process, but in this instance, the

1 reinforcement band 36 moves at the same rate with the pliable end of the pipe 10 as the pipe
2 10 is urged onto the mandrel 40.

3 Once the mandrel 40 is inserted into the one of the pipe 10, or the one end of
4 the pipe 10 is urged onto the mandrel 40, a cooling agent such as water is applied to the
5 now-enlarged end of the pipe 10. The cooling agent cools the pipe 10 and conforms the
6 enlarged end of the pipe 10 to the shape of the mandrel 40. From this point, the mandrel 40
7 is removed from the pipe 10, or vice versa, and the pipe 10 has acquired the contour of the
8 mandrel 40 and the reinforcement band 36 is positioned thereon.

9 Once the mandrel 40 is removed from the pipe 10, the internal threads 28 and
10 external threads 32 are formed. In the preferred embodiment, the internal threads 28 are
11 machined into at least a portion of the interior surface of the second cylinder section 24, or
12 alternatively, throughout the entire interior surface of the second cylinder section 24, using
13 processes that are well known in the art. Similar processes form the external threads 32 on
14 the male end 18.

15 When the female end 14 of the pipe 10 does not have an enlarged exterior
16 diameter 20 like the alternative embodiment shown in Figs. 5 & 5A, the process to install
17 the reinforcement band 36 on the female end 14 may be altered. One way to manufacture this
18 embodiment of the present is to shrink fit the reinforcement band 36 on the female end 14.
19 Shrink-fitting is a well-known manufacturing process. The reinforcement band 26 is
20 initially sized such that its interior dimensions are almost identical to the dimensions of the
21 outer wall of the pipe 10 at the female end 14. The reinforcement band 36 is also made from
22 a material that has a coefficient of thermal expansion which allows the reinforcement band
23 36 to expand when heated and contract back to its original shape when cooled. In this

1 regard, the reinforcement band 36 is preferably made from a material that has a high
2 coefficient of thermal expansion, such as aluminum or brass. The reinforcement band 36 is
3 heated and expands, and then, is positioned around the female end 14 of the pipe 10. After it
4 is moved to its desired position, the reinforcement band 36 is cooled and contracts back to
5 its original shape, causing it to press against the outer wall of the pipe 10.

6 It should be finally noted that the pipe 10 of the present invention is not
7 limited to extruded pipe 10. The apparatus of the present invention can be implemented into
8 thermosetting pipe and pipes made from other composite materials. In this regard, adding a
9 step for installation of the reinforcement band 36 can be implemented into manufacturing
10 processes that are well known for these other types of pipe. For example, and not by way of
11 limitation, positioning the reinforcement band 36 over the mandrel 40 during the filament
12 winding processes for FRP pipe is within the scope of the apparatus contemplated by the
13 present invention.

14 Although the present invention has been described with reference to specific
15 embodiments, this description is not meant to be construed in a limiting sense. Various
16 modifications of the disclosed embodiments, as well as alternative embodiments of the
17 invention will become apparent to persons skilled in the art upon the reference to the above-
18 description of the invention. It is, therefore, contemplated that the appended claims will
19 cover such modifications that fall within the scope of the invention.

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1 I claim:

- 2 1. A single piece of pipe connectable to a similar adjacent pipe, said pipe
3 comprising:
4 a male end having external threads;
5 a female end having an enlarged exterior diameter;
6 an intermediate section between said male end and said female end having a
7 uniform interior diameter;
8 a first section at said female end having an interior diameter to receive a male
9 end of said similar adjacent pipe therethrough;
10 a second section at said female end having internal threads to mate with
11 external threads of a male end of said similar adjacent pipe;
12 said first section positioned to funnel said male end of said similar adjacent
13 pipe to said second section;
14 said second section being positioned between said intermediate section and
15 said first section;
16 at least one circular reinforcement band positioned circumferentially around
17 at least a portion of said female end, said at least one reinforcement band including a first
18 side facing said internal threads of said second section, an opposite second side facing away
19 from said internal threads of said second section, and edges located where said first side and
20 said second side terminate; and
21 said pipe being disconnectable from said similar adjacent pipe and reusable,

1 wherein the at least one reinforcement band has an inside diameter that is no
2 greater than the enlarged exterior diameter of the portion of the female end around which the
3 reinforcement band is positioned, and

4 wherein said second side of said reinforcement band is substantially free of
5 contact with said female end and the edges of said reinforcement band are at least partially
6 embedded in the outer wall of said pipe at said female end.

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8 2. The pipe of claim 1, wherein said interior diameter of said first
9 section is slightly larger than the outer diameter of the male end of said similar adjacent
10 pipe.

11

12 3. The pipe of claim 1 or 2, wherein said internal threads of said second
13 section of said pipe and said external threads of said male end of said similar adjacent pipe
14 create a watertight connection when said threads are mated.

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16 4. The pipe of claim 1, 2 or 3, wherein said pipe is an extruded
17 thermoplastic pipe.

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19 5. The pipe of claim 4, wherein said pipe is a polyvinyl chloride (PVC)
20 drop pipe.

21

22 6. The pipe of claim 1, wherein said pipe is manufactured from a
23 thermosetting plastic.

1 7. The pipe of claim 6, wherein said pipe is fiber reinforced plastic
2 (FRP) pipe.

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4 8. The pipe of any one of claims 1 to 7, wherein said reinforcement band
5 extends partially around at least a portion of said female end.

6

7 9. The pipe of any one of claims 1 to 8, wherein said reinforcement band
8 is positioned opposite from and extends along the length of at least a portion of said internal
9 threads of said second section.

10

11 10. The pipe as recited in Claim 9, wherein said reinforcement band is
12 positioned opposite from and extends along the length of substantially all of said internal
13 threads of said second section.

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15 11. The pipe of Claim 9, wherein said internal threads include a last
16 internal thread that is closest to said intermediate section, and wherein said reinforcement
17 band extends beyond a last internal thread of said internal threads.

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19 12. The pipe of Claim 9, wherein said internal threads include a first
20 internal thread that is closest to said first section, and wherein said reinforcement band
21 extends beyond a first internal thread of said internal threads.

22

1 13. The pipe of claim 1, wherein the edges of said reinforcement band are
2 totally embedded in the outer wall of said pipe at said female end.

3

4 14. The pipe of any one of claims 1 to 13, wherein said reinforcement
5 band is metal.

6

7 15. A single piece of pipe connectable to a similar adjacent pipe, said pipe
8 comprising:

9 a male end having external threads terminating said male end;

10 a female end having an enlarged exterior diameter;

11 an intermediate section between said male end and said female end having a
12 uniform interior diameter;

13 a first enlarged interior diameter of said pipe at said female end, said first
14 enlarged interior diameter having internal threads to mate with external threads of a male
15 end of said similar adjacent pipe;

16 a second enlarged interior diameter being larger than said first enlarged
17 interior diameter and terminating said pipe at said female end, said second enlarged interior
18 diameter being slightly larger in diameter than said male end of said similar adjacent pipe to
19 receive said male end of said similar adjacent pipe therethrough;

20 at least one circular reinforcement band positioned circumferentially around
21 at least a portion of said female end, said at least one reinforcement band including a first
22 side facing said internal threads of said female end, an opposite second side facing away

1 from said internal threads of said female end, and edges located where said first side and
2 said second side terminate; and

3 said pipe being disconnectable from said similar adjacent pipe and reusable,
4 wherein the at least one reinforcement band has an inside diameter that is no
5 greater than the enlarged exterior diameter of the portion of the female end around which the
6 reinforcement band is positioned, and

7 wherein said second side of said reinforcement band is substantially free of
8 contact with said female end and the edges of said reinforcement band are at least partially
9 embedded in the outer wall of said pipe at said female end.

10

11 16. The pipe of claim 15, further comprising a shoulder between said
12 female end and said intermediate section.

13

14 17. The pipe of Claim 15 or 16, wherein said external threads and said
15 internal threads are tapered and wherein said internal threads of said first enlarged interior
16 diameter of said pipe and said internal threads of said external threads of the male end of
17 said similar adjacent pipe interlock to form a watertight connection.

18

19 18. The pipe of claim 17, wherein said watertight connection is formed
20 when said internal and external threads are mated to hand tight.

21

22 19. The pipe of claim 17, wherein said watertight connection is formed
23 when said internal and external threads are mated to wrench tight.

1 20. The pipe of claim 15 wherein said pipe is an extruded thermoplastic
2 pipe.

3

4 21. The pipe of any one of claims 15 to 20, wherein said reinforcement
5 band is positioned opposite from and extends along the length of at least a portion of said
6 internal threads of said first enlarged interior diameter.

7

8 22. The pipe of claim 21 wherein said reinforcement band is positioned
9 opposite from and extends along the length of substantially all of said internal threads of
10 said first enlarged interior diameter.

11

12 23. The pipe of Claim 21, wherein said internal threads include a last
13 internal thread that is closest to said intermediate section, and wherein said reinforcement
14 band extends beyond the last internal thread of said internal threads.

15

16 24. The pipe of Claim 21, wherein said internal threads include a first
17 internal thread that is farthest from said intermediate section, and wherein said
18 reinforcement band extends beyond the first internal thread of said internal threads.

19

20 25. The pipe of any one of claims 15 to 24, wherein edges of said
21 reinforcement band are totally embedded in the outer wall of said pipe at said female end.

22

1 26. The pipe of any one of claims 15 to 25, wherein said reinforcement
2 band extends partially around at least a portion of said female end.

3

4 27. A method for manufacturing a single piece of thermoplastic pipe
5 comprising:

6 extruding said pipe into a predetermined interior diameter and exterior
7 diameter;

8 cutting said pipe into a desired length, said length of pipe having a male end
9 and a female end;

10 positioning a reinforcement band circumferentially around at least a portion
11 of said female end;

12 enlarging the interior and exterior diameters of said female end with a
13 mandrel;

14 cooling said female end of said pipe with a cooling agent while said mandrel
15 is within said pipe; and

16 forming internal threads into the enlarged diameter of said female end and
17 external threads into said male end.

18

19 28. The method of claim 27 further comprising:

20 embedding at least a portion of edges of said reinforcement band into an
21 outer wall of said pipe at said female end where said exterior diameter is enlarged, prior to
22 cooling said female end.

23

1 29. The method of claim 27 or 28 further comprising:
2 heating said female end of said pipe to render it pliable prior to enlarging the
3 exterior diameter of said pipe at said female end.

4

5 30. The method of claim 27, 28, or 29, wherein said mandrel is inserted
6 into said female end of said pipe to enlarge the exterior diameter of said pipe at said female
7 end.

8

9 31. The method of claim 27, 28, or 29, wherein said pipe is urged onto
10 said mandrel to enlarge the exterior diameter of said pipe at said female end.

11

12 32. The method of any one of claims 27 to 31, wherein said reinforcement
13 band extends partially around at least a portion of said female end.

14

15 33. The method of any one of claims 27 to 32, wherein said reinforcement
16 band is a cylinder.

17

18 34. A single piece of pipe connectable to a similar adjacent pipe, said pipe
19 comprising:

20 a male end having external threads;

21 a female end having an enlarged exterior diameter;

22 an intermediate section between said male end and said female end having a
23 uniform interior diameter;

1 a first section at said female end having an interior diameter to receive a male
2 end of said similar adjacent pipe therethrough;

3 a second section at said female end having internal threads to mate with
4 external threads of a male end of said similar adjacent pipe;

5 a shoulder formed between the first section and the second section for
6 forming distinct first and second sections;

7 said first section positioned to funnel said male end of said similar adjacent
8 pipe to said second section;

9 said second section being positioned between said intermediate section and
10 said first section;

11 at least one circular reinforcement band positioned circumferentially around
12 the enlarged exterior diameter opposite from at least a portion of said internal threads of said
13 second section, said at least one reinforcement band including a first side facing said internal
14 threads of said second section, an opposite second side facing away from said internal
15 threads of said second section, and edges located where said first side and said second side
16 terminate; and

17 said pipe being disconnectable from said similar adjacent pipe and reusable,
18 wherein the at least one reinforcement band has an inside diameter that is no
19 greater than the enlarged exterior diameter of the portion of the female end around which the
20 reinforcement band is positioned, and

21 wherein said second side of said reinforcement band is substantially free of
22 contact with said female end and the edges of said reinforcement band are at least partially
23 embedded in the outer wall of said pipe at said female end.

1 35. The pipe of claim 34 wherein the first section is elongated so as to
2 receive a substantial portion of the external threads of the male end of said similar adjacent
3 pipe.

4

5 36. The pipe of claim 34 or 35, wherein said interior diameter of said first
6 section is slightly larger than the outer diameter of the male end of said similar adjacent
7 pipe.

8

9 37. The pipe of claim 34, 35 or 36, wherein said internal threads of said
10 second section of said pipe and said external threads of said male end of said similar
11 adjacent pipe create a watertight connection when said threads are mated.

12

13 38. The pipe of any one of claims 34 to 37, wherein said pipe is an
14 extruded thermoplastic pipe.

15

16 39. The pipe of claim 38, wherein said pipe is a polyvinyl chloride (PVC)
17 drop pipe.

18

19 40. The pipe of any one of claims 34 to 37, wherein said pipe is
20 manufactured from a thermosetting plastic.

21

22 41. The pipe of any one of claims 34 to 37, wherein said pipe is fiber
23 reinforced plastic (FRP) pipe.

1 42. The pipe of any one of claims 34 to 41, wherein said reinforcement
2 band extends partially around at least a portion of said female end.

3

4 43. The pipe of any one of claims 34 to 42, wherein said reinforcement
5 band is positioned opposite from and extends along the length of substantially all of said
6 internal threads of said second section.

7

8 44. The pipe of any one of claims 34 to 42, wherein said internal threads
9 include a last internal thread that is closest to said intermediate section, and wherein said
10 reinforcement band extends beyond a last internal thread of said internal threads.

11

12 45. The pipe of any one of Claims 34 to 42, wherein said internal threads
13 include a first internal thread that is closest to said first section, and wherein said
14 reinforcement band extends beyond a first internal thread of said internal threads.

15

16 46. The pipe of any one of claims 34 to 45, wherein the edges of said
17 reinforcement band are totally embedded in the outer wall of said pipe at said female end.

18

19 47. The pipe of any one of Claims 34 to 46, wherein said reinforcement
20 band is metal.

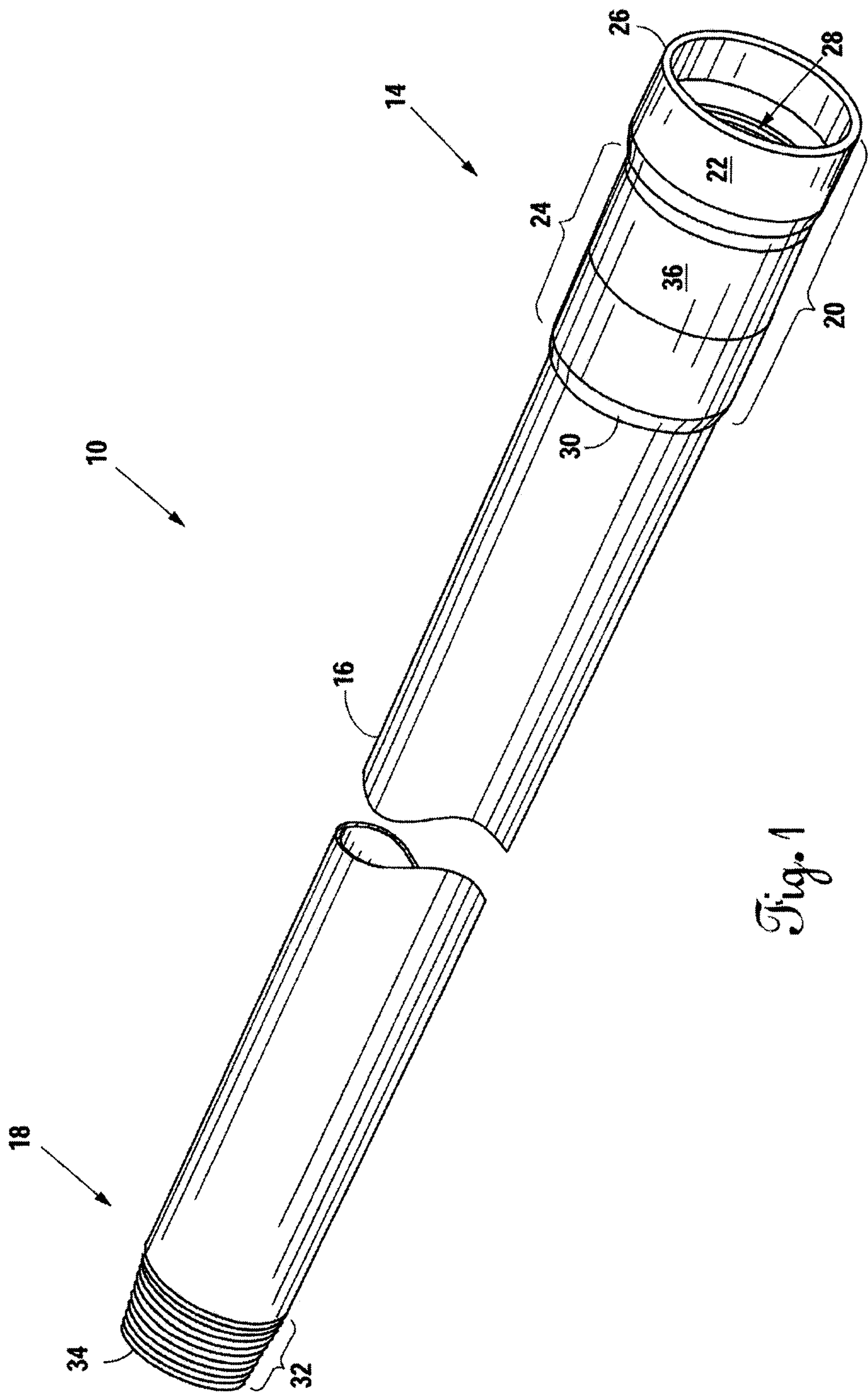


Fig. 1

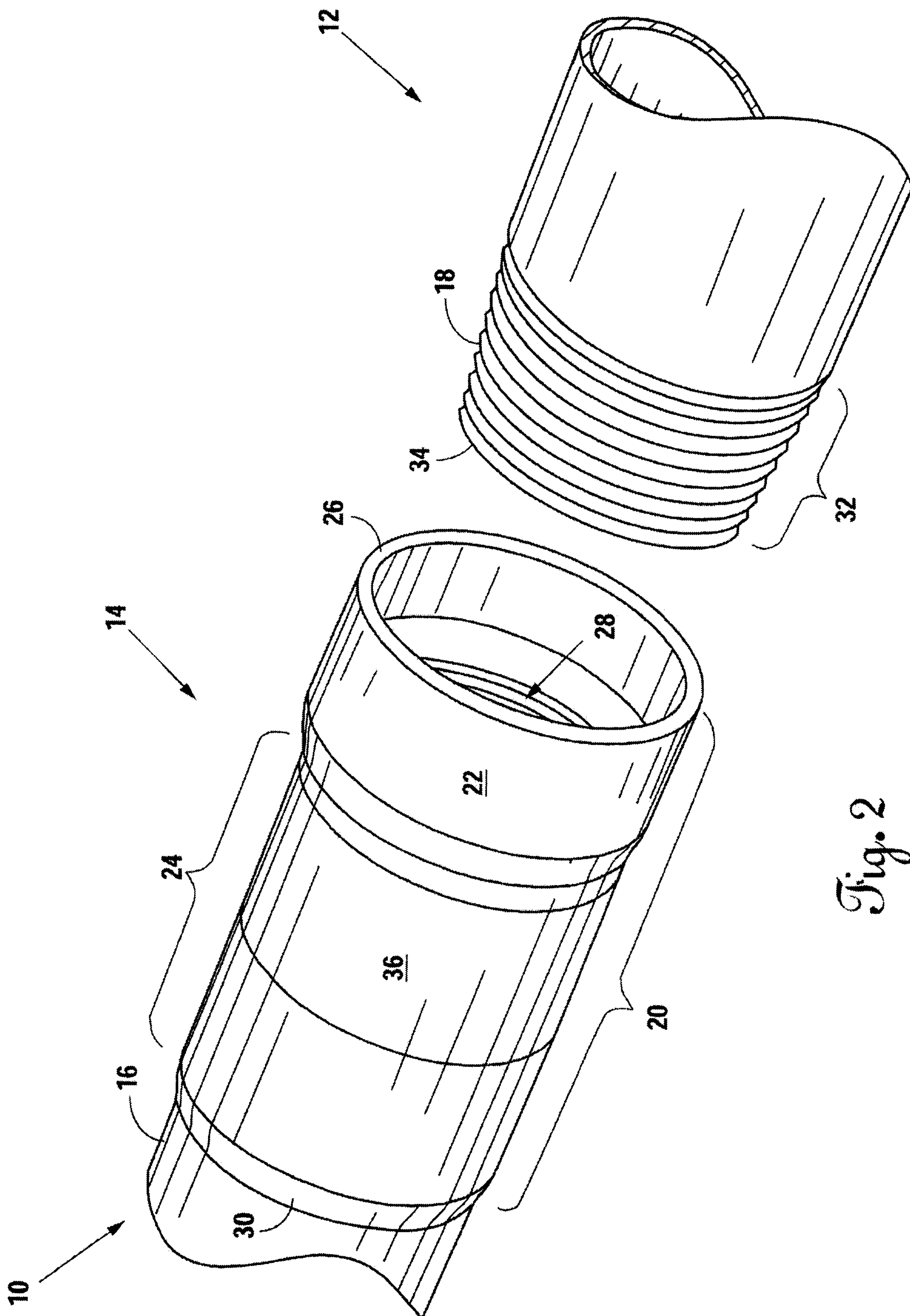


Fig. 2

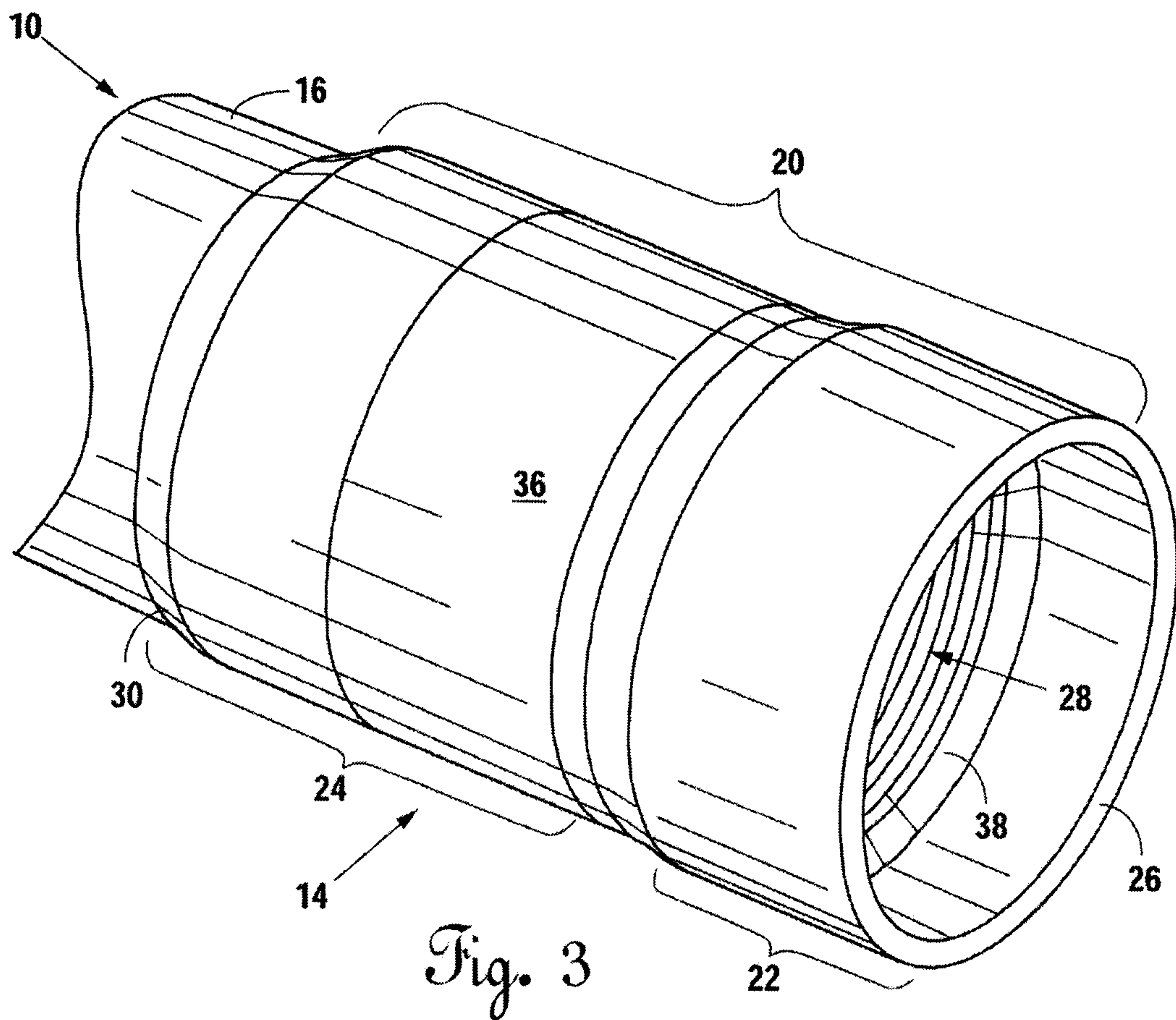
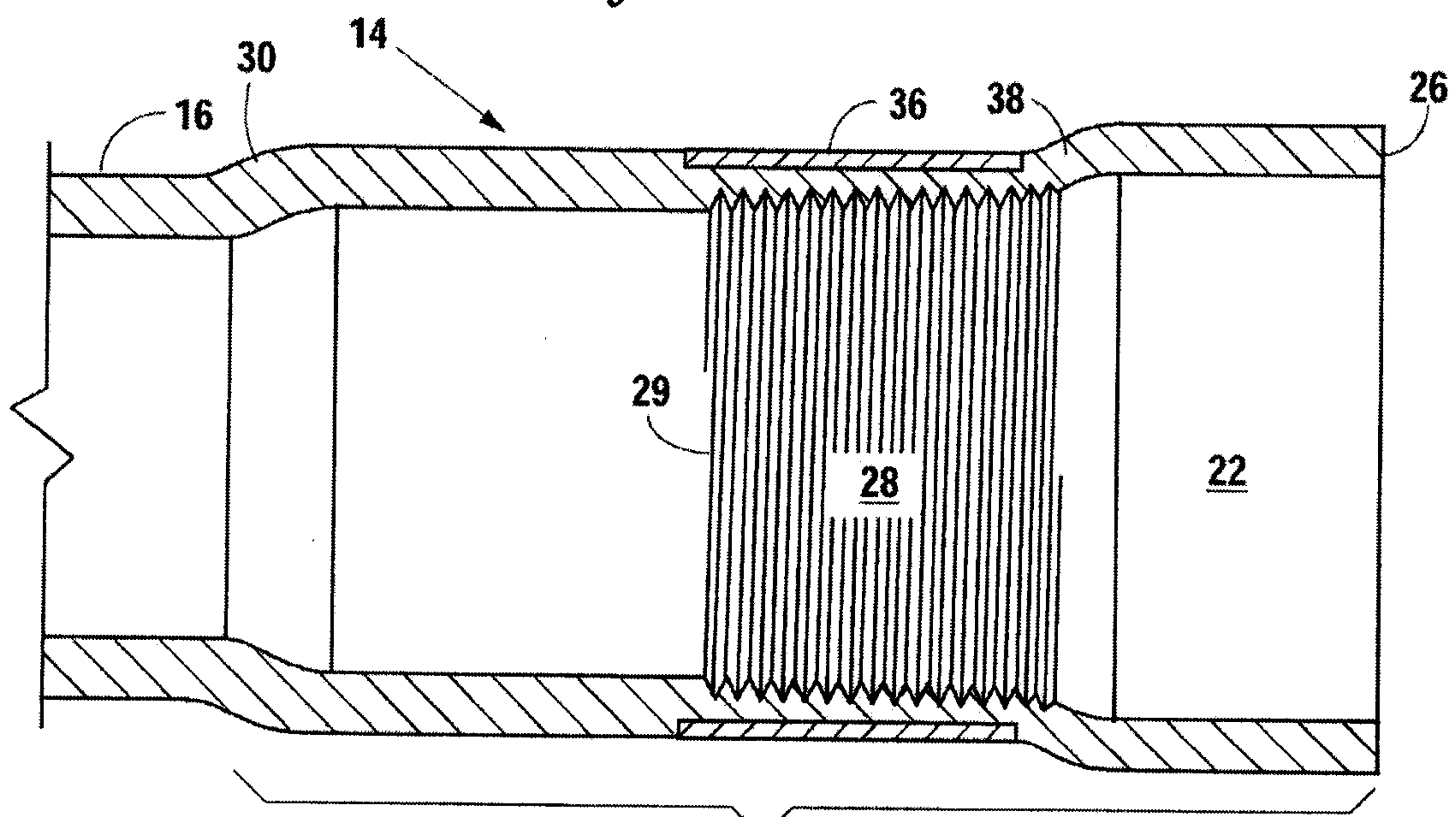


Fig. 3



20
Fig. 3A

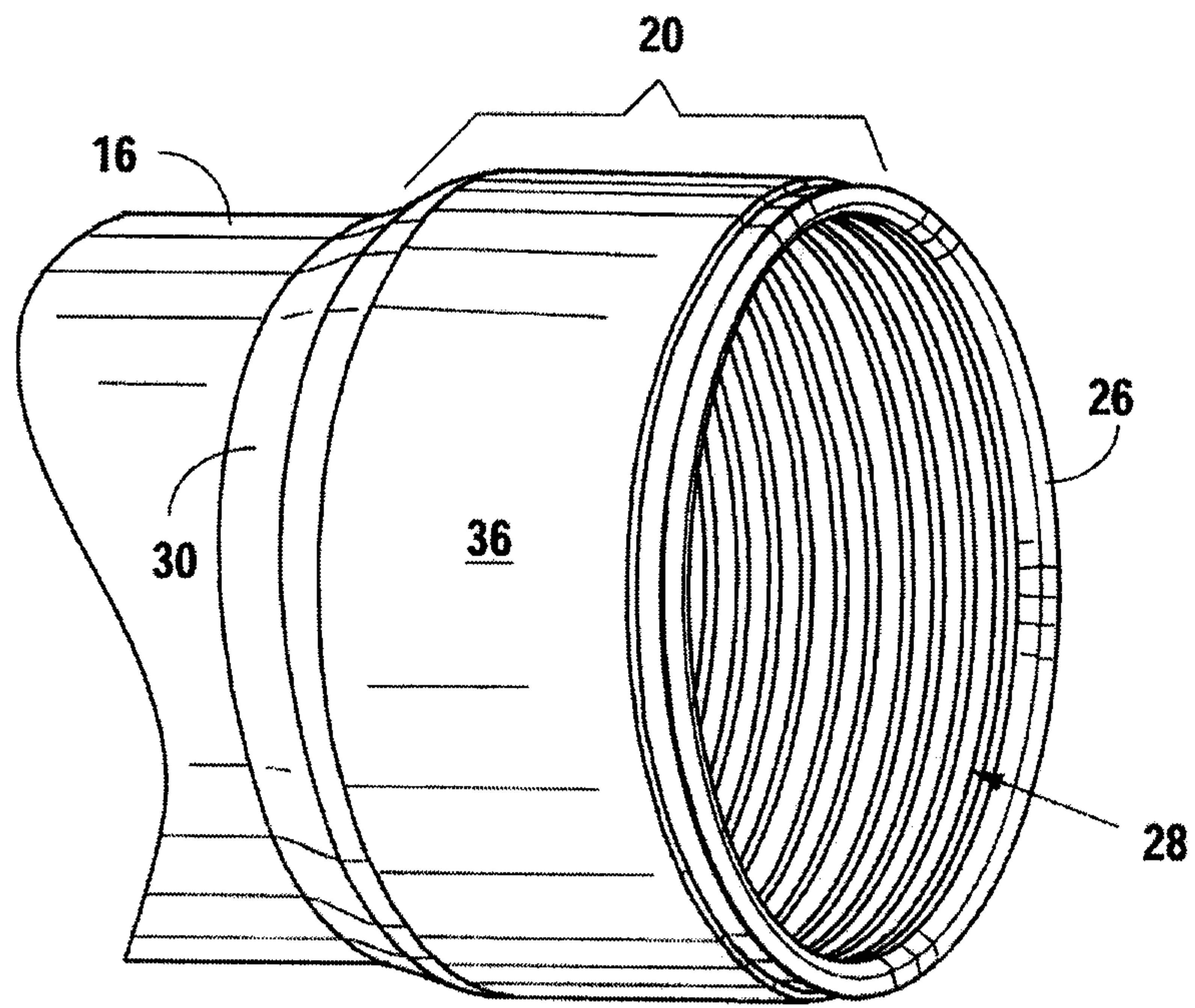


Fig. 4

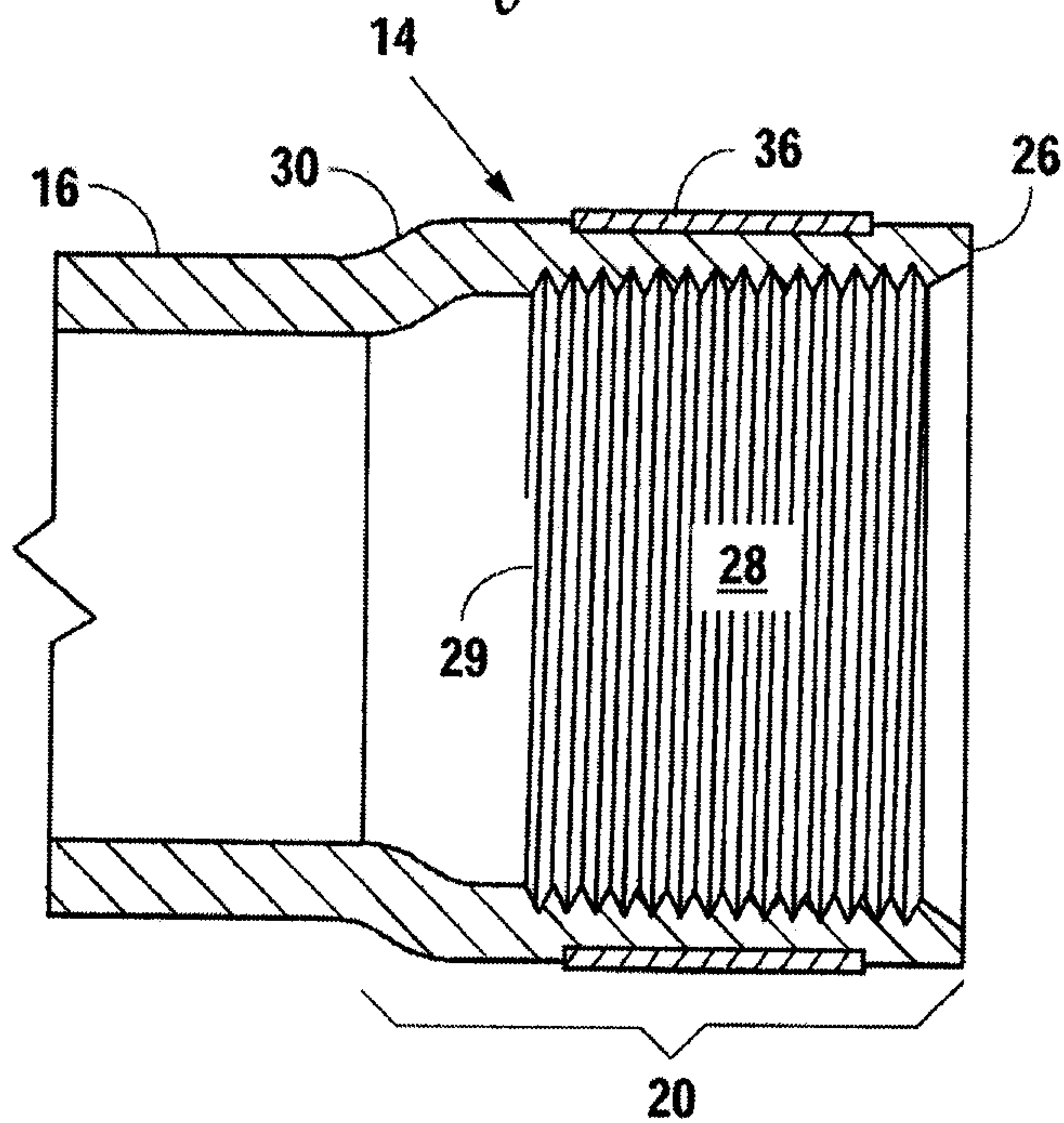


Fig. 4A

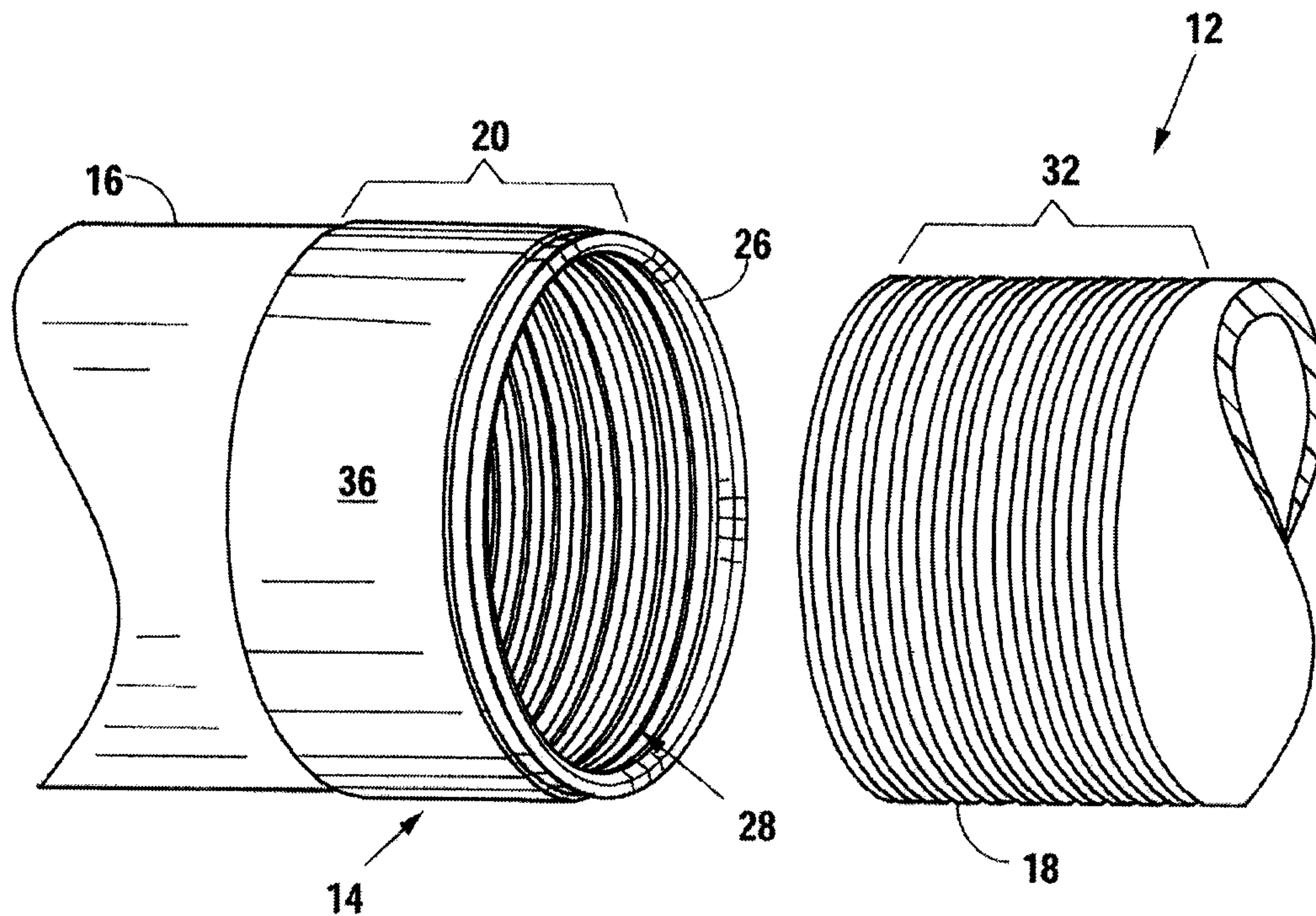


Fig. 5

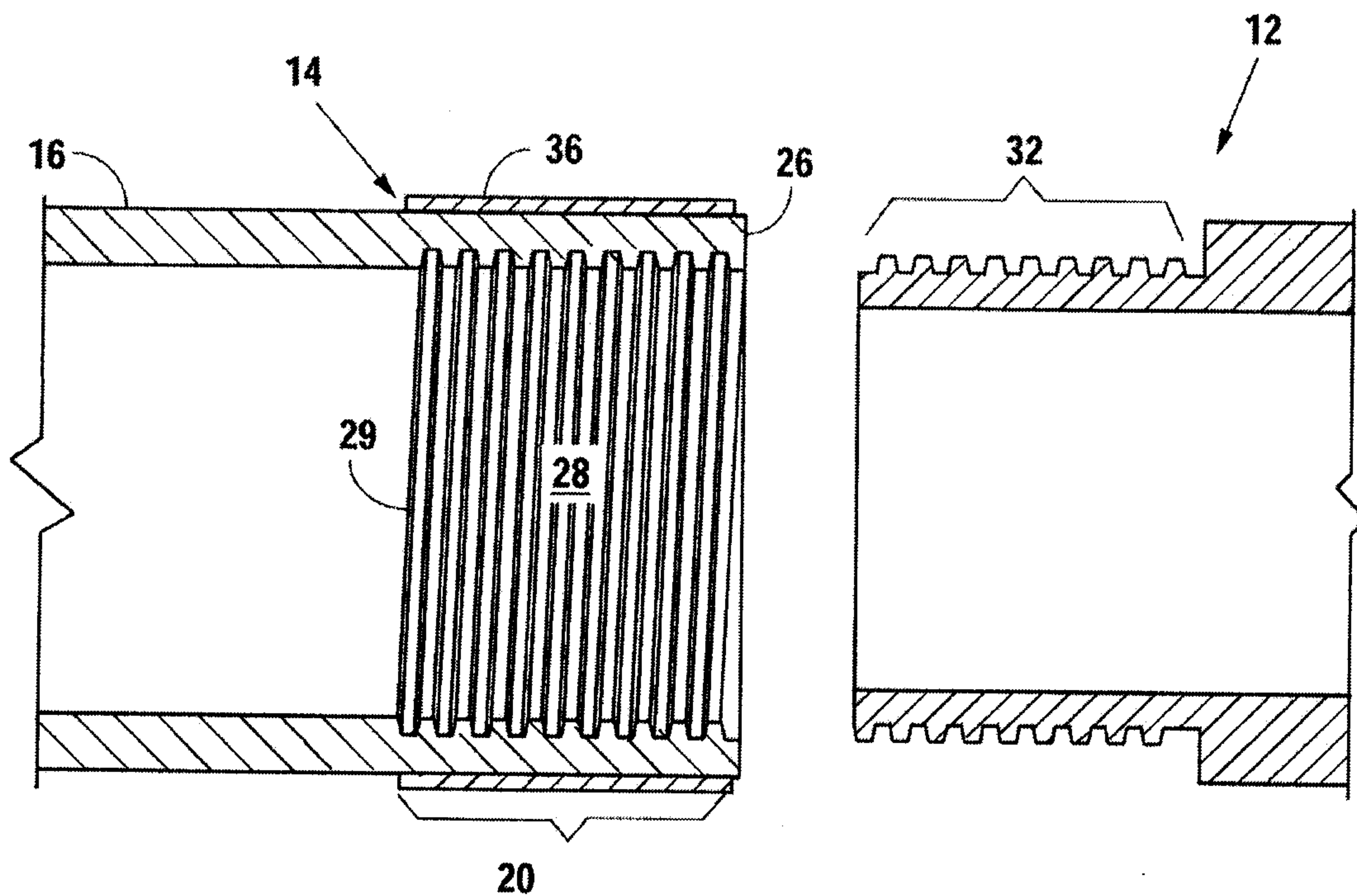


Fig. 5A

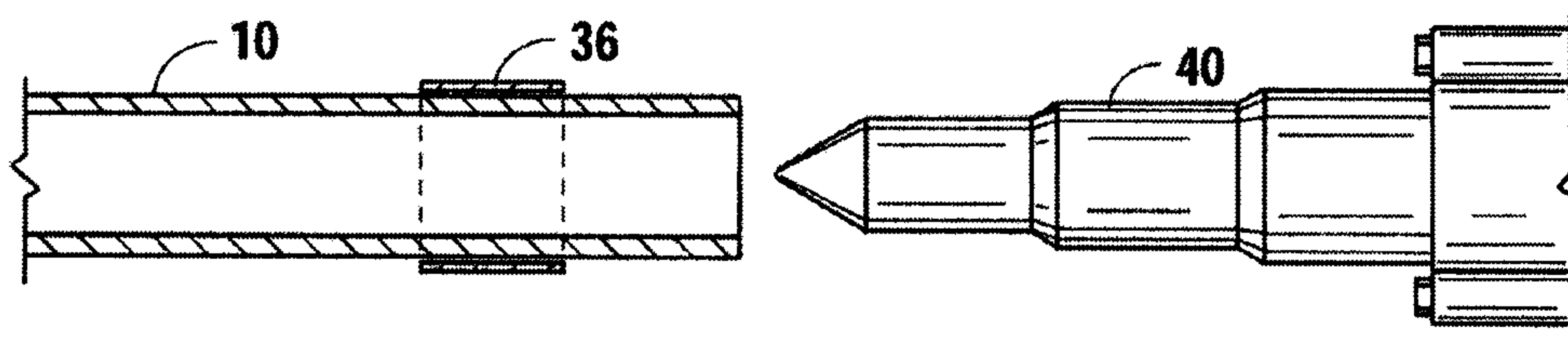


Fig. 6

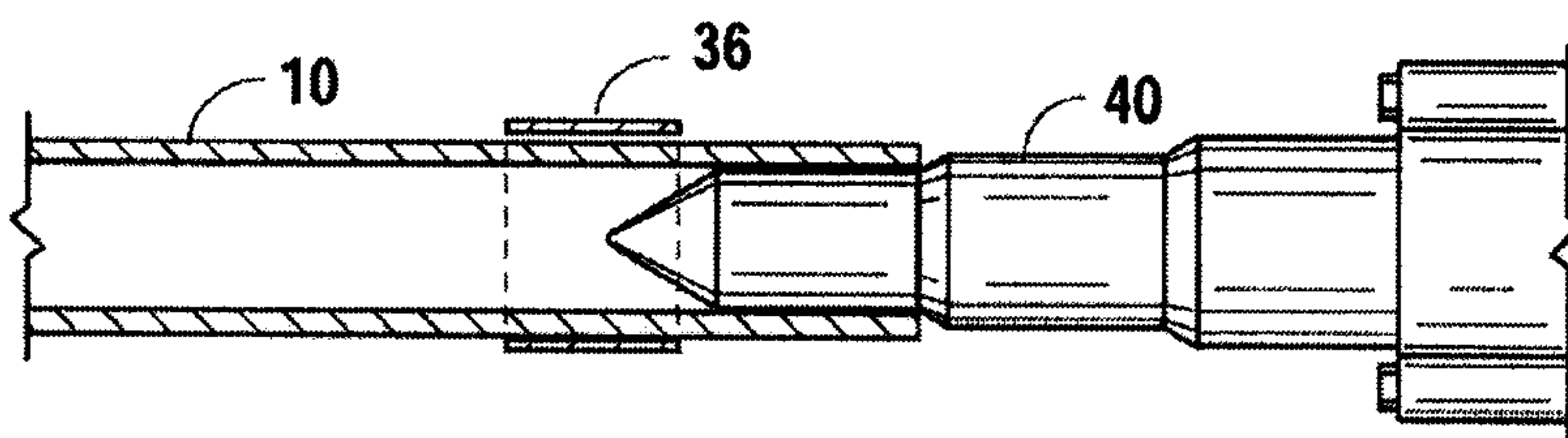


Fig. 6A

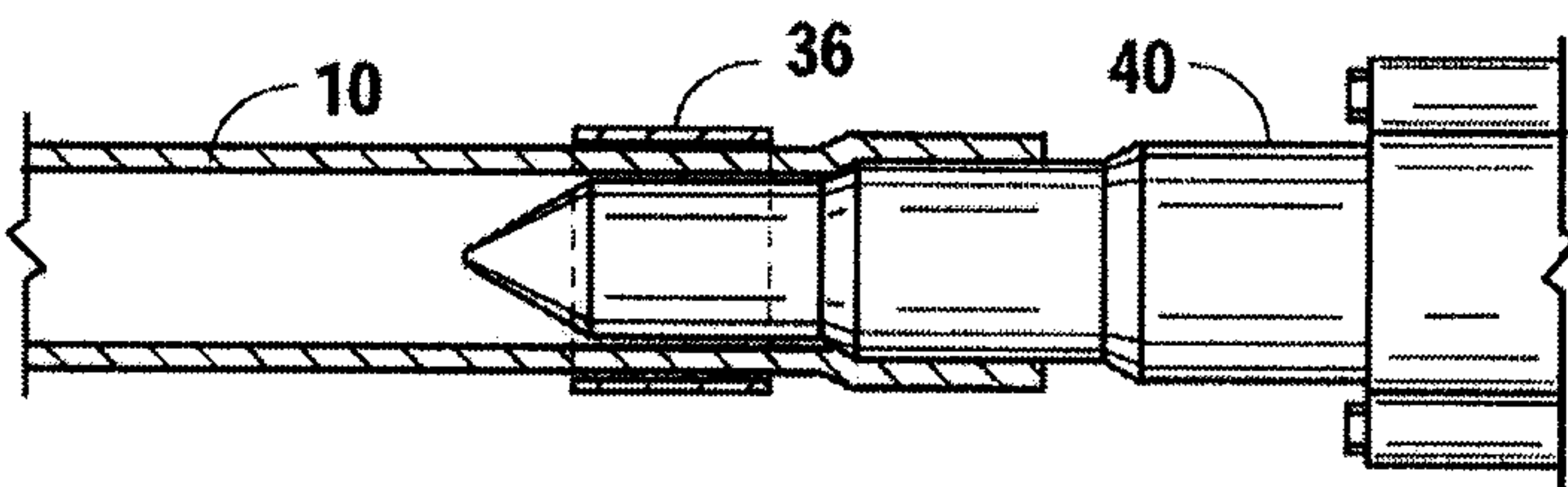


Fig. 6B

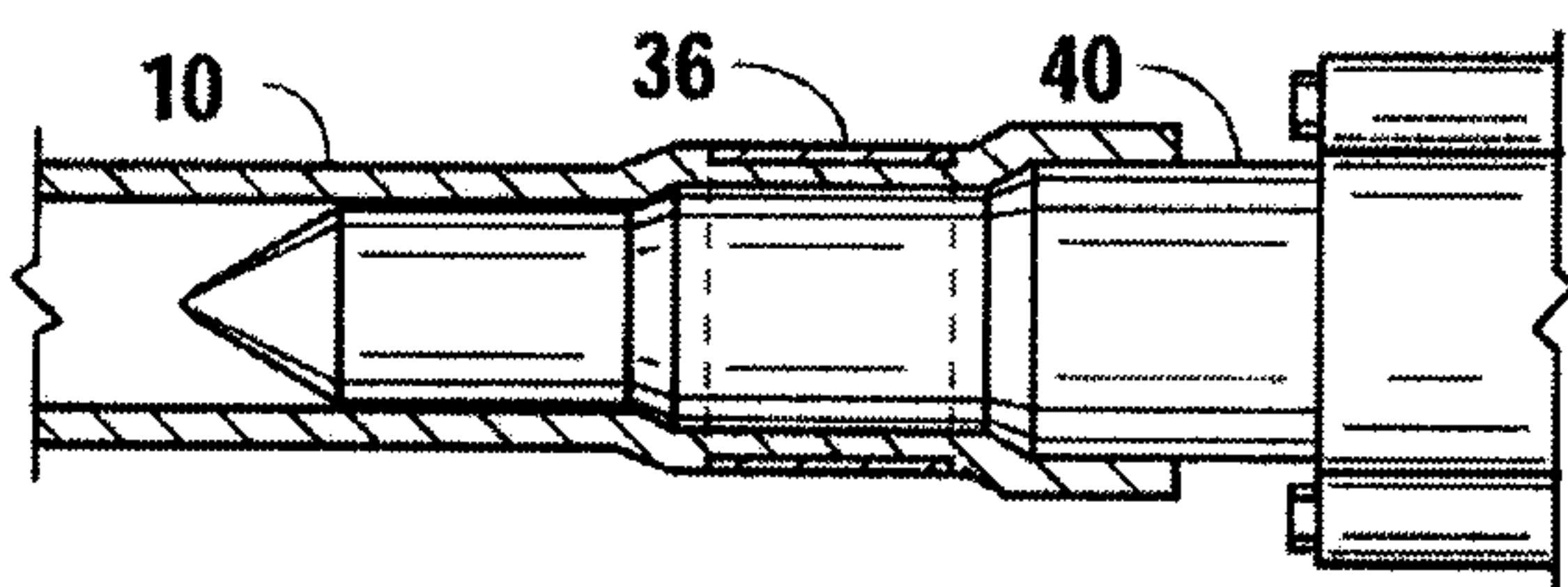


Fig. 6C

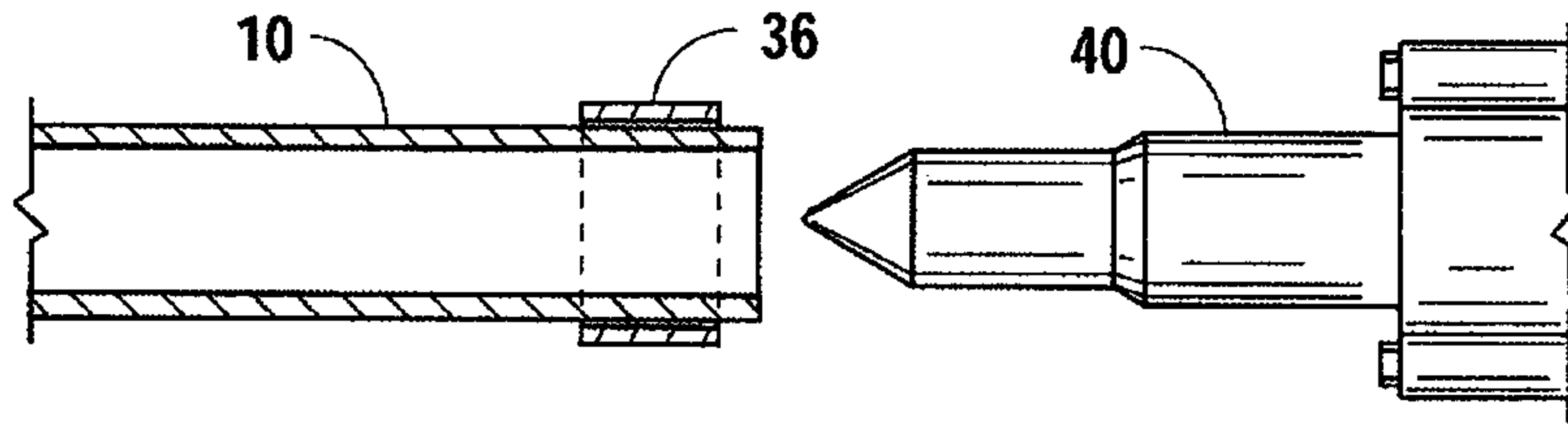


Fig. 7

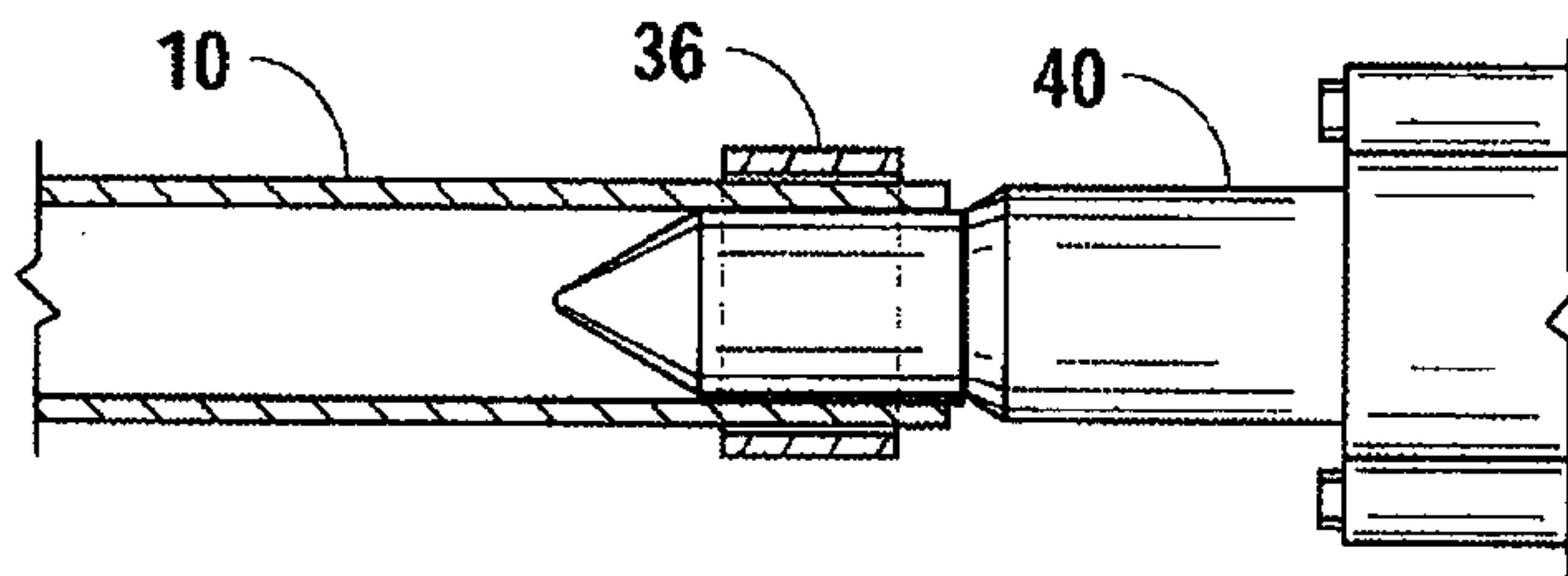


Fig. 7A

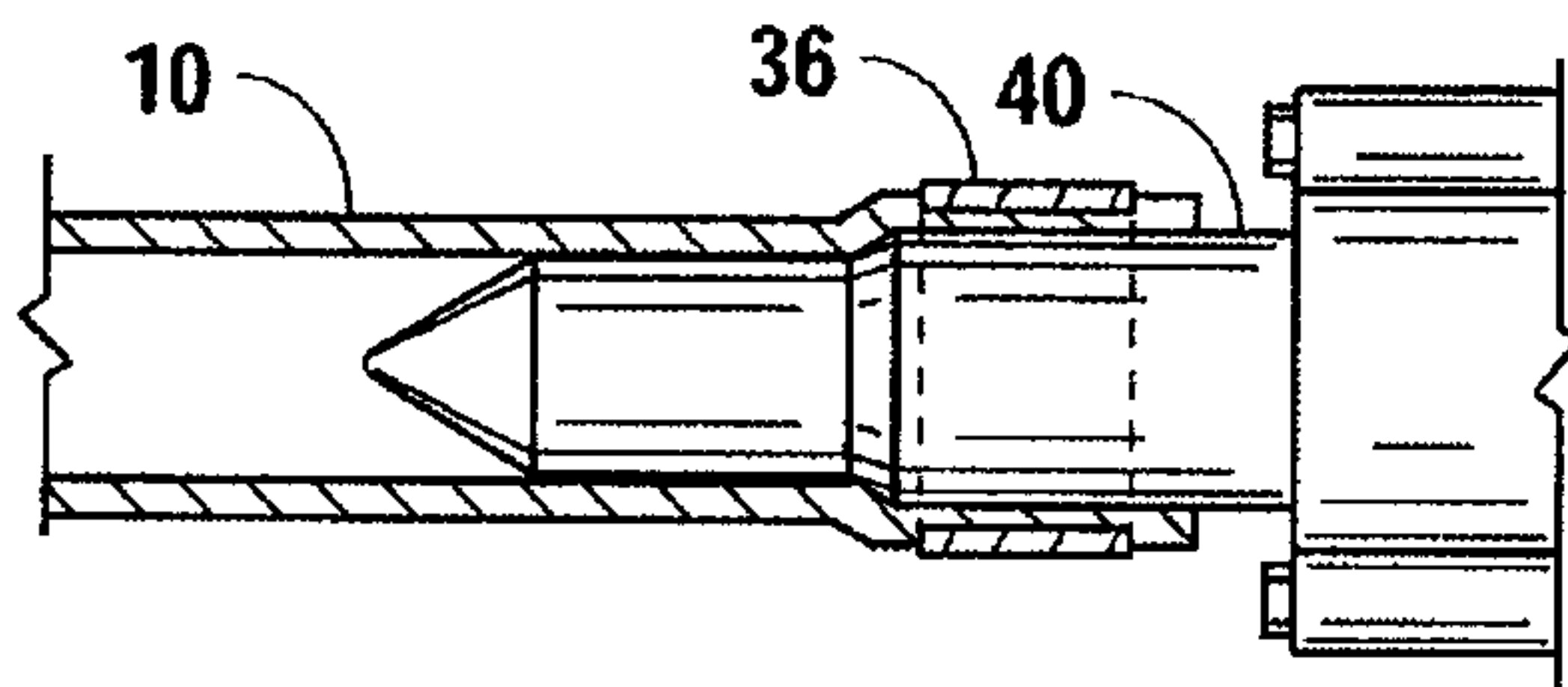


Fig. 7B

