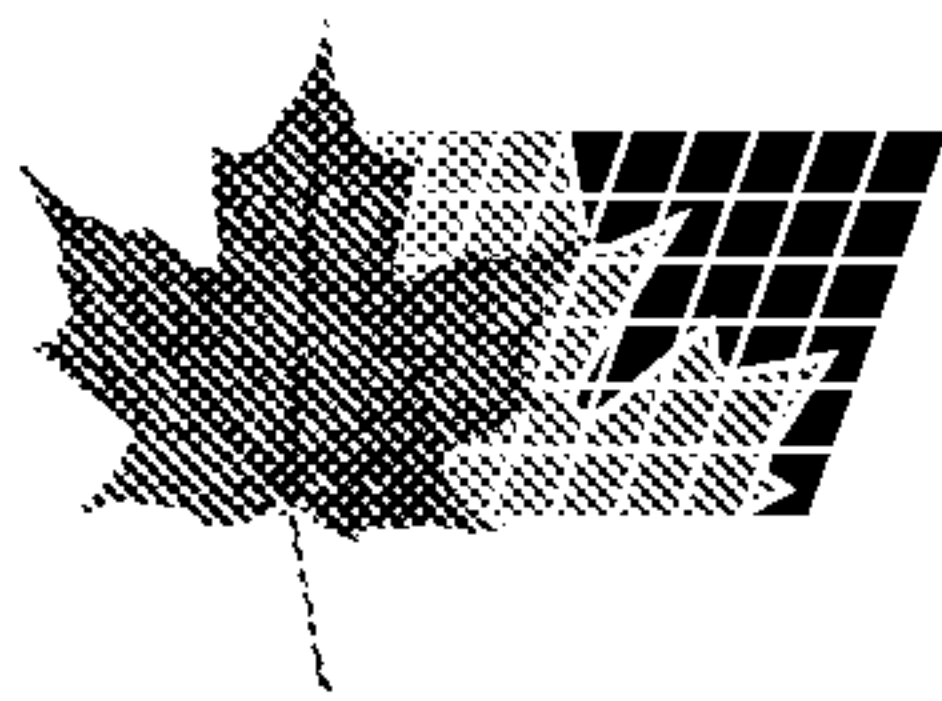
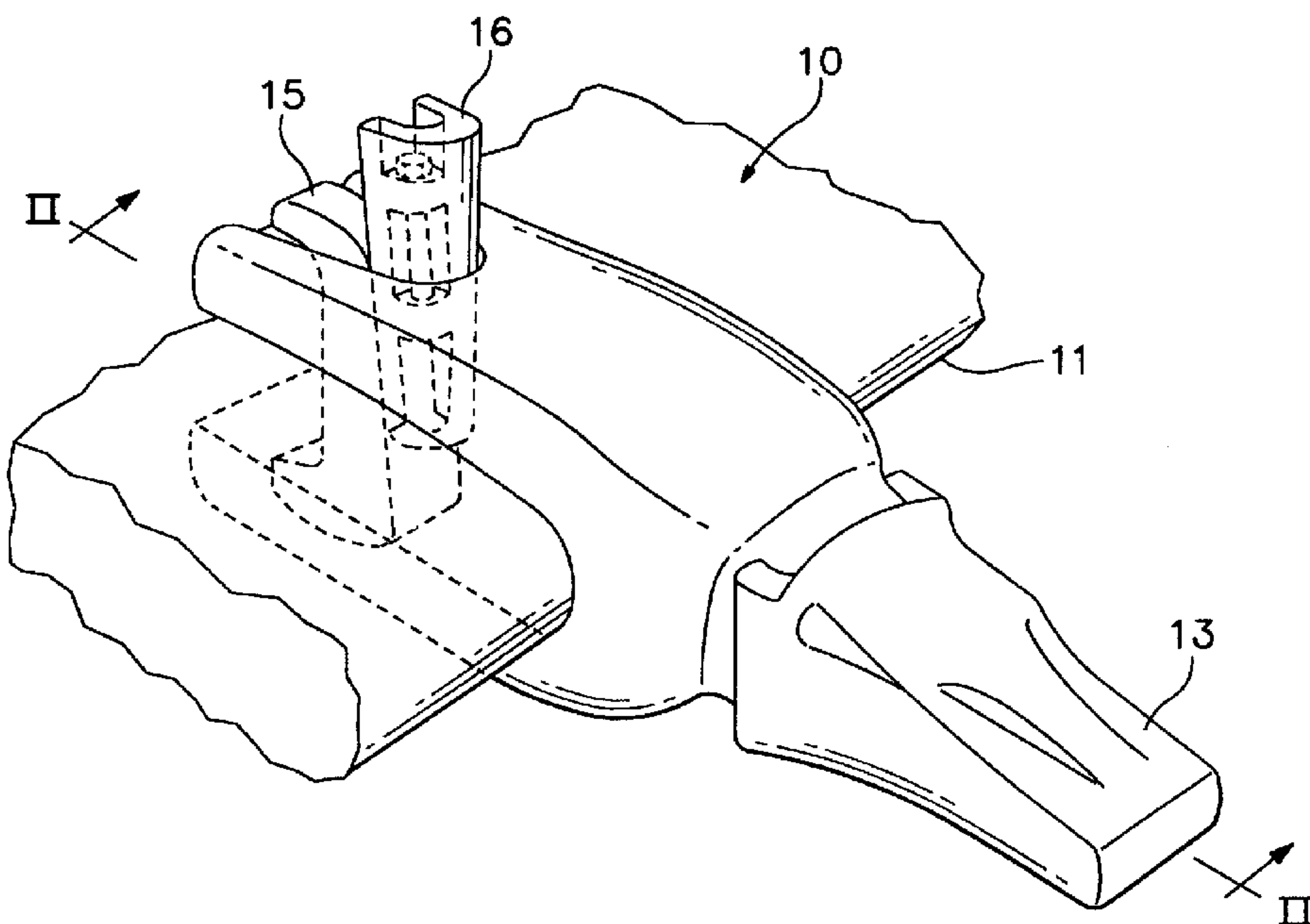




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(54) **ENSEMBLE DE COIN ET DE BOBINE**
(54) **A WEDGE AND SPOOL ASSEMBLY**



(57) A wedging device is suitable for insertion in aligned apertures between components of earth moving equipment such as an adaptor and a bucket of an excavating device. The wedging device is expandable to wedge together the adaptor and the bucket. The wedging device has a typically C-shaped insert or spool cooperating with a wedge element, the spool and wedge element being interconnected by a tensioning screw which upon rotation in either direction respectively forces the wedge downwardly so that the wedging device achieves its wedging function, and in the reverse direction the wedge is pulled up to release the engagement so that the parts can be disconnected.



A WEDGE AND SPOOL ASSEMBLY

ABSTRACT OF THE DISCLOSURE

5 A wedging device is suitable for insertion in
aligned apertures between components of earth moving
equipment such as an adaptor and a bucket of an
excavating device. The wedging device is expandable to
wedge together the adaptor and the bucket. The wedging
device has a typically C-shaped insert or spool
10 cooperating with a wedge element, the spool and wedge
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upon rotation in either direction respectively forces the
wedge downwardly so that the wedging device achieves its
wedging function, and in the reverse direction the wedge
15 is pulled up to release the engagement so that the parts
can be disconnected.

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A WEDGE AND SPOOL ASSEMBLY

FIELD OF THE INVENTION

The present invention relates to a wedging
5 device for fixing an attachment to a support means. The
wedging device may be used to connect an attachment to
excavating equipment such as a dragline bucket,
rope/hydraulic shovel or other excavating device.
Accordingly, embodiments of the invention find
10 application in the landscaping and mining fields.

BACKGROUND OF THE INVENTION

Devices for fixing attachments such as teeth or
adaptors carrying sacrificial wear parts to excavation
15 equipment, such as dragline buckets or rope shovels, are
known in the prior art.

Two piece wedging assemblies have been used to
secure an adaptor to the lip of an excavating device such
as a rope shovel. Generally, to secure an adaptor to the
20 lip of the excavation device, the adaptor is fitted onto
a corresponding position on the lip so that cavities in
each of the upper and lower arms of the adaptor are
aligned with a corresponding aperture in the lip. A
spool is inserted into the cavities and aperture. (As
25 used herein and in the claims, the term "spool" refers
generally to insert members such as C-clamps for adaptor
and lip assemblies as well as spools for tooth and nose
or adaptor and nose assemblies.) A wedge is then
inserted adjacent to the spool in the cavities and
30 aperture. The wedge is hammered with a sledge hammer to
cause the spool to move into wedging engagement, thus
securing the adaptor to the lip.

Similar wedging assemblies have also been used
to attach teeth to dragline buckets. The adaptor is
35 fitted onto a dedicated portion of the dragline bucket
and a spool is inserted into a passageway formed through
the adaptor and the nose portion. A wedge is inserted

into the passageway between the spool and the tip region of the nose portion, and then hammered into the passageway with a sledge hammer, causing the spool to move rearwardly from the tip of the nose portion and
5 press against the adaptor to thereby force the adaptor tightly onto the nose portion.

However, these types of wedging systems suffer from several drawbacks. First, the use of a sledge hammer to drive the wedge for both tightening and
10 removing the wedge poses inherent safety risks. In addition, removal of the wedge requires an operator to strike the wedge from below. It is often awkward to swing the sledge hammer upward from underneath the lip so as to strike the wedge with sufficient force to dislodge
15 the wedge. Further, it is undesirable for operators to work beneath large excavation buckets. The underside of the buckets may have pieces of material such as dirt or rock which may fall on an operator, and the buckets themselves are very heavy.

20 Accordingly, it has been desired to replace the wedging assemblies that are hammered together with safer systems that do not pose the safety risks inherent in such assemblies. However, the wedging assemblies are used in demanding environments and must withstand
25 tremendous forces. Due to the size of the dragline buckets and rope shovels, as well as the nature of the forces exerted on the buckets during use, the wedging devices are correspondingly large. Wedging devices used to secure adaptors to rope shovels, for example, weigh up
30 to 38 kg, while wedging devices used to secure adaptors to nose portions of a dragline bucket weigh up to 15 kg or more. The devices must be easy to install and remove, because downtime of excavation equipment is very expensive and because the excavation equipment is often
35 located in remote environments. Likewise, the number of component parts must be kept to a minimum to avoid the

risk of losing parts in the field, and to speed installation and removal.

The wedging assemblies are also used in excavating environments that present soil fines. Such soil fines can fill in all of the cavities and spaces within those portions of the excavating equipment in contact with the earth. The large forces exerted on the soil fines can compress these fines within and around the wedging assembly. In addition, the chemistry of some soil fines is such that the soil fines become nearly cement-like in consistency when compacted into the spaces within the excavating equipment. Accordingly, any wedging assembly must be capable of being removed easily notwithstanding the presence of soil fines.

A wedging device comprising a wedge connected to a spool by means of a bolt is disclosed in U.S. Patent No. 4,433,496. The wedge has an arcuate surface which bears against a correspondingly contoured arcuate surface on the spool. When the bolt is rotated the wedge is drawn up the arcuate surface of the spool so that a curved contact surface of the wedge is placed into abutment with the nose portion of the dragline bucket. However, the wedge exerts an offset force against the nose portion causing the adaptor to skew as it is drawn onto the nose portion when the bolt is rotated which presents difficulty to the work person fixing the adaptor in position.

A wedging device consisting of two spools and a separate wedge assembly is disclosed in U.S. Patent No. 5,638,621. The wedge assembly is comprised of two wedges and a bolt which extends through a passageway formed in one of the wedges and is threadably received in the other wedge. In use, the wedge assembly is positioned between the spools in the passageway formed through the adaptor and the nose portion of the dragline bucket, and the bolt rotated so that the spools are forced apart as the wedges are drawn toward each other causing one of the spools to

be pressed against the nose portion and the other spool to be pressed against the adaptor. Accordingly, the movement of the wedges results in the adaptor being drawn onto, and fixed to, the nose portion.

5 However, the substantial forces which are exerted on the device during an excavating operation can cause a wedge to tilt and so bend the bolt in a region adjacent to the wedge. This may result in difficulty when loosening the bolt to remove the wedging device, and
10 possibly seizure of the device in the dragline bucket. It may also lead to increased downtime of the dragline bucket while the wedging device is removed or at the least, the need for maintenance to the wedging device.

 A further wedging device is disclosed in U.S.
15 Patent No. 5,452,529. This device consists of a single spool and a separate wedge assembly comprising two wedges receiving a bolt. As with the device disclosed in U.S. Patent No. 5,638,621, the bolt extends through a passageway formed in one of the wedges and is threadably
20 received in the other wedge. Accordingly, the arrangement suffers from the same drawback as the device disclosed in U.S. Patent No. 5,638,621 in that the bolt is prone to bending forces which may result in damage to the wedging device.

25 The wedging devices disclosed in U.S. Patent No. 5,638,621 and U.S. Patent No. 5,452,529 also require installation of at least one wedge piece from underneath the apertures. Thus, an operator must reach under the excavating device at some point during installation
30 and/or removal of these wedging devices.

 A further development in the art is disclosed in U.S. Patent No. 5,868,518 which discloses a wedging device locatable between two components and consisting of a plurality of parts connected together such that the
35 device remains as a single cohesive assembly during all phases of operation. The wedging device includes a spool having two inclined surfaces, a pair of wedges arranged

such that the wedges are able to be moved up the inclined surfaces, one to each, and a rotatable threaded member extending through an aperture formed in the spool and being received by the wedges. Rotation of the threaded member when the device is located between the two components causes the wedges to move toward each other up the respective inclined surfaces of the spool and be pressed against one of the components to thereby force the spool against the other component.

10 In order to cause the wedges to move up the inclined surfaces, the wedging device may be provided with a nut having a female thread engaged with a male thread formed on a shaft of the threaded member, wherein the nut is arranged to be able to exert a pressure on one
15 of the wedges so that the nut and threaded member together force the wedges toward each other when the threaded member is rotated. Alternatively, the male thread of the threaded member may be engaged with a female thread provided on the one wedge itself.

20 So that the wedges may move up the inclined surfaces the aperture formed in the spool and/or apertures defined in the wedges which receive the threaded member can have a width which is substantially greater than that of the shaft of the threaded member.

25 The threaded member is formed such that the engagement of the threaded member with the nut or a female thread formed in one of the wedges holds the wedges on the threaded member. This, together with the reception of the threaded member in the aperture formed
30 in the spool, maintains the wedging device in the form of a single cohesive assembly. Removal of this wedging device is accomplished by use of a sledge hammer.

Yet another type of wedging device is disclosed in Australian Patent Application No. 75357/96, which
35 discloses a wedging device used to secure an adaptor to a nose portion of a dragline bucket. A spool and wedge unit are connected together with a bolt that is rotatably

mounted to the spool. The wedge member has a threaded bore to receive the bolt, so that rotation of the bolt in one direction causes the wedge unit to move in a direction such that the assembly expand in width, while rotation of the bolt in an opposite direction causes the assembly to decrease in width. The bolt is retained on one side with a thin circlip that partially surrounds the bolt and fits within an annular groove in the bolt. The relatively small circlip, however, lacks strength and may fail during use. In particular, where the cavities surrounding the bolt have filled with soil fines during excavation, a large amount of force may be needed to cause the wedge unit to move, which may cause the circlip to fail. If this happens, the bolt cannot be used to remove the wedge unit, and instead the wedge unit must be hammered out of the passageway. In addition, the spool and wedge unit are difficult to assemble and insert into the passageway, because the receiving portion 8 of the spool must be inserted into the channel 6 before the bolt can be screw threadably engaged with the receiving portion. As a consequence, the wedging device is only useful for components in which the overall width of the assembled wedging device is small enough to pass through the passageway.

What is therefore desired is a wedging device that may be used to secure two components together that have aligned apertures that does not require a sledge hammer or other impact device to cause wedging engagement and/or wedge removal. It is also desired to minimize the amount of time required to be spent by an operator underneath an excavating device during installation or removal of the wedging device, and in particular to reduce or eliminate the need for heavy physical exertion from underneath the excavating device. It is further desired that the wedging device be easily removed even in environments that cause a build-up of soil fines within the wedging device, that it be sturdy enough to withstand

the large forces imparted on the wedging device during use, and that it improve operator safety during installation and removal.

5 BRIEF SUMMARY OF THE INVENTION

The present invention is directed to embodiments which can provide numerous advantages over previous proposals and in particular aimed to provide safe and convenient fitting and removal in a rugged
10 working environment with a high degree of safety and speed. Downtime of very expensive mining equipment must be minimized and with this requirement in mind embodiments of the present invention facilitate such fitting with just one person.

15 The present invention in one aspect provides a wedging device for securing together first and second components having respective apertures which align such that the wedging device can be inserted through the apertures and expanded in a wedging action to secure the
20 components together. The wedging device comprises an insert member and a wedging member. The insert member and said wedging member have respective abutment surfaces shaped such that relative movement in a first direction between the insert member and the wedging member causes
25 the overall width of the members to expand for wedging engagement in the aligned apertures in the first and second components. Relative movement of the members in an opposite direction causes the overall width of said members to decrease. The wedging device further includes
30 a tensioning screw interconnecting the insert member and the wedge member. The tensioning screw has a threaded shank and is rotatably mounted on one of the insert member and the wedging member. The threaded shank is adapted to engage with a threaded portion of the other of
35 the insert member and the wedging member such that: (1) rotation of the tensioning screw in a first rotary direction causes relative movement in the first direction

between the insert member and the wedging member so as to cause wedging engagement; and (2) rotation of the tensioning screw in an opposite direction causes relative movement in the opposite direction between the insert member and the wedging member so as to release the wedging engagement. The wedging member has a pair of spaced rear walls defining a cavity in communication with an end of the wedging member for receiving a projection on the abutment surface of the insert member, the projection having a recess for receiving the tensioning screw.

This aspect of the invention overcomes the drawbacks of the prior art by providing a wedging device that may be installed and removed without the need for a sledge hammer to impart force to the wedge, and that reduces the need for an operator to be under the excavating device during installation or removal of the wedging device. In addition, this aspect of the invention has the advantage of allowing the use of wedging devices which have an overall width that is greater than the width of the passageway formed by the aligned apertures of the first and second components.

In another separate aspect of the present invention, there is provided a wedging device for securing together first and second components having respective apertures which align such that the wedging device can be inserted through the apertures and expanded in a wedging action to secure the components together. The wedging device comprises an insert member and a wedging member. A tensioning screw interconnects the insert member and the wedging member. The insert member and the wedging member have respective abutment surfaces shaped such that relative movement in a first direction between the insert member and the wedging member causes the overall width of the members to expand for wedging engagement in the aligned apertures in the first and second components, and such that relative movement in an

opposite direction between the insert member and the wedging member causes the overall width of the members to decrease. The tensioning screw has a threaded shank and first and second abutment faces for applying axially directed forces. Each of the first and second abutment faces extends substantially around a longitudinal axis of the tensioning screw and each is rigidly connected to the tensioning screw. A threaded portion is associated with one of the insert member and the wedge member for engagement with the shank of the tensioning screw. A first abutment portion and a second abutment portion is associated with the other of the insert member and the wedging member. The first abutment portion receives axially directed force from the first abutment face of the tensioning screw when the tensioning screw is rotated in a first rotational direction to cause relative movement of the insert member and the wedging member in the first direction. The second abutment portion receives axially directed force from the second abutment face of the tensioning screw when the tensioning screw is rotated in a second rotational direction to cause relative movement of the insert member and the wedging member in the opposite direction.

As with the first aspect of the invention, this aspect provides a wedging device that may be installed and removed without the need for a sledge hammer to impart force to the wedge, and that reduces the need for an operator to be under the excavating device during installation or removal of the wedging device. In addition, this embodiment provides a sturdy tensioning screw that is capable of withstanding the forces applied to the tensioning screw during installation and removal of the wedging device, as well as operation of the excavating equipment.

In one embodiment a head portion of the tensioning screw in use abuts with the wedging member and the threaded shank is adapted to engage in a

correspondingly threaded cavity through a portion of the insert member. In another embodiment, a head portion of the tensioning screw abuts with the insert member, and the threaded shank is received in a threaded bore of the
5 wedging member.

An advantageous embodiment of the invention is one in which the insert member has an arm portion adapted to engage and support the wedging device upon presentation to the components thereby facilitating
10 rotation of the tensioning screw to establish wedging interconnection. That is, the arm portion supports the insert member once the insert member has been inserted into the respective apertures of the first and second components, so that the operator is not required to
15 continue holding the insert member during installation of the wedging member. The operator is free to use both hands during insertion of the wedging member and tightening of the tensioning screw.

Most preferably the form of the wedging device
20 is such that the insert member is generally C shaped with a face inclined to the first direction to provide a ramp and the wedging member has a corresponding ramp surface for engaging the ramp and a remote surface adapted to engage the other component.

Embodiments of the invention can be arranged as elegant, simple and effective devices which use a wedge system with a single incline or tapered surface with a single wedge member to be moved. Since the insert member has means for cooperation preferably with the second
25 component, an insert member can be simply placed in position and the operator then has both hands free to insert and then tighten the wedge member.
30

A most important feature is that a screw system is provided for subsequent removal of the wedging device.
35 This is accomplished by the tensioning screw being operable in one direction to cause wedging and in the other direction to cause unwedging.

A preferred embodiment is one in which the tensioning screw has a captive head portion freely rotatable in and retained in a portion associated with one of the insert member and the wedging member and the other has a threaded bore for receiving the threaded shank of the tensioning screw whereby rotation of the screw in a first direction causes the insert member and wedging member to be moved relative to one another in a wedging direction and rotation of the tensioning screw in the opposite direction causes displacement force to be provided to reverse the relative movement for unwedging the device.

In one embodiment the captive head portion of the tensioning screw is located in a portion associated with the wedging member e.g. by lateral insertion into a slotted arm of the wedging member and the screw threaded shank is engaged in a threaded bore associated with the insert member, for example, in a corresponding body portion of the insert member. Advantageously in this arrangement the head portion can be uppermost for receiving engagement with a spanner or wrench.

Thus, preferred embodiments can be advantageous in obviating any hammering to install or remove the wedging device. The device is removable readily in a field situation where the application of mechanical advantage through a large wrench can be used.

In another aspect, the invention extends to an adaptor for mounting a working tool on an implement and arranged to be secured in position by a wedging device in anyone of the forms described herein. Preferably, the adaptor has at its rearward end portion transverse walls for inter-engaging with the insert member and preferably there is included a recess for co-operating with a projecting lug from the upper arm of the insert member.

In yet a further aspect, the invention extends to a method of mounting one component on another wherein

a wedging device in any one of the forms described herein is utilized.

In yet a further separate aspect, the invention provides a wedging device for securing together first and second components having respective apertures which align such that the wedging device can be inserted through the apertures and expanded in a wedging action to secure the components together. The wedging device comprises an insert member and a wedging member. The insert member and the wedging member have respective abutment surfaces shaped such that relative movement in a first direction between the insert member and the wedging member causes the overall width of the members to expand for wedging engagement in the aligned apertures in the first and second components. The insert member comprises an upper arm having a projection engageable with one of the first and second components whereby on initial assembly, with the apertures of the first and second components aligned vertically, the insert member remains in a supported position. This aspect of the invention has the advantage of improved ease of installation and safety. The projection allows the insert member to be supported by the second component, thus facilitating assembly by a single operator. In addition, the risk of the insert member dropping through the aperture is reduced.

In yet a further separate aspect, the invention provides a wedging device for securing together first and second components having respective apertures which align such that the wedging device can be inserted through the apertures and expanded in a wedging action to secure the components together. The wedging device comprises an insert member, a wedging member and a tensioning screw. The insert member and the wedging member have respective abutment surfaces shaped such that relative movement in a first direction between the insert member and the wedging member causes the overall width of the members to expand for wedging engagement in the aligned apertures in the

first and second components. The insert member and the wedging member are adapted to be interconnected by and driven into wedging engagement by the tensioning screw. A cap is associated with the tensioning screw.

5 In a related aspect, the invention also provides a wedging device for attachment to excavating equipment. A member defines a threaded bore. An elongate screw has a threaded shank and an end portion adapted to receive a torque-applying tool. A portion of
10 the shank is received within the bore and the end portion of the screw projects away from the bore. A cap substantially covers the end portion.

 The foregoing aspects of the invention reduce the problems associated with soil fines by providing a
15 protective cap. The cap may serve two functions. First, the cap prevents accumulation of soil fines around the end portion of the screw, so that time is not consumed in cleaning the end portion to allow installation of the wrench or spanner to start removal of the wedge member.
20 The cap is quickly pulled or pried off the screw with pliers or a screw driver. Second, the cap may prevent accumulation of soil fines around the exposed threaded portion of the screw, thereby reducing resistance to rotation of the screw in the second direction for
25 removal.

 In yet another embodiment, the cap prevents rotation of the tensioning screw.

 In yet a further aspect, the invention provides a method for removing a wedging device having an insert
30 member and a wedging member from engagement with a first component and a second component, the first and second components having respective apertures which align such that the wedging device is inserted through the apertures and expanded in a wedging action to secure the components
35 together. The method comprises the steps of providing a connecting member attached to the insert member. The wedging member is removed from the respective apertures.

A grasping member is connected to the connecting member. The grasping member is then pulled so as to pivot and lift the insert member from said respective apertures.

The novel method of removal of the insert member provides significant advantages for ease of removal and improved safety. By attaching a grasping member to the insert member, the insert member may be more securely manipulated, thus improving safety during handling of the insert member. This is particularly important since the insert members are very heavy.

The foregoing and other objectives, features, and advantages of the invention will be more readily understood upon consideration of the following detailed description of the invention, taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

By way of example only, embodiments of the invention will now be described with a reference to the accompanying drawings, of which:

FIG. 1 is a perspective view of an embodiment applied to securing a replaceable digging tool to the front lip of an excavator bucket.

FIG. 2 is a schematic cross-sectional view taken along the line II-II but prior to the wedging device being inserted.

FIG. 3 is a part cross-sectional side elevation through an embodiment of the wedging device embodying the invention.

FIG. 4 is a cross sectional view of the embodiment corresponding to FIG. 3 but showing just the insert member installed and supported on a second component of two inter-engaged components which are to be wedged together.

FIG. 5 is a view corresponding to FIG. 4 showing the assembled wedging device and disposed for

rotation to be applied to the tensioning screw to cause wedging engagement.

FIG. 6 is a view corresponding to FIG. 5 but showing the wedging device when installed in wedging engagement and adapted to be unwedged by counter rotation of the tensioning screw.

FIG. 7 is a part cross-sectional side elevation of a second embodiment with the wedging member in cross-section.

FIG. 8 is an end view of FIG. 7.

FIG. 9 is a plan view of FIG. 7.

FIG. 10 is a part cross-sectional front elevation of a third embodiment with the wedging member in cross-section.

FIG. 11 is an end elevation of FIG. 10.

FIG. 12 is a plan view of FIG. 10.

FIG. 13 is a front elevation of FIG. 10.

FIG. 14 is a plan cross-sectional view taken along the line AB-AB of FIG. 13.

FIG. 15 is a plan view in cross-section taken along the line AW-AW of FIG. 13.

FIG. 16 is a plan cross-sectional view taken along the line AX-AX of FIG. 13.

FIG. 17 is a plan cross-sectional view taken along the line AY-AY of FIG. 13.

FIG. 18 is a part cross-sectional front elevation of a fourth embodiment with the wedging member and insert member shown in cross-section.

FIG. 19 is a part cross-sectional side elevation of the embodiment of FIG. 18 showing the lip and adaptor in cross-section and showing removal of the insert member.

FIG. 20 is a detail view of FIG. 19 in cross-section of one embodiment of the pipe having an o-ring.

FIG. 21 is a cross-section of an embodiment of the pipe having an eccentric portion.

FIG. 22 is a detail view of FIG. 21.

FIG. 23 is a cross-section taken along the line 23-23 of FIG. 21.

FIG. 24 is another detail view like FIG. 22 except showing the pipe rotated.

5 FIG. 25 is a view like FIG. 23 except showing the pipe rotated.

FIG. 26 is a detail view like FIG. 20 showing an alternative embodiment of a pipe having internal threads.

10 FIG. 27 shows an adaptor and dedicated nose portion of a dragline bucket.

FIG. 28 shows an embodiment of the wedging device of the present invention used in conjunction with an adaptor and dedicated nose portion of a dragline
15 bucket.

FIG. 29 shows a perspective view of a screw-locking cap and a wedging device.

FIG. 30 shows the cap of FIG. 29 fitted over the end of the tensioning screw of the wedging device.

20 FIG. 31 shows a horizontal cross-section through the cap along the line A-A of FIG. 29.

FIG. 32 shows a horizontal cross-section through the spool and wedge unit along the line B-B of FIG. 29.

25 FIG. 33 shows a detail view showing a vertical cross-section of the cap fitted over the tensioning screw of the wedging device.

FIG. 34 shows an alternative embodiment of a screw-locking cap.

30 FIG. 35 shows a vertical cross-section of the cap of FIG. 34 fitted over a tensioning screw of a wedging device.

FIG. 36 shows a side elevational view of a further alternative embodiment of a screw-locking cap.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In various embodiments like numerals have been used for corresponding parts.

Referring first to FIGS. 1 and 2, an excavator
5 bucket has a leading lip 10 which extends generally horizontally in normal use, the lip terminating in a leading edge 11 and having a rectangular or rounded aperture 12 at each location where a replaceable digging
10 tooth 13 is to be mounted. Each tooth 13 is mounted on a shoe-like adaptor 14 by means of a conventional wedging pin (not shown). At regular intervals, just the tooth is removed in the field and replaced. The adaptor 14 also requires replacing at intervals and this embodiment of the invention uses a wedging device shown in overall view
15 prior to tightening in FIG. 1 and in more detailed side elevation in FIG. 3.

The wedging device comprises an insert member such as a generally C-shaped spool 15 and a wedge unit 16, the wedging device being adapted to fit into the
20 aperture 12 in the lip and to urge the adaptor 14 rearwardly relative to the lip 10, i.e. in the direction of arrow A shown in FIG. 2.

As most clearly seen in FIG. 2, the adaptor is forked and comprises upper and lower arms 17 and 18 with
25 rearwardly extending cavities 19 and 20 and transverse walls 21 and 22 in the central region and over which arms 23 and 24 of the C-shaped spool extend. The upper transverse wall 21 has a recess 25 into which an engaging portion, such as a lug 26 of the upper arm of the spool,
30 extends in hooking engagement, whereby the spool is retained in position. This is most clearly shown in FIG. 4 during initial assembly. The engaging portion allows the spool 15 to be supported by the adaptor when the spool 15 is inserted into the aligned apertures. A
35 single operator can readily achieve this assembly and then proceed to insert the wedge unit 16 without the need to simultaneously hold the spool 15 in position.

FIG. 5 shows the wedge unit 16 positioned into its initial position and a tensioning screw 27 inserted and ready for tightening. As shown in FIG. 1, the wedge unit 16 in plan view is generally U-shaped and is
5 downwardly tapered with a front wedging wall 28 and a pair of spaced rear walls 29 between which a cavity 30 is defined, the walls 29 being adapted to engage in abutment with an inclined front face 31 of the spool 15. Near its upper end, the wedge unit has an interior transverse wall
10 32.

The U-shaped wedge unit and corresponding cavity 30 provide a significant advantage by allowing the overall width of the assembled wedging device to exceed the width of the apertures of the components to be
15 secured together. As shown in FIG. 4, the extending upper and lower arms 23 and 24 require that the spool 15 be inserted into the apertures separately from the wedge unit 16. Because the cavity 30 in the wedge unit 16 communicates with the lower end of the wedge unit 16, the
20 projection 37 on the spool 15 may be received within the cavity, thus allowing the wedge unit 16 to pass over the projection 37 when the wedge unit is inserted into the apertures. The tensioning screw 27 can thereafter be engaged with the threaded bore in the projection 37 of
25 the spool 15 even though the space remaining in the apertures after insertion of the spool is quite limited. The tensioning screw 27 has a head portion comprising a hexagonal head 35 and a spaced collar 35A between which a plain shank portion or neck 35B is provided, the portion
30 35B having a greater axial length than the thickness of the transverse wall 32. In this embodiment the transverse wall 32 has a slot extending into the wall from the left edge as shown in FIG. 3 so that the neck 35B can simply be slipped laterally into the slot prior to assembly.

35 Clockwise rotation, as shown in FIG. 5, causes the screw threaded shank of the tensioning screw 27 to threadably engage in the projection 37 of the insert

member and thereby the wedging member 16 is drawn downwardly and urged into wedging engagement. The operator simply positions the threaded leading end of the screw 27 and rotates it to screw threadably engage in a threaded bore 36 which extends downwardly through an integral body portion, such as projection 37 of the spool 15, the tensioning screw thereby extending parallel to the inclined leading face 31 of the spool. The screw 27 is tightened in a clockwise direction as indicated in FIG. 5 thereby drawing down the wedging unit 16 and consequently causing the wedging device to expand in the horizontal direction with a reaction force applied between surfaces 28 of the wedging unit and 12 of the aperture in the lip. This forces a rearwardly directed interior surface 39 of the spool toward confronting respective surfaces of the transverse walls 21 and 22 so that the adaptor moves rearwardly relative to the lip 10 whereby the adaptor tightens against the leading edge 11 of the lip 10. Further tightening of the screw 27 causes tensioning of the adaptor whereby its forked arms 17 and 18 are drawn down onto the substantially parallel top and bottom surfaces of the lip.

In order to disassemble the parts, an operator simply applies a torque-applying tool such as a spanner to the top of the tensioning screw and rotates it in an anti-clockwise direction as shown in FIG. 6 thereby causing the collar 35A to abut against the lower surface of the transverse wall 32 thereby forcing the wedging member upwardly and out of wedging engagement.

Referring now to the embodiment of FIGS. 7 to 9, the C-shaped spool 15 has the extra feature of a handle 47 to facilitate manipulating the wedging device in its initial installation. Otherwise like parts have been given like reference numerals.

This embodiment is characterized by the tensioning screw 27, when rotated, applying force downwardly to drive the wedge unit 16 down for wedging

engagement or upon reverse rotation to drive the wedge unit upwardly for disassembly.

This function is achieved by the provision of a cavity 40 for accommodating the head 35 of the tensioning screw 27 along with a series of belleville washers 44 located on an upper shank portion 43. The washers are supported on a pair of ribs 42, one of which extends behind the tensioning screw (as seen in FIG. 7) and the other rib (not shown) is located in front of the screw. The ribs 42 are integral with the wedge unit 16, as is a transverse wall 41 having a lower surface confronting the free end of the head of the tensioning screw.

The stack of belleville washers 44 acts as a locking mechanism to maintain tension on the tensioning screw, which in turn increases the resistance to rotation by the tensioning screw. Preventing rotation by the tensioning screw once the tensioning screw has been tightened is important to maintain a secure locking relationship among the spool, wedge unit, adaptor and lip. Other locking mechanisms could be used in place of a stack of belleville washers to resist rotation of the tensioning screw, such as coil springs, elastomers, and/or lock washers.

The transverse wall 41 also has an access bore 46 for receiving an allen key which engages in a hexagonal aperture 45 in the end of the head 35 of the tensioning screw 27 for rotating the screw in either direction.

The projection 37 from the spool has a screw threaded bore in which the screw-threaded portion of the shank 43 is engaged.

The C-shaped spool can be dropped into position with the lug 26 engaging in a corresponding recess in the adaptor. The wedge unit and tensioning screw are then installed. An allen key is inserted into the end of the tensioning screw and driven to tighten the wedging unit. To remove the wedge unit, reverse rotation is applied to

loosen the wedge unit so that the whole wedging device can be removed.

Referring now to FIGS. 10 to 17 which shows another embodiment, similar mechanical principles are used but in this version the upper end of the screw 51 is a reduced size free end portion 50 having a hexagonal outer profile and accommodated in an access recess 53 in the upper portion of the wedge unit 16 and above the transverse wall 57 of the wedge. In this case the transverse wall 57 of the wedge has a screw threaded bore for threaded engagement with the threaded portion of the shank 52 of the tensioning screw and the lower end of the tensioning screw is retained but freely rotatable within the projection 37A from the spool 15.

At the lower end, the tensioning screw has a plain head 54 on which is supported a group of belleville washers 44 and immediately above the projection 37A a retaining collar 55 is provided on the tensioning screw.

Assembly comprises the steps of locating the washers 44 on the shank of the tensioning screw; the shank is then upwardly inserted through the bore in the projection 37A so that the washers abut the lower surface of the projection. The collar 55 is screw threadably engaged on the shank and rotated to move down to be adjacent the top of the projection 37A and to align a cross bore in the shank with a cross bore in the collar so that a pin 56 can be inserted to rigidly lock together the two components. Assembly of the tensioning screw to the spool may be done by the manufacturer, or at least at a location remote from the excavating device, so that the assembly need not take place in the field.

The assembled spool and tensioning screw are inserted into the aligned apertures of the adaptor and lip. The wedge unit is then lowered into position such that the cavity 58 receives the projection 37A such that the wedge unit 16 passes over the projection 37A. The screw threaded bore in the transverse wall 57 is placed

over the end portion 50 of the tensioning screw, and the tensioning screw rotated to tighten the wedging device.

A socket tool is applied to rotate the tensioning screw by engagement with the free end 50, thereby causing the wedge unit to be screw threadably engaged and pulled downwardly to expand the wedging device. Reverse motion removes the wedge unit upwardly.

This embodiment has the advantage that the tensioning screw is affixed to the spool by means of the collar and pin. This is in contrast to the first two embodiments, in which the tensioning screw is only loosely held and therefore must be grasped and guided during insertion of the tensioning screw into the bore in the spool. In contrast, in the third embodiment, once the collar and pin are affixed to the tensioning screw, the tensioning screw is held in place on the spool so that it is aligned with the bore of the wedge unit as the wedge unit is lowered into position. This provides a significant advantage to the operator by facilitating installation of the wedge unit. In addition, the narrow end portion 50 fits easily within the bore. Thus, the bore in the transverse wall 57 of the wedge unit 16 may be easily aligned with the tensioning screw when the wedge unit 16 is dropped into place adjacent to the spool 15.

Referring now to FIGS. 18 to 19 which shows a preferred embodiment, similar mechanical principles like those employed in the embodiment of FIGS. 10-17 are used but in this version the screw 51 does not have a retaining collar. In this embodiment, the upper end of the screw 51 is a reduced diameter free end portion 50 having a hexagonal outer profile and accommodated in an access recess 53 in the upper portion of the wedge unit 16 and above the transverse wall 57 of the wedge. The hexagonal outer profile of end portion 50 allows engagement of a tool, such as a torque wrench, for rotating the screw 51, but other structures could be

used, such as a hexagonal recess for receiving an allen key, a slot, or other conventional structure. The transverse wall 57 of the wedge unit 16 has a screw threaded bore for threaded engagement with the threaded portion of the shank 52 of the tensioning screw 51. The lower end of the tensioning screw 51 is retained but freely rotatable within the projection 37A from the spool 15. The wedge unit 16 has a U-shaped cross-sectional cavity 58 for receiving the projection 37A. The tensioning screw 51 also has a smooth front portion 60 between the end portion 50 and threaded portion of the shank 52. This smooth portion 60 has an outside diameter that is equal to or less than the inside diameter of the threaded bore in the transverse wall 57 and facilitates assembly by allowing the threaded bore of the wedge member to be aligned with the axis of the tensioning screw before thread engagement occurs.

At the lower end, the tensioning screw 51 has a plain head 54 on which is supported a stack of belleville washers 44.

The tensioning screw 51 is held in fixed relationship with respect to the spool 15 by both the projection 37A and a pin 62. A portion of the pin 62 is received in a bore 64 in the spool 15. The pin 62 is held in place within the bore 64 by the use of threads on both the lower portion of the pin 62 and within the bore 64. Alternatively, the pin 62 may be held in place in the bore 64 through a press fit without the use of threads. In use, as the tensioning screw 51 is rotated to tighten the wedging device, the wedge unit 16 travels downward to cause expansion of the wedging device. The projection 37A resists movement of the plain head 54 of the screw 51 as the screw 51 is rotated to expand the wedging device. The lower surface of the projection 37A acts as an abutment surface which opposes a first abutment face of the plain head 54, which directly abuts the stack of belleville washers 44. In contrast, the pin

62 resists movement of the plain head 54 of the screw 51 as the screw 51 is rotated in the opposite direction to cause the wedge unit 16 to move upward and to cause the wedging device to contract. The exterior of the pin 62
5 acts as an abutment surface against an opposing second abutment face of the plain head 54 to resist movement.

The embodiment of FIGS. 18-19 has the advantage of a longer travel path for the wedge unit 16 relative to the spool 15. This is a consequence of the lack of
10 external structure arranged on the tensioning screw, such as a collar on the shank 52. Thus, the entire shank 52 is available for threaded engagement with the transverse wall 57. The longer travel path thus allows greater expansion of the wedging device, and hence a tighter fit
15 between the adaptor and the lip.

Assembly and installation of the wedging device is as follows. First, the screw 51 is attached to the spool 15 by placing the stack of belleville washers on the screw 51 and then inserting the screw 51 into the
20 projection 37A. The pin 62 is then inserted into the bore 64. Assembly of the screw 51 and pin 62 with the spool 15 may be done by the manufacturer, or at least at a location remote from the excavating device, rather than in the field. Thus, like the embodiment of FIGS. 10-17,
25 the embodiment of FIGS. 18-19 has the advantage that the tensioning screw may be affixed to the spool 15, so that the tensioning screw 51 and spool 15 form an integral unit. Again, this provides the advantage of easier installation.

30 To attach the wedging device to the adaptor and lip, the assembled spool 15 and tensioning screw 57 is lowered into the aligned cavities of the adaptor and lip aperture. The wedge unit 16 is then lowered into position with the screw threaded bore in the transverse
35 wall 57 placed over the end portion 50 of the tensioning screw 51. A socket tool is applied to rotate the tensioning screw 51 by engagement with the end portion

50, thereby causing the wedge unit 16 to be screw threadably engaged and pulled downwardly to expand the wedging device. Like the embodiment of FIGS. 10-17, the embodiment of FIGS 18-19 has the advantage of the upside
5 down orientation of the tensioning screw 51. This orientation facilitates assembly, by allowing the bore in the transverse wall 57 of the wedge unit 16 to be aligned with the axis of the tensioning screw 51 prior to threaded engagement.

10 To remove the wedging device from the lip and adaptor, a tool engages the end portion 50 to counter-rotate the screw 51. This causes the wedge unit 16 to travel upward until the threads of the screw 51 disengage from the threads of the bore in the transverse wall 57.
15 The wedge unit 16 may then be lifted out.

In yet another alternative embodiment, the tensioning screw is provided with two oppositely threaded portions on either end of the tensioning screw. One threaded portion is received within a threaded bore
20 within the insert member, while the other oppositely threaded portion of the tensioning screw is received within a threaded portion associated with the wedge unit. Rotation of the tensioning screw in one direction causes the wedge unit and insert member to move in one direction
25 to cause expansion of the wedging device, while rotation of the tensioning screw in the opposite direction causes the wedging device to decrease in width.

In another separate aspect of the invention, an optional protective elastomeric cap 66 may be placed over
30 the end portion 50 of the screw 51 as shown in FIG. 18. The cap 66 prevents the in-fill and packing of soil fines into the access recess 53, which could interfere with access to the end portion 50 and removal of the wedging unit 16. Preferably, the cap 66 is of sufficient length
35 to cover the end portion 50 of the screw 51 and covers the exposed threads of the shank 52 down to the transverse wall 57. The cap 66 may be cylindrical, and

may have an open or closed end above the end portion 50. The cap 66 preferably has an inner diameter that is slightly less than the outer diameter of the screw 51, so that the cap 66 is held in place through frictional
5 engagement between the cap 66 and the screw 51. The cap 66 may be formed from any suitable durable, flexible material, such as any suitable elastomer, such as polyurethane or silicone rubber.

The present invention also provides a screw-
10 locking cap, several embodiments of which are shown in FIGS. 29-36. During installation, a substantial amount of torque is applied to the tensioning screw to tighten the wedging device. However, the present inventors have found that during use of the wedge and spool assemblies
15 described herein, the wear-in of the cast surfaces of the assembly can be very fast in difficult digging with abrasive soil fines. This results in a loss of the initially applied torque, which could lead to unwinding of the tensioning screw during use. Accordingly, it is
20 desired to prevent rotation of the tensioning screw during use independently of any torque applied to the tensioning screw. The screw-locking caps disclosed in FIGS. 29-36 prevent rotation of the tensioning screw 214 about its longitudinal axis 215 with respect to the spool
25 and/or wedge unit, and therefore prevent disassembly of the wedge and spool assembly.

In a first embodiment disclosed in FIGS. 29-33, the spool 202 and cap 200 have opposing engagement surfaces 204 and 206 to prevent rotation of the cap. The
30 wedge unit 208 and spool 202 together define a cavity 210 for receiving the tool-adapted end 212 of the tensioning screw 214. In the embodiment shown in FIGS. 29-33, the spool 202 has a plurality of longitudinal ribs 216. Alternatively, the ribs could be provided on the wedge
35 unit, or on both the spool and wedge unit. Each of the ribs 216 defines on either side an engagement surface 204. Each engagement surface 204 is angularly offset

from a radial line R extending from the center of the tensioning screw 214 to the engagement surface as shown in FIG. 32. (The term "angularly offset" means that the radial line is not normal to the engagement surface.)

5 The cap 200 has twelve longitudinal ribs 218 spaced approximately 30° apart, each defining a pair of engagement surfaces 206. When the cap 200 is placed over the tool-adapted end 12 of the tensioning screw 214 as shown in FIG. 30, the engagement surfaces 204 of the
10 spool oppose the engagement surfaces 206 of the cap 200. Accordingly, the cap 200 is prevented from rotating within the cavity 210 about the longitudinal axis 215 of the tensioning screw 214.

In this first embodiment, the cap 200 comprises
15 an extension member 220 extending into an elastomeric member 222. The extension member 220 is a steel shaft having an internal cavity 224 for receiving the tool-adapted end 212 of the screw 214. The internal cavity 224 is shaped to be matingly engageable with the tool-
20 adapted end 212 of the tensioning screw so as to prevent rotation of the tensioning screw with respect to the cap 200. In the embodiment shown in FIGS. 29-33, the tool-adapted end 212 of the tensioning screw 214 has a horizontal hexagonal cross-section, and likewise the
25 extension member 220 has an internal cavity 224 having a horizontal hexagonal cross-section. The extension member 220 includes a tool-adapted end 226 having one or more annular grooves 228. The tool-adapted end 226 allows the operator to turn the tensioning screw by turning the cap
30 200 using the same tightening tool as is used to tighten the tensioning screw 214. The annular groove 228 allows the cap 200 to be pried out of the cavity 210 after use.

When the cap 200 is placed over the tensioning screw as illustrated in FIG. 30, the cap 200 prevents
35 rotation of the tensioning screw 214 about its longitudinal axis 215. The mating engagement of the internal cavity 224 of the cap 200 with the end 212 of

the tensioning screw 214 prevents rotation of the cap 200 with respect to the screw 214, while the engagement surfaces 204 and 206 of the spool 202 and cap 200 prevent rotation of the cap 200 with respect to the spool 202. Accordingly, the tensioning screw 214 is held immobile, preventing rotation of the screw 214 and hence disassembly of the device even in the absence of torque on the tensioning screw.

In practice, the tensioning screw is tightened to a desired torque (e.g., approximately 400 ft-lbs) during initial installation of the wedge and spool assembly. The angular orientation of the tool-adapted end 212 of the tensioning screw about the longitudinal axis 215 is completely variable, according to the specific dimensionality of the components and the specific torque applied. It is desired to provide a cap that can be placed over the tool-adapted end 212 at any angular orientation of the tool-adapted end 212 and nevertheless prevent rotation of the tensioning-screw 214. Accordingly, the cap 200 provides sufficient internal and external clearances to allow the cap 200 to be inserted into the cavity 210 and over the tool-adapted end 212 at any angular orientation of the tensioning-screw 214. The internal cavity 224 of the extension member 220 is wider than the tool-adapted end 212 of the tensioning screw 214 so as to allow some limited angular freedom of movement of the cap 200 even when placed over the tool-adapted end 212. In addition, the exterior surface of the cap 200 is sized so as to provide clearance between the rib surfaces 206 of the cap 200 and the rib surfaces 204 of the spool 202. These clearances provide enough angular freedom of movement of the cap 200 about the longitudinal axis 215 when the cap 200 is placed over the tool-adapted end 212 to allow the ribs 218 of the cap 200 to be aligned to fit within the grooves defined between the ribs 216 of the spool 202. Thus, regardless of the angular orientation of the tool-

adapted end 212, the cap 200 may be fitted over the tool-adapted end 212 and into the cavity 210. Additionally, the use of an elastomer to form the ribs 218 further aids placement of the cap 200 within the cavity 210 for all
5 angular orientations of the tool-adapted end 212.

In theory, to provide engagement surfaces to prevent rotation of the cap 200 with respect to the wedge 208 and spool 202, it is only necessary to provide a cap 200 having a sufficiently eccentric or non-circular
10 horizontal cross-section and corresponding cavity 210 shape to prevent the cap from rotating within the cavity 210. A non-circular cross-section will provide a plurality of engagement surfaces which are angularly offset from a radial line drawn from the center of the
15 tensioning screw to the engagement surface. Providing opposing engagement surfaces on the cap and at least one of the spool and wedge unit will prevent rotation of the protective cap within the cavity. However, as described above, it is desired to allow the cap to be fitted over
20 the tool-adapted end 212 of the tensioning screw 214 for any angular orientation of the tensioning screw about the longitudinal axis 215. It is therefore preferred to provide a plurality of engagement surfaces at many angular locations about the longitudinal axis 215 to
25 provide for a substantial number of possible angular orientations of the cap 200 about the longitudinal axis 215. Thus, it is preferred that the engagement surfaces 206 are formed by at least four longitudinal ribs 218. Alternatively, the cap may be formed to have a horizontal
30 cross-section shaped like a polygon having a large number of sides (i.e., at least four sides).

To retain the cap 200 in place over the end of the tensioning screw 214, the interior surface of the cap 200 is provided with an annular elastomeric ridge 230
35 that projects inwardly into the internal cavity 224 of the cap 200. The tensioning screw 214 has a corresponding annular groove 232 for receiving the ridge

230 when the cap 200 is placed over the end of the tensioning screw 214, as is illustrated in FIG. 33. Alternatively, the ridge may be provided on the exterior of the cap 200 while the groove is defined by the spool 202 and/or wedge 208. Alternatively, a simple o-ring may be used in place of the ridge 230. As yet another alternative, the cap 200 may be fastened to the tensioning screw using a mechanical fastener, such as a clip, pin or bolt.

10 In use, the cap 200 is simply pushed onto the tool-adapted end 212 of the tensioning screw 214 following tightening of the tensioning screw, so as to engage the ridge 230 with the groove 232. Removal of the cap 200 may be accomplished using one of at least two methods. In one method, a tool such as a socket wrench is applied to the tool-adapted end 226 of the extension member 220. The extension member 220 is rotated so as to unwind the tensioning-screw 214. The cap 200 will be pushed out of the cavity 210 by either the wedge 208 or soil fines which are also being pushed out by the wedge 208. This method may cause the destruction of the ribs 218 of the cap 200. Alternatively, the cap 200 may be removed using a pry bar and prying against the groove 228.

25 The elastomeric member 222 of the cap 200 may be formed from a variety of elastomeric materials, such as rubber or polyurethane. Alternatively, the cap 200 may be formed of other materials, such as steel. Where the cap 200 is formed of a non-elastomeric material, additional clearance must be provided between the cap and the wedge and spool surfaces to allow alignment of the ribs of the cap with the ribs of the spool and/or wedge.

30 An alternative cap 200a shown in FIGS. 34-35 is similar to the preceding cap 200 but lacks the extension member 220. The cap 200a has an internal cavity 224 shaped for receiving the tool-adapted end 212 of the tensioning screw 214. For example, where the tensioning

screw 214 has a hexagonal end, the cavity has a horizontal hexagonal cross-section so as to receive the hexagonal end of the tensioning screw 214. Like the embodiment of FIGS. 29-33, the cap 200a may be provided with an internal ridge for holding the cap on the tensioning screw. The cap 200a is installed by simply pushing the cap 200a over the tool-adapted end so as to engage the ridge inside the cavity of the cap 200a with the groove 232 of the spool 202. The cap 200a is removed by unwinding the tensioning screw 214 until the cap is pushed by soil fines or the wedge to be high enough so as to be pried out of the cavity.

Yet another alternative embodiment 200b is shown in FIG. 36. The upper portion 240 of the cap 200b, including the ribs, is made of steel, while the lower portion 242 of the cap is made of silicone rubber. The lower portion provides an annular ridge 244 for engagement with a groove defined by the spool 202. The interior cavity 246 of the lower portion is sized to fit snugly over the threaded portion of the tensioning screw 214, while the upper portion provides a hexagonal cavity for receiving the tool-adapted end 212 of the tensioning-screw 214.

The present invention also provides a novel method for removal of the insert member. FIG. 19 illustrates removal of the spool 15. Because the handle 47 often wears away during use, it is often unavailable to facilitate lifting of the spool 15 during removal. Accordingly, an optional pipe 68 may be used to facilitate lifting of the spool 15. One end of the pipe 68 is placed over the screw 51. The pipe 68 may then be pulled rearwardly as indicated by the arrow in FIG. 19 to pivot the spool 15 out of the lip aperture and adaptor cavities. The use of the pipe 68 provides a significant advantage in that the leverage afforded by use of the pipe reduces the amount of work needed to lift and remove the heavy spool. In addition, the pipe 68 has the

advantage of allowing the spool 15 to be more securely grasped and manipulated, thus improving safety associated with handling of the spool 15.

Various mechanisms may be used to more securely attach the pipe 68 to the screw 51. In one embodiment, the pipe 68 may have an o-ring 70 of hard rubber or other elastomeric material which fits within an annular groove 72 located at one end of the pipe 68. The internal diameter of the o-ring 70 is larger than the external diameter of the screw 51, so that the pipe 68 may be slipped over the threads of the screw. Once the pipe 68 is slipped over the threads, the pipe 68 is pulled rearward, causing one side of the o-ring to engage the threads of the screw. This is illustrated in FIG. 20. Engagement of the o-ring with the threads allows the pipe 68 to more securely grasp the screw.

In yet another embodiment, the inside of the pipe may include an eccentric member 74 as illustrated in FIGS. 21 - 25. The eccentric member 74 may either have a smooth interior surface (not shown), or may have annular ridges 76 as illustrated. The eccentric member may be made of mild steel, plastic, or other material. The eccentric member 74 has a thin portion 78 such that the combination of the pipe and thin portion of the eccentric member is narrower than the space between the screw 51 and the spool 15, so that the pipe may be slipped over the screw 51 as shown in FIGS. 21-23. Once the pipe is over the screw, the pipe is rotated so that a thick portion 80 of the eccentric member 74 is wedged between the screw and the spool 15 as shown in FIGS. 24-25. Where the eccentric member 74 includes annular ridges 76, the ridges engage the outer edges of the threads of the screw when the pipe is rotated. In any event, wedging the thick portion 80 between the screw and the insert member further facilitates grasping of the spool.

Alternatively, in another embodiment, the pipe may have internal threads that engage the threads of the

screw. The pipe 68 is screwed over the threads of the screw 51 so that the pipe may securely grasp the spool 15, as illustrated in FIG. 26. Alternatively, other grasping devices, such as a handle, may be attached to the screw 51 to facilitate removal of the spool. Alternatively, the pipe 68 may be attached to some other connecting member to facilitate pivotal movement and removal of the spool 15.

The various aspects of the present invention also find utility in other applications. For example, the present invention may be used to secure a tooth or an adaptor to a nose portion of a dragline bucket. An adaptor 116 and a nose portion 117 of a dragline bucket are illustrated in FIGS. 27-28. Adaptor 116 has a tip region 118 formed to receive a sacrificial wear part (not shown). The sacrificial wear part is fitted on tip region 118 by a locking device (not shown) which passes through aperture 119, when adaptor 116 is fitted on nose portion 117. Upper and lower surfaces 122 and 123 of adaptor 116 have openings 124 and 125 which align with openings 126 and 127 of nose portion 117 to form a passageway 128 in which the wedging device is inserted. A wedging device similar to the embodiment of FIGS. 18-19 is shown inserted into the passageway 128 in FIG. 28. The wedging device comprises an insert member, or spool 150, a wedge unit 152, and an interconnecting tensioning screw 154. The tensioning screw fits through a bore in the projection 156 of the spool 150. The wedge unit 152 includes a transverse wall 158 which has a threaded bore for receiving the projection 156. The wedge unit 152 is U-shaped in plan view, such that a cavity 160 is defined by the spaced rear walls 162 of the wedge unit. The tensioning screw includes a plain head 164, which is disposed between a stack of belleville washers 166 and pin 168. A cap 169 covers the tool-adapted end portion 170 of the tensioning screw.

The faces of the end regions 129 of spool 150 bear against ledges 131 of adaptor 116. As the tensioning screw 154 is rotated, contact surface 132 of the wedge unit 152 is brought into face-to-face contact with inner surface 133 of nose portion 117, thereby forcing the faces of end regions 129 of spool 150 against ledges 131 of adaptor 116, causing the adaptor to be moved rearwardly onto the nose portion. The wedge is drawn further into passageway 128 with continued rotation of the tensioning screw, resulting in adaptor 116 being fixedly secured to nose portion 117 of the dragline bucket.

In order to remove adaptor 116 from nose portion 117, the tensioning screw 154 is rotated in an opposite direction.

The terms and expressions which have been employed in the foregoing specification are used therein as terms of description and not of limitation, and there is no intention, in the use of such terms and expressions, of excluding equivalents of the features shown and described or portions thereof, it being recognized that the scope of the invention is defined and limited only by the claims which follow.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

- 5 1. A wedging device for securing together first and second components having respective apertures which align such that the wedging device can be inserted through the apertures and expanded in a wedging action to secure the components together, the wedging device
- 10 comprising:
- (a) an insert member;
 - (b) a wedging member;
 - (c) said insert member and said wedging member having respective abutment surfaces shaped
 - 15 such that relative movement in a first direction between said insert member and said wedging member causes the overall width of said members to expand for wedging engagement in the aligned
 - 20 apertures in the first and second components, and relative movement in an opposite direction causes the overall width of said members to decrease;
 - (d) a tensioning screw interconnecting said
 - 25 insert member and said wedging member, said tensioning screw having a threaded shank and being rotatably mounted on one of said insert member and said wedging member;
 - (e) said threaded shank being adapted to
 - 30 engage with a threaded portion of the other of said insert member and said wedging member such that
 - (i) rotation of said tensioning screw in
 - 35 a first rotary direction causes relative movement in said first direction between said insert member

- and said wedging member so as to cause wedging engagement, and
- 5 (ii) rotation of said tensioning screw in an opposite direction causes relative movement in said opposite direction between said insert member and said wedging member so as to release the wedging engagement.
- 10 (f) said wedging member having a pair of spaced rear walls defining a cavity in communication with an end of said wedging member for receiving a projection on said insert member, said projection having a
- 15 recess for receiving said tensioning screw.

2. The wedging device of claim 1 wherein said recess in said projection is a threaded bore for receiving said threaded shank of said tensioning screw

20 and said tensioning screw is rotatably mounted on said wedging member.

3. The wedging device of claim 1 wherein said recess in said projection is a smooth bore for rotatably

25 mounting said tensioning screw on said insert member.

4. The wedging device of claim 1 further comprising access means providing access to an end portion of said tensioning screw when said device is

30 assembled and in use, said access means permitting said tensioning screw to receive applied torque from a tool to rotate said tensioning screw.

5. The wedging device of claim 1 wherein said

35 tensioning screw further comprises first and second abutment faces rigidly connected to said tensioning screw, said abutment faces applying axially directed

forces to cause said insert member and said wedging member to move in said first direction and said opposite direction.

5 6. The wedging device of claim 5 wherein said first and second abutment faces are located on a head portion of said tensioning screw.

10 7. The wedging device of claim 5 wherein said first and second abutment faces confront one another and define shoulders at opposite ends of an intermediate portion of said tensioning screw.

15 8. The wedging device of claim 5 wherein one of said first and second abutment faces is located on a collar rigidly mounted on said screw.

20 9. The wedging device of claim 1 wherein said tensioning screw has at one end one of an enlarged head portion and a narrow portion adapted to be engageable with a torque applying tool to apply torque to rotate said tensioning screw.

25 10. The wedging device of claim 1 wherein said tensioning screw is affixed to said insert member.

30 11. The wedging device of claim 1 wherein said insert member further comprises (i) a main portion which in use extends through the aligned apertures of the first and second components and (ii) an upper arm having an engagement portion engageable with a portion of one of the first and second components whereby on initial assembly, with the apertures of the first and second components aligned vertically, said insert member is
35 supported by said arm.

12. The wedging device of claim 11 wherein
said engagement portion extends downwardly for engaging a
corresponding recess in the second component whereby said
insert member is retained from falling through the
5 apertures of the first and second components.

13. The wedging device of claim 11 wherein
said insert member is generally C-shaped with said upper
arm and a lower arm extending from said main portion to
10 provide the C-shaped structure.

14. The wedging device of claim 1 further
comprising a cap associated with said tensioning screw.

15 15. The wedging device of claim 1 further
comprising a locking mechanism associated with said
tensioning screw.

16. The wedging device of claim 1 wherein the
20 first component is a lip of an excavator bucket.

17. The wedging device of claim 1 wherein the
first component is the nose portion of a bucket of an
excavating device.

25 18. A wedging device for securing together
first and second components having respective apertures
which align such that the wedging device can be inserted
through the apertures and expanded in a wedging action to
30 secure the components together, the wedging device
comprising:

- (a) an insert member;
- (b) a wedging member;
- (c) a tensioning screw for interconnecting
35 said insert member and said wedging
member;

- 5 (d) said insert member and said wedging member having respective abutment surfaces shaped such that relative movement in a first direction between said insert member and said wedging member causes the overall width of said members to expand for wedging engagement in the aligned apertures in the first and second components, and such that relative movement in an opposite direction between said insert member and said wedging member causes the overall width of said members to decrease;
- 10 (e) said tensioning screw having
- 15 (i) a threaded shank and
- (ii) first and second abutment faces for applying axially directed forces, each of said first and second abutment faces extending
- 20 substantially around a longitudinal axis of said tensioning screw and each being rigidly connected to said tensioning screw;
- 25 (f) a threaded portion associated with one of said insert member and said wedging member for engagement with said threaded shank of said tensioning screw;
- 30 (g) a first abutment portion and a second abutment portion associated with the other of said insert member and said wedging member;
- 35 (h) said first abutment portion receiving axially directed force from said first abutment face of said tensioning screw when said tensioning screw is rotated in a first rotational direction to cause relative movement of said insert member

and said wedging member in said first direction; and

- (i) said second abutment portion receiving axially directed force from said second abutment face of said tensioning screw when said tensioning screw is rotated in a second rotational direction to cause relative movement of said insert member and said wedging member in said opposite direction.

19. The wedging device of claim 18 further comprising access means providing access to an end portion of said tensioning screw when said device is assembled and in use, said access means permitting said tensioning screw to receive applied torque from a tool to rotate said tensioning screw.

20. The wedging device of claim 18 wherein said first and second abutment faces are located on a head portion of said screw.

21. The wedging device of claim 18 wherein said first and second abutment faces confront one another and define shoulders at opposite ends of an intermediate portion of said tensioning screw.

22. The wedging device of claim 18 wherein one of said first and second abutment faces is located on a collar mounted on said screw.

23. The wedging device of claim 18 wherein said tensioning screw has at one end one of an enlarged head portion and a narrow portion adapted to be engageable with a torque applying tool to apply torque to rotate said tensioning screw.

24. The wedging device of claim 18 wherein said tensioning screw further comprises a smooth portion adjacent said threaded shank.

5 25. The wedging device of claim 18 wherein said tensioning screw is affixed to said insert member.

10 26. The wedging device of claim 25 wherein said tensioning screw has a head portion rotatably mounted adjacent to at least one of said abutment portions.

15 27. The wedging device of claim 18 wherein said insert member further comprises (i) a main portion which in use extends through the aligned apertures of the first and second components and (ii) an upper arm having an engagement portion engageable with a portion of one of the first and second components whereby on initial assembly, with the apertures of the first and second
20 components aligned vertically, said insert member is supported by said arm.

25 28. The wedging device of claim 27 wherein said engagement portion extends downwardly for engaging a corresponding recess in said second component whereby said insert member is retained from falling through the apertures of the first and second components.

30 29. The wedging device of claim 27 wherein said insert member is generally C-shaped with said upper arm and a lower arm extending from said main portion to provide the C-shaped structure.

35 30. The wedging device of claim 18 wherein said wedging member has a pair of spaced rear walls defining a cavity in communication with an end of said wedging member for receiving a projection on said insert

member, said projection having a recess for receiving said tensioning screw.

5 31. The wedging device of claim 30 wherein said recess in said projection is said threaded portion for engagement with said threaded shank of said tensioning screw and said tensioning screw is rotatably mounted on said wedging member.

10 32. The wedging device of claim 30 wherein said recess in said projection is a smooth bore for rotatably mounting said tensioning screw on said insert member, and said threaded portion for engagement with said threaded shank of said tensioning screw is
15 associated with said wedging member.

 33. The wedging device of claim 18 further comprising a cap associated with said tensioning screw.

20 34. The wedging device of claim 18 further comprising a locking mechanism associated with said tensioning screw.

25 35. The wedging device of claim 18 wherein a pin provides one of said abutment portions.

 36. The wedging device of claim 18 wherein the first component is a lip of an excavator bucket.

30 37. The wedging device of claim 18 wherein the first component is the nose portion of a bucket of an excavating device.

35 38. A wedging device for securing together first and second components having respective apertures which align such that the wedging device can be inserted through the apertures and expanded in a wedging action to

secure the components together, the wedging device comprising:

- (a) an insert member;
- (b) a wedging member;
- 5 (c) said insert member and said wedging member having respective abutment surfaces shaped such that relative movement in a first direction between said insert member and said wedging member causes the overall
10 width of said members to expand for wedging engagement in the aligned apertures in the first and second components; and
- 15 (d) said insert member comprising an upper arm having an engagement portion engageable with one of said first and second components whereby on initial assembly, with the apertures of the first and second components aligned vertically, the insert
20 member remains in a supported position.

39. The wedging device of claim 38 wherein said engagement portion extends downwardly.

25 40. The wedging device of claim 38 wherein said engagement portion is hook-shaped.

41. The wedging device of claim 40 further comprising a tensioning screw interconnecting said insert
30 member and said wedging member.

42. The wedging device of claim 41 wherein said tensioning screw is rotatably mounted to one of said wedging device and said insert member.

43. The wedging device of claim 41 wherein said engagement portion extends downwardly for engaging a corresponding recess in said second component.

5 44. The wedging device of claim 43 wherein said insert member is generally C-shaped with said upper arm and a lower arm extending from a main portion to provide the C-shaped structure.

10 45. A wedging device for securing together first and second components having respective apertures which align such that the wedging device can be inserted through the apertures and expanded in a wedging action to secure the components together, said wedging device
15 comprising:

- (a) an insert member;
- (b) a wedging member;
- (c) said insert member and said wedging member having respective abutment surfaces shaped
20 such that relative movement in a first direction between said insert member and said wedging member causes the overall width of said members to expand for wedging engagement in the aligned
25 apertures in the first and second components;
- (d) said insert member and said wedging member being adapted to be interconnected by and driven into wedging engagement by a
30 tensioning screw having a threaded shank; and
- (e) a cap covering an end portion of said tensioning screw, said end portion adapted to engage a torque-applying tool.

35

46. The wedging device of claim 45 wherein said cap is elastomeric.

45

47. The wedging device of claim 45 wherein said tensioning screw is affixed to one of said insert member and said wedging member.

5 48. The wedging device of claim 45 wherein said cap covers an exposed portion of said threaded shank.

10 49. A wedging device for attachment to excavating equipment, comprising:
 (a) a member defining a threaded bore;
 (b) an elongate tensioning screw having a threaded shank and an end portion adapted to receive a torque-applying tool,
15 rotation of said tensioning screw causing wedging engagement by said member;
 (c) a portion of said threaded shank being received within said bore and said end portion of said screw projecting away from
20 said bore; and
 (d) a cap substantially covering said end portion.

25 50. The wedging device of claim 49 wherein said cap covers an exposed portion of said threaded shank.

30 51. The wedging device of claim 49 wherein said member further defines an access recess and said end portion is received within said access recess, so that said cap prevents accumulation of soil around said end portion within said access recess.

35 52. The wedging device of claim 49 wherein said end portion has a hexagonal cross-section.

53. The wedging device of claim 49 wherein said cap has an inner diameter that is less than an outer diameter of said threaded shank.

5 54. A method for removing a wedging device having an insert member and a wedging member from engagement with a first component and a second component, said first and second components having respective apertures which align such that the wedging device can be
10 inserted through the apertures and expanded in a wedging action to secure the components together, comprising the steps of:

- (a) providing a connecting member attached to said insert member;
- 15 (b) removing said wedging member from said respective apertures;
- (c) connecting a grasping member to said connecting member; and
- 20 (d) pulling said grasping member so as to pivot and lift said insert member from said respective apertures.

55. The method of claim 54 wherein said connecting member is a threaded screw.

25

56. The method of claim 54 wherein said grasping member is an elongate pipe.

57. The method of claim 56 wherein said pipe
30 further comprises an o-ring.

58. The method of claim 56 wherein said pipe further comprises an eccentric portion.

35 59. The method of claim 56 wherein said pipe further comprises internal threads.

60. The method of claim 54 wherein said insert member further comprises (i) a main portion which in use extends through the aligned apertures of the first and second components and (ii) an upper arm having an engagement portion engageable with a portion of one of the first and second components whereby on initial assembly, with the apertures of the first and second components aligned vertically, said insert member is supported by said upper arm.

61. The method of claim 60 wherein said engagement portion extends downwardly for engaging a corresponding recess in said second component.

62. The method of claim 60 wherein said insert member is generally C-shaped with said upper and a lower arm extending from said main portion to provide the C-shaped structure.

63. A wedging device for attachment to excavating equipment, comprising:

(a) a tensioning screw having a longitudinal axis and interconnecting an insert member and a wedge member, said tensioning screw having a tool-adapted end, said tool-adapted end being received within a cavity defined by at least one of said insert member and said wedge member;

(b) at least one of said insert member and said wedge member having a first engagement surface; and

(c) a cap having an internal surface defining an internal cavity for receiving said tool-adapted end of said tensioning screw, said cap having on an exterior surface a second engagement surface opposing said first engagement surface to prevent

rotation of said screw about said longitudinal axis.

5 64. The device of claim 63 wherein said first engagement surface is provided on a longitudinal rib of said insert member.

10 65. The device of claim 63 wherein said first engagement surface is provided on a longitudinal rib of said wedge member.

 66. The device of claim 63 wherein said cap has a non-circular exterior cross-section.

15 67. The device of claim 66 wherein said cap has a plurality of longitudinal ribs.

20 68. The device of claim 63 wherein said cap further includes an extension member for receiving said tool-adapted end of said tensioning screw, said extension member defining said internal cavity of said cap.

25 69. The device of claim 63 wherein said interior surface of said cap further comprises an annular ridge, and said tool-adapted end of said tensioning screw defines an annular groove for receiving said annular ridge.

30 70. The device of claim 63 wherein said exterior surface of said cap further comprises an annular ridge, and at least one of said insert member and said wedge member defines an annular groove for receiving said annular ridge.

35 71. The device of claim 63 wherein said internal cavity of said cap has a non-circular horizontal cross-section.

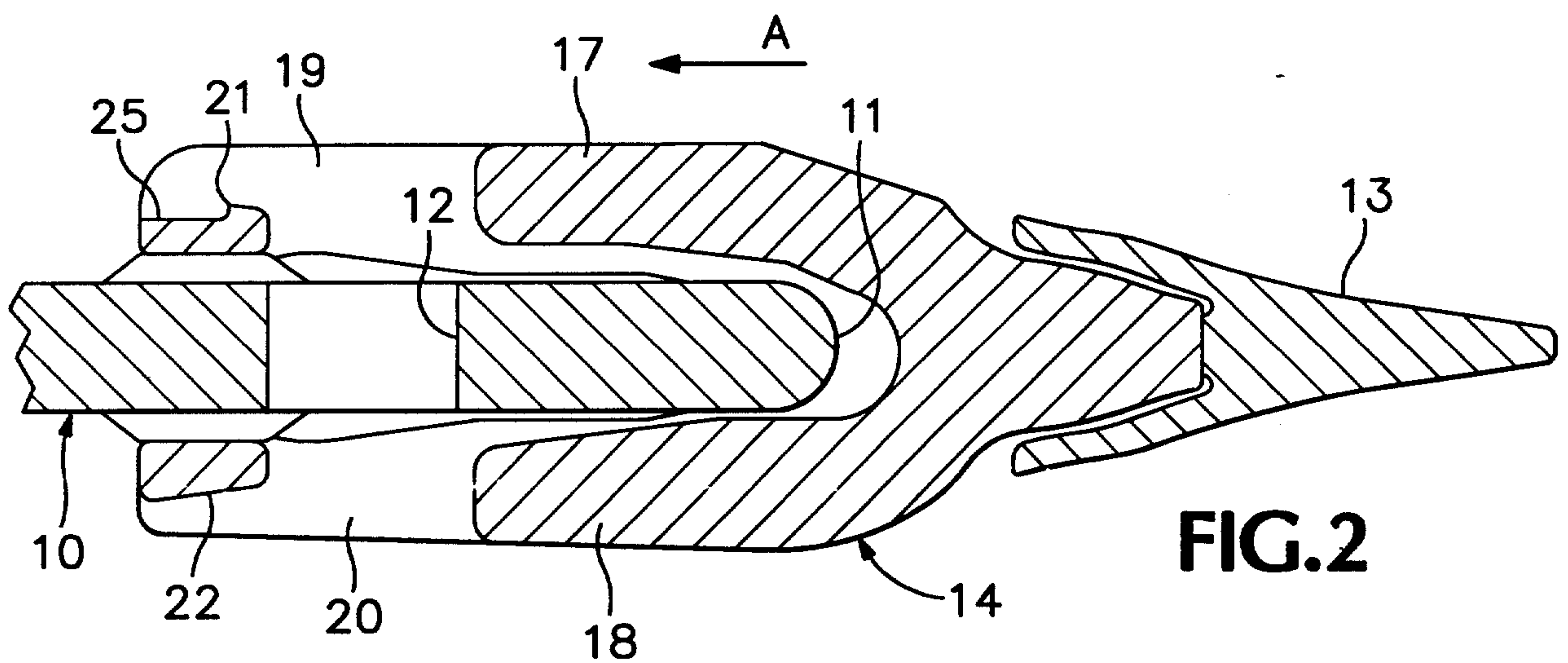
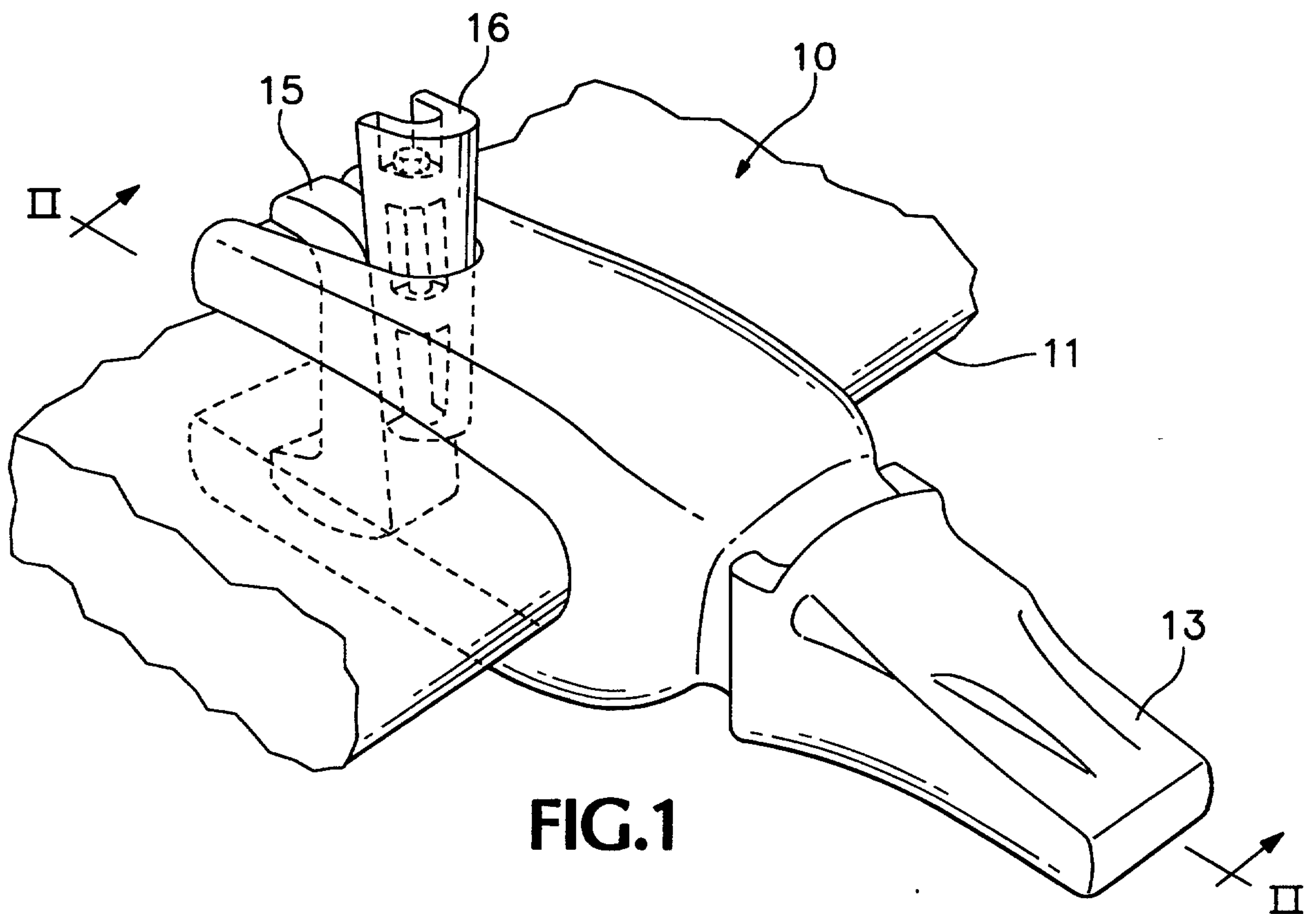
72. The device of claim 63 wherein said cross-section is hexagonal.

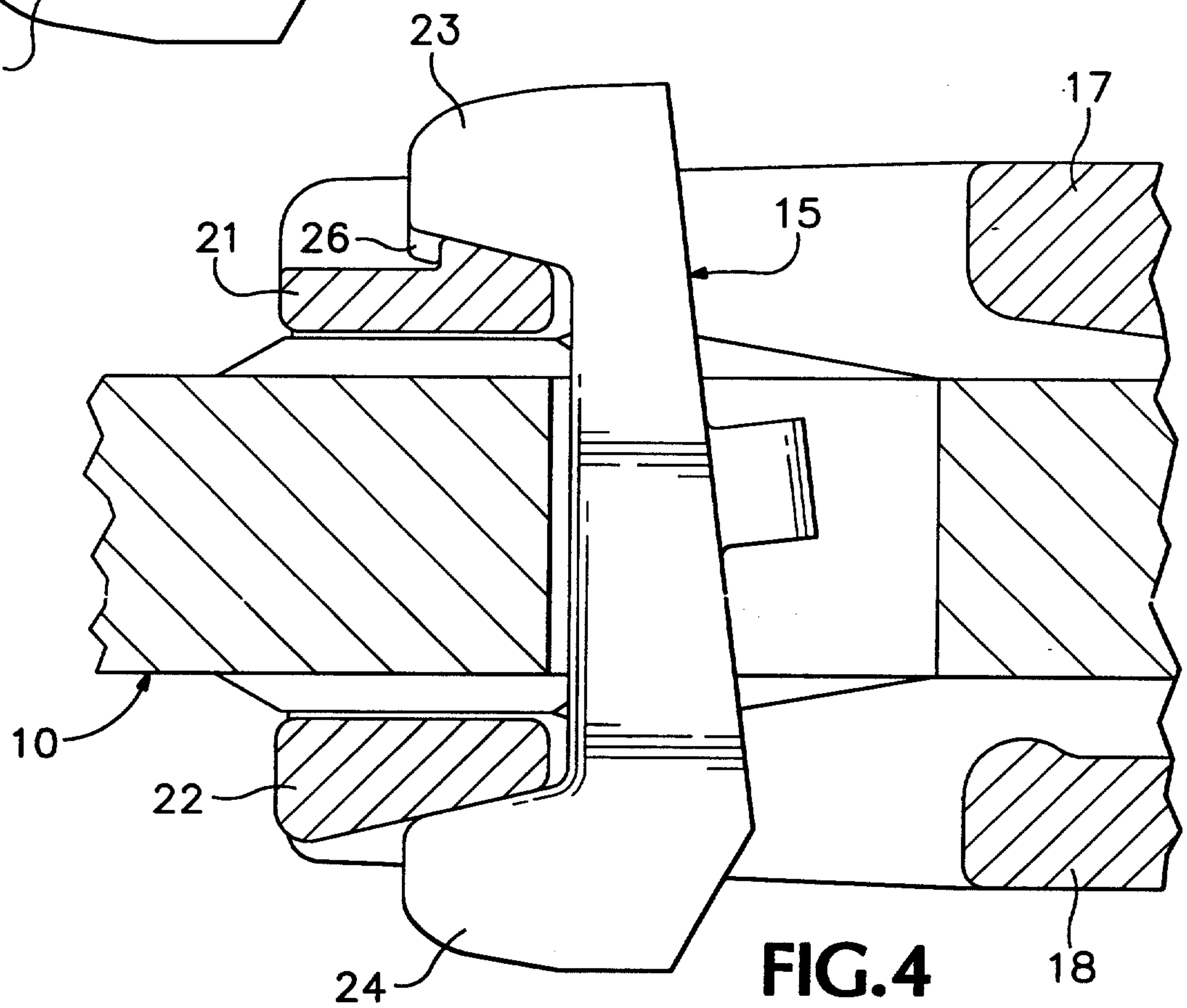
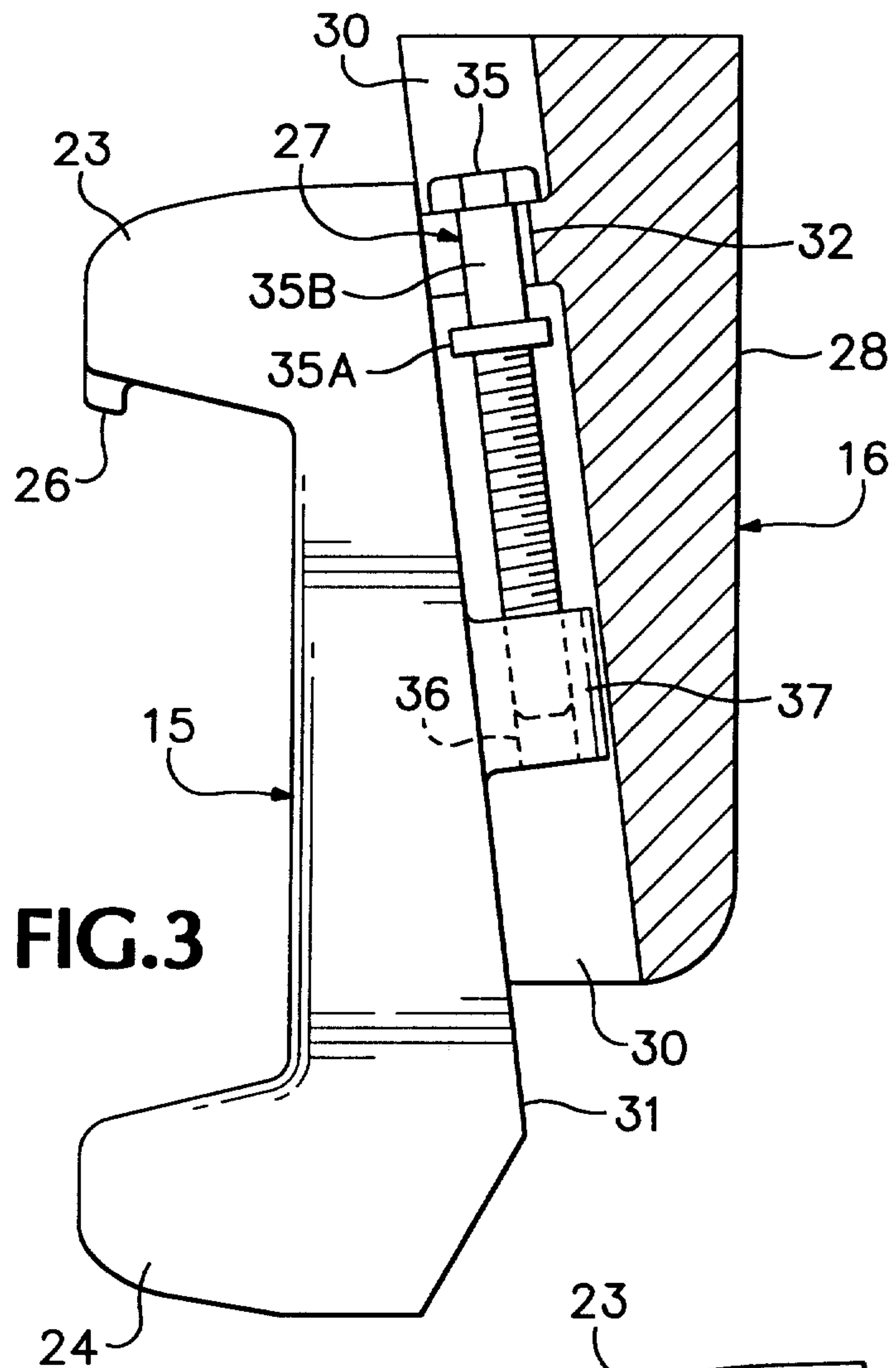
5 73. The device of claim 63 wherein said tool-adapted end of said tensioning screw has a horizontal hexagonal cross-section.

10 74. The device of claim 63 wherein said cap has a metal upper portion.

75. The device of claim 74 wherein said upper portion includes a plurality of ribs providing said engagement surfaces of said cap.

15 76. The device of claim 63 wherein said cap has an external annular groove for prying said cap out of said cavity.





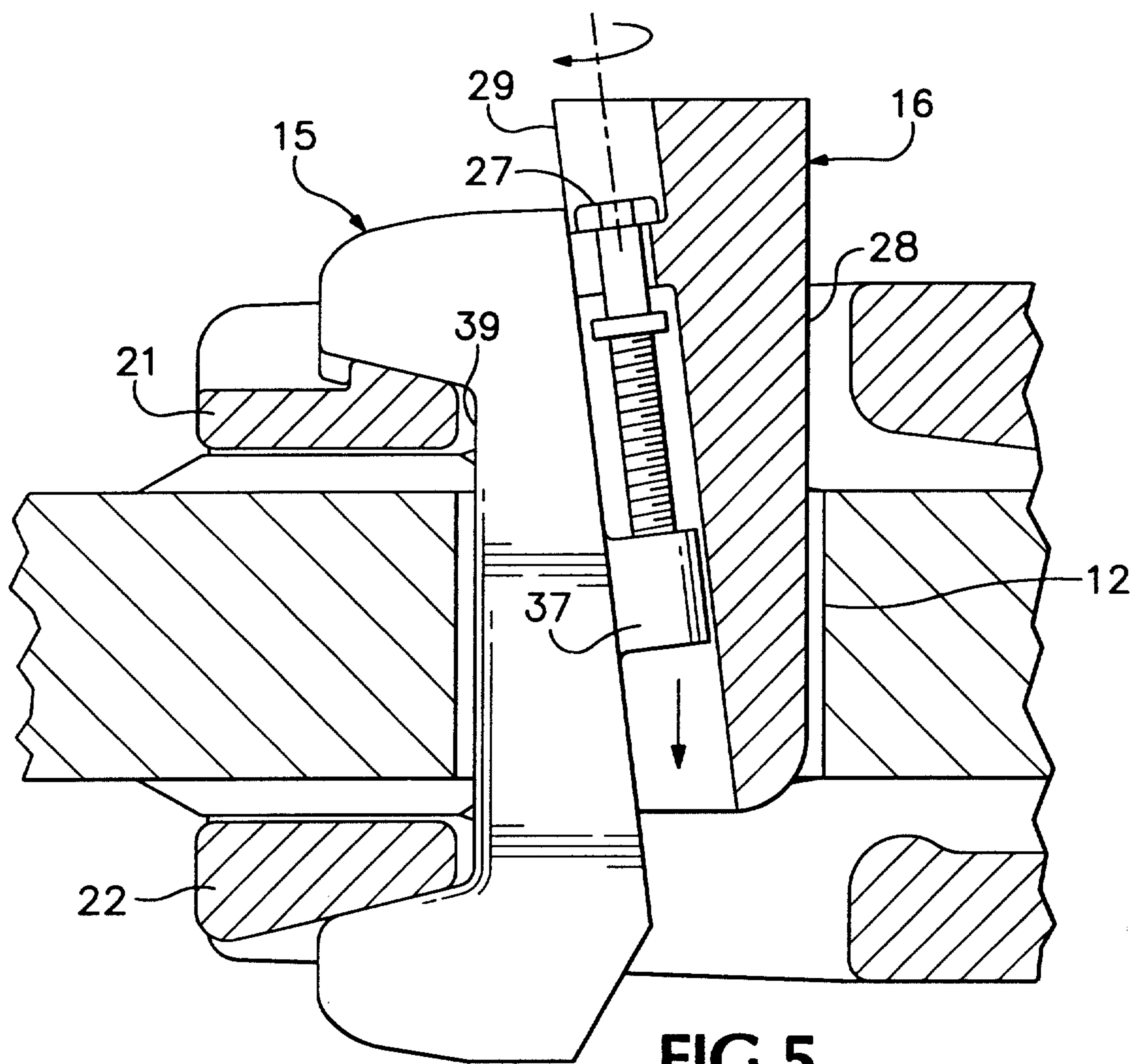


FIG. 5

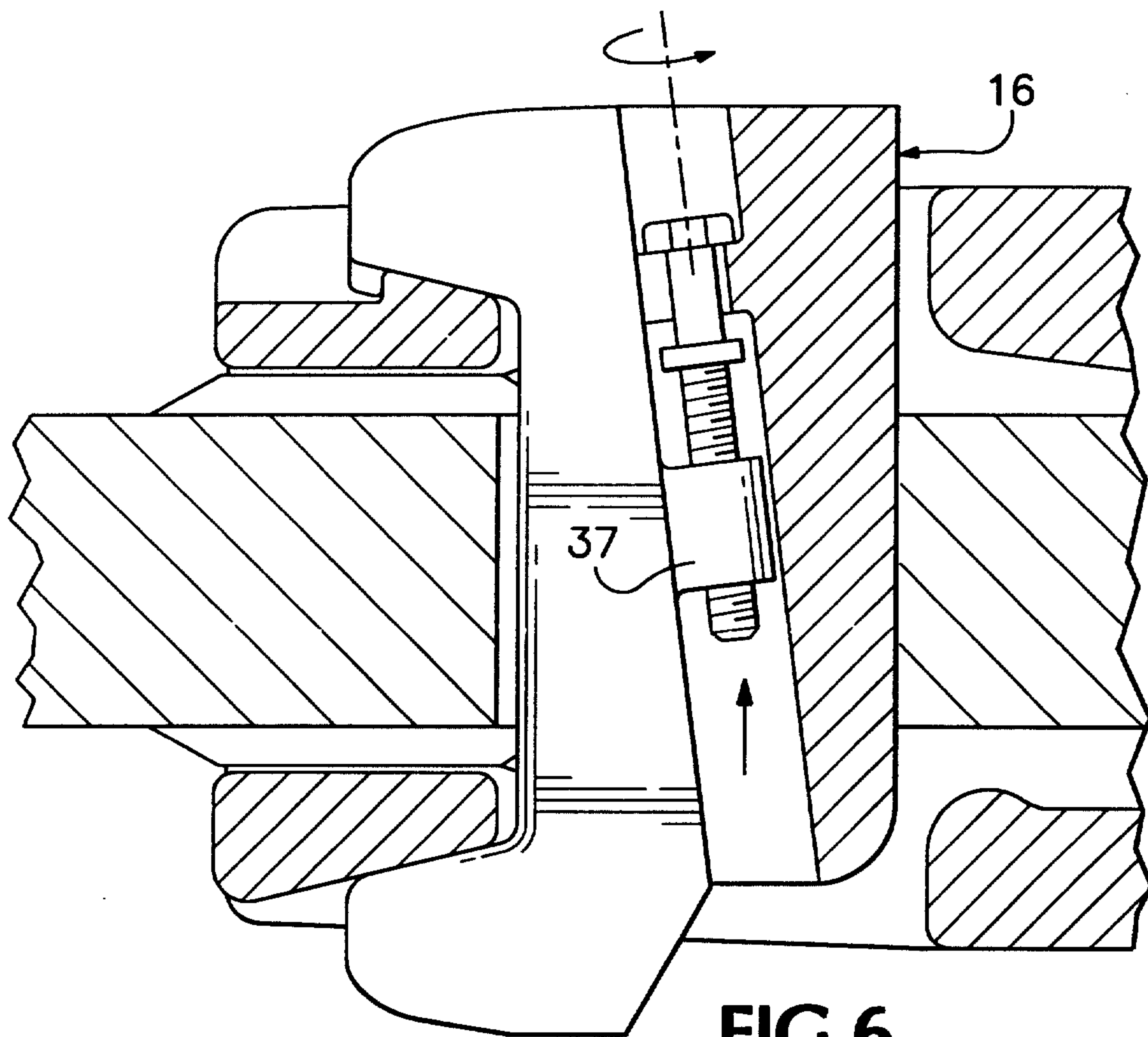


FIG. 6

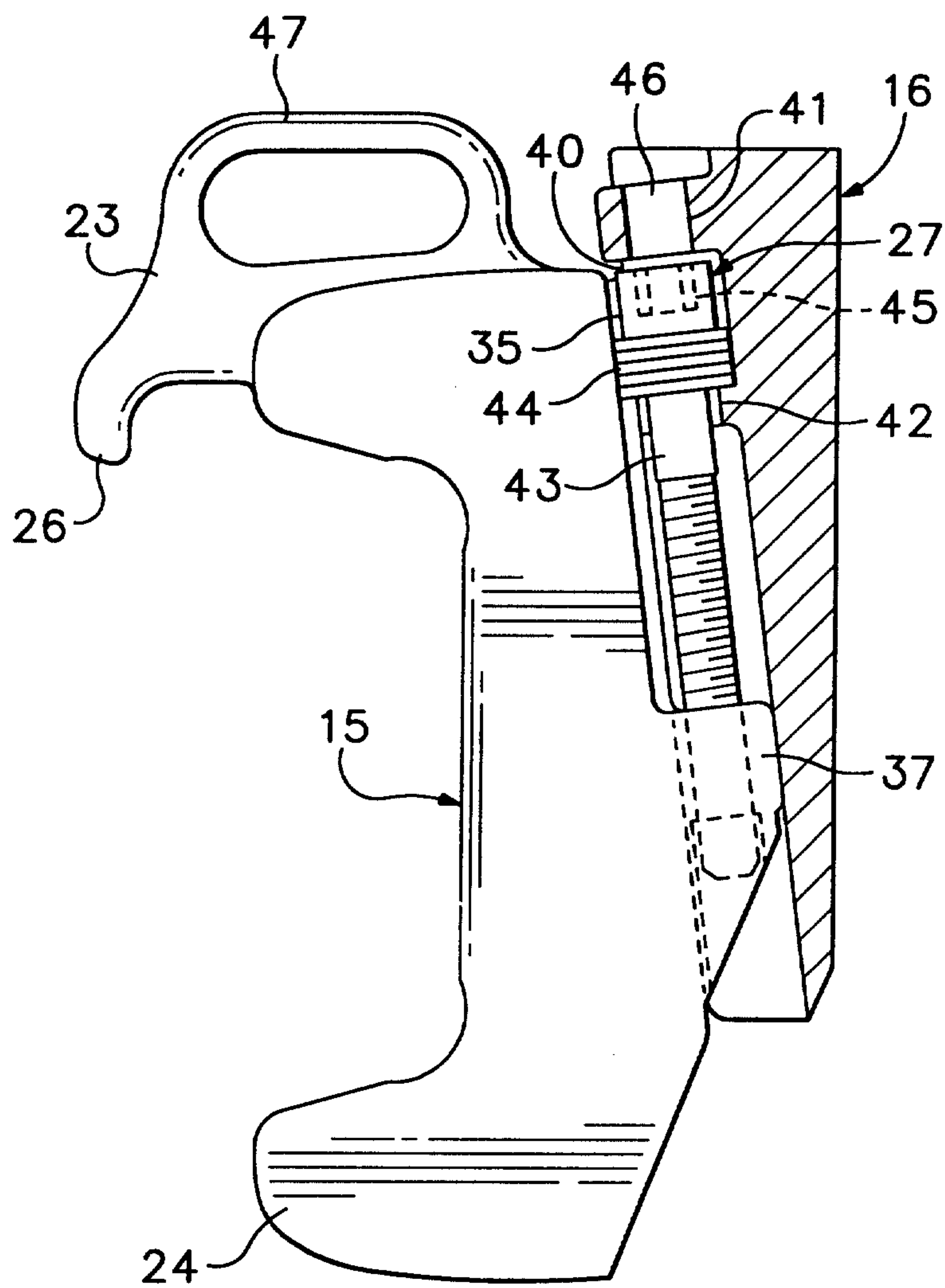


FIG. 7

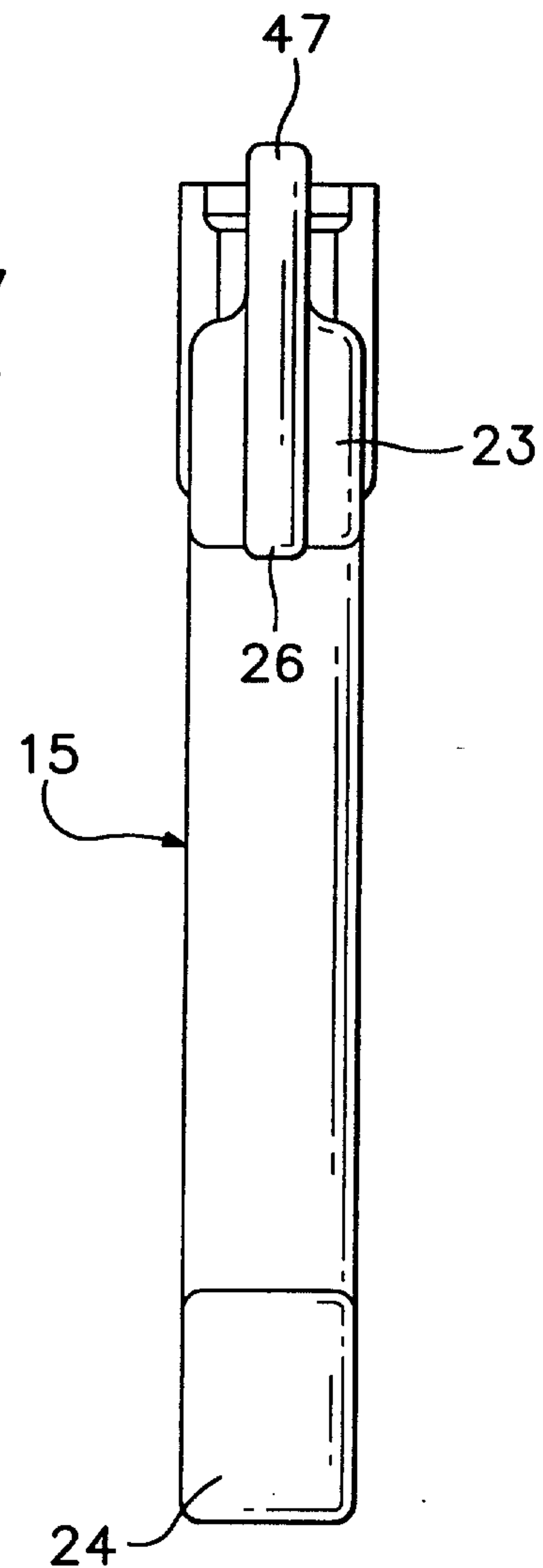


FIG. 8

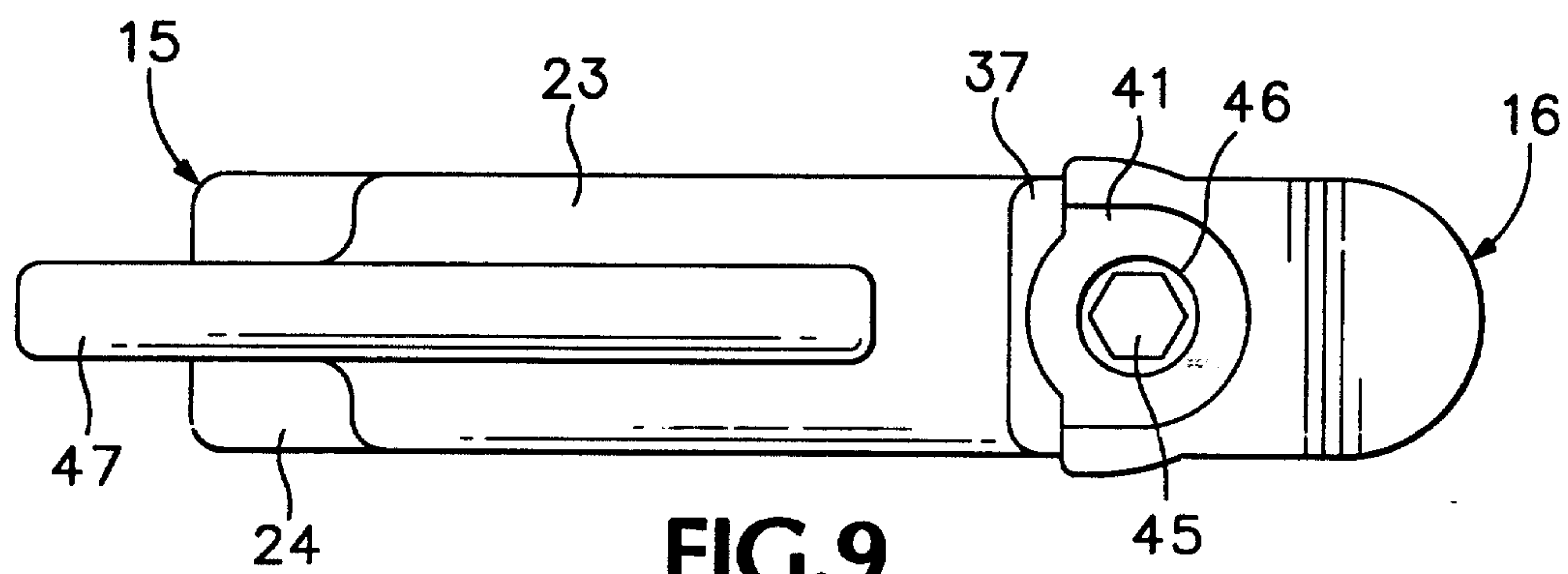


FIG. 9

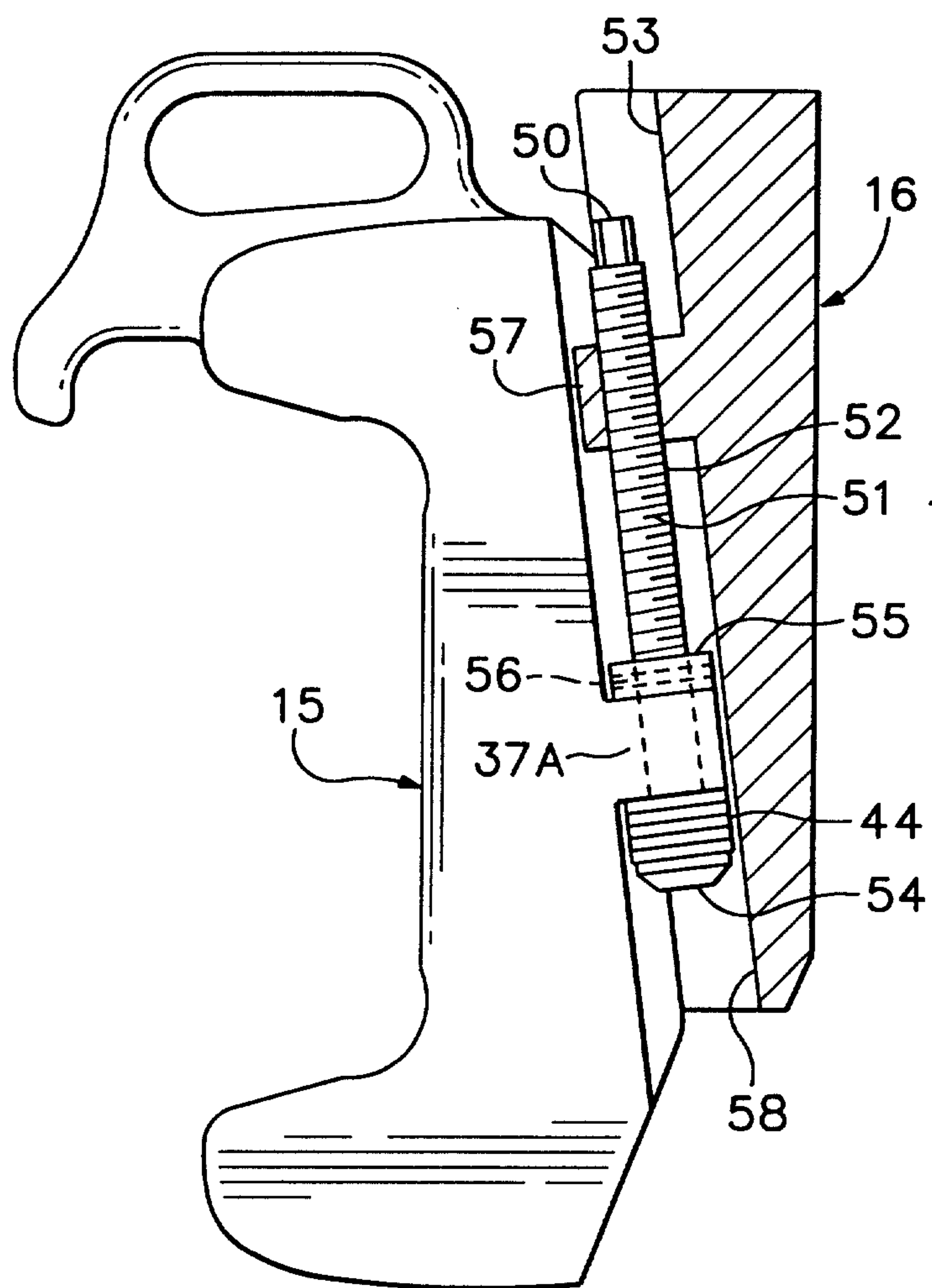


FIG.10

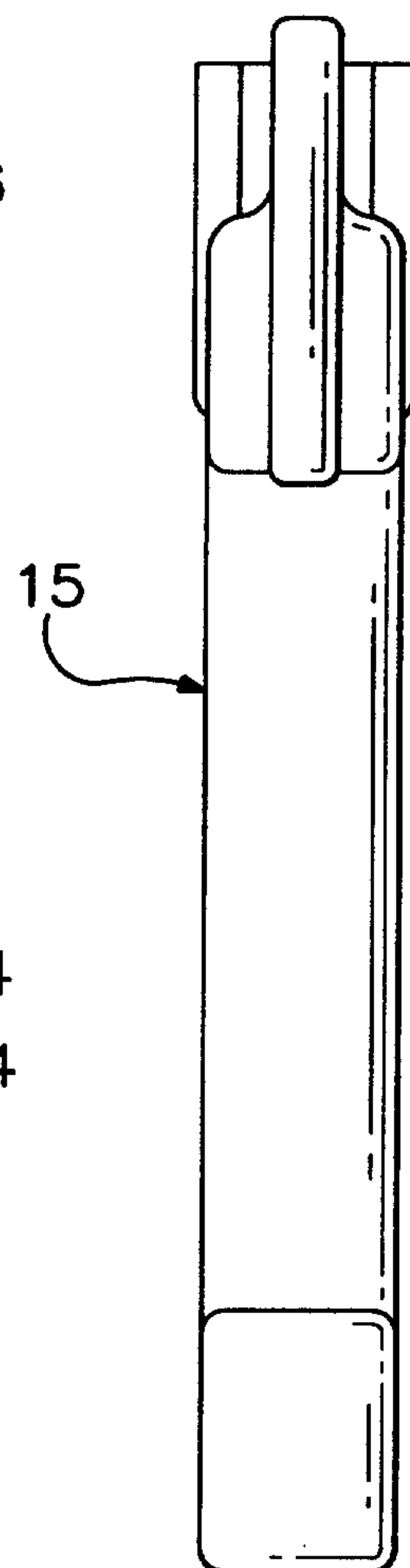


FIG.11

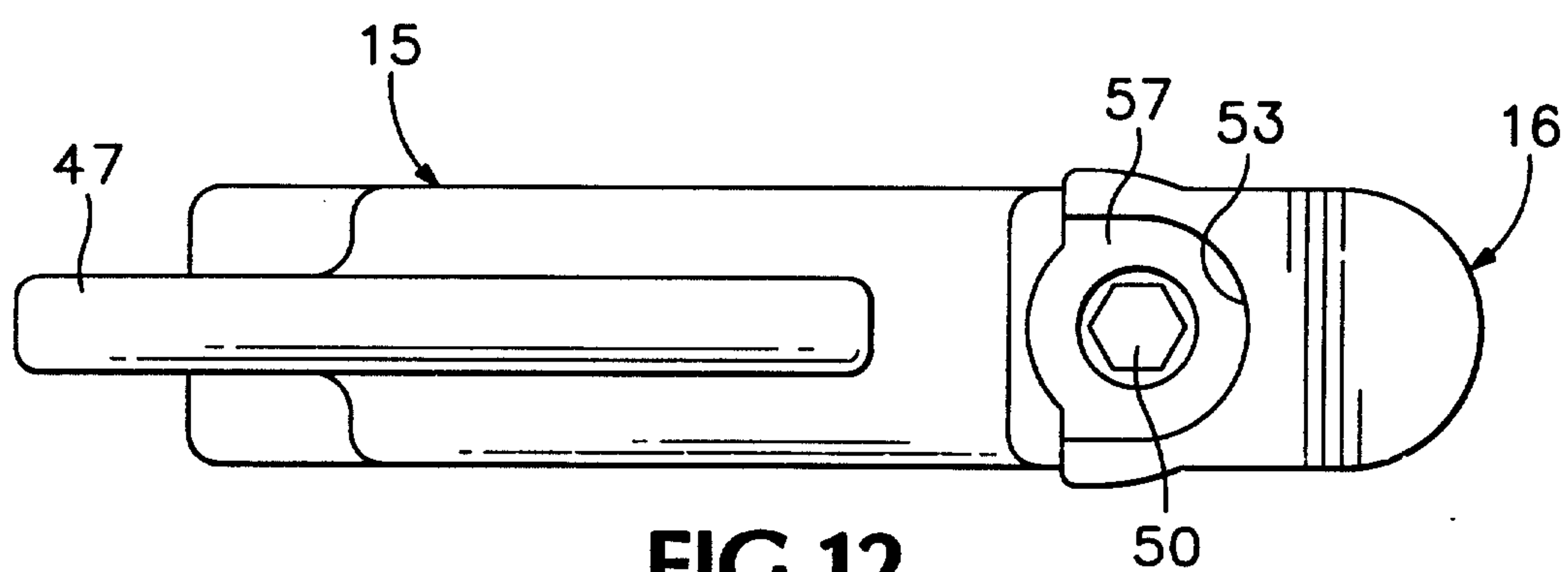
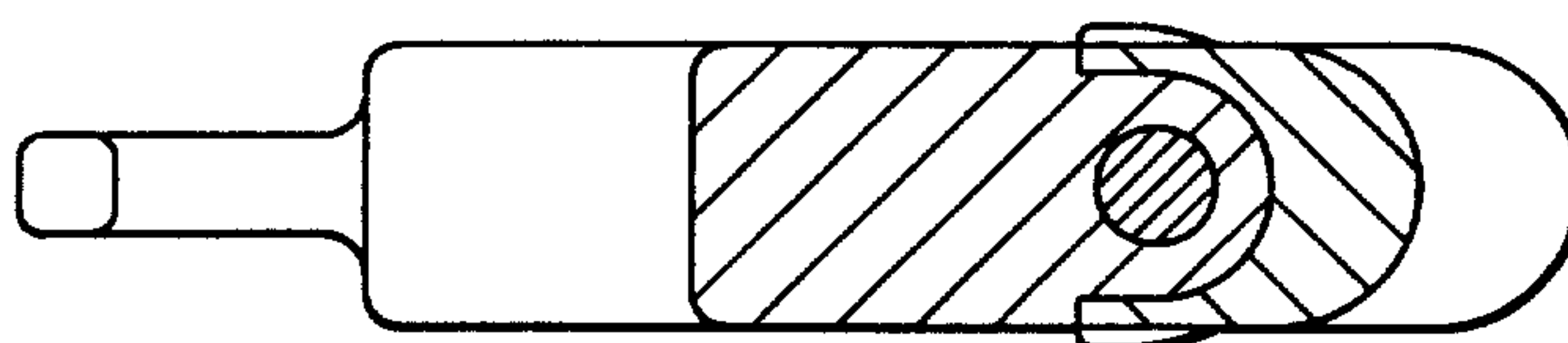
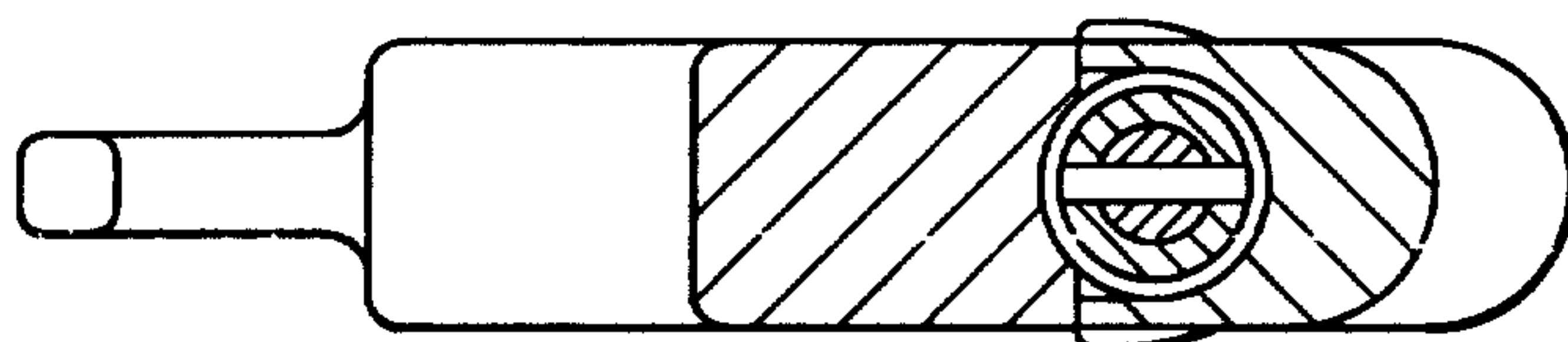
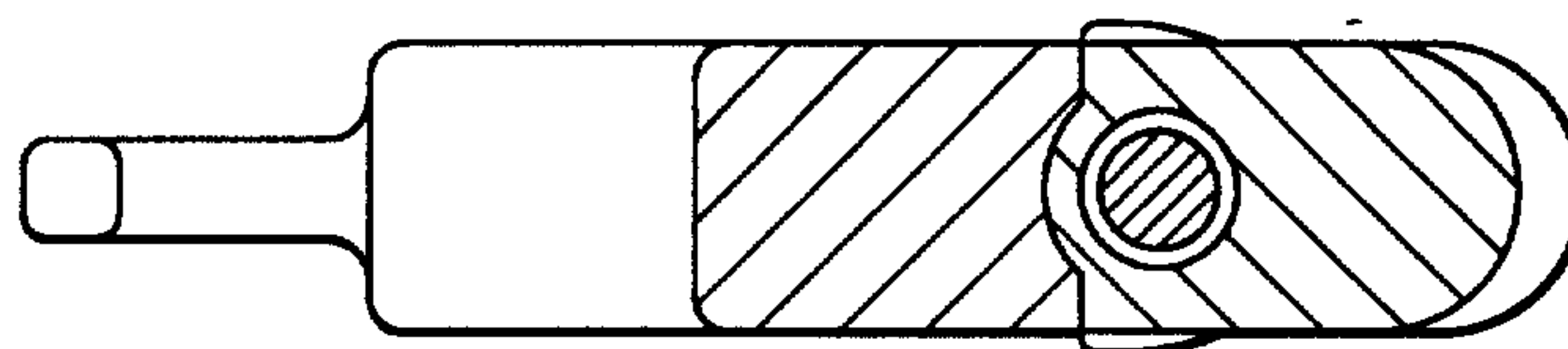
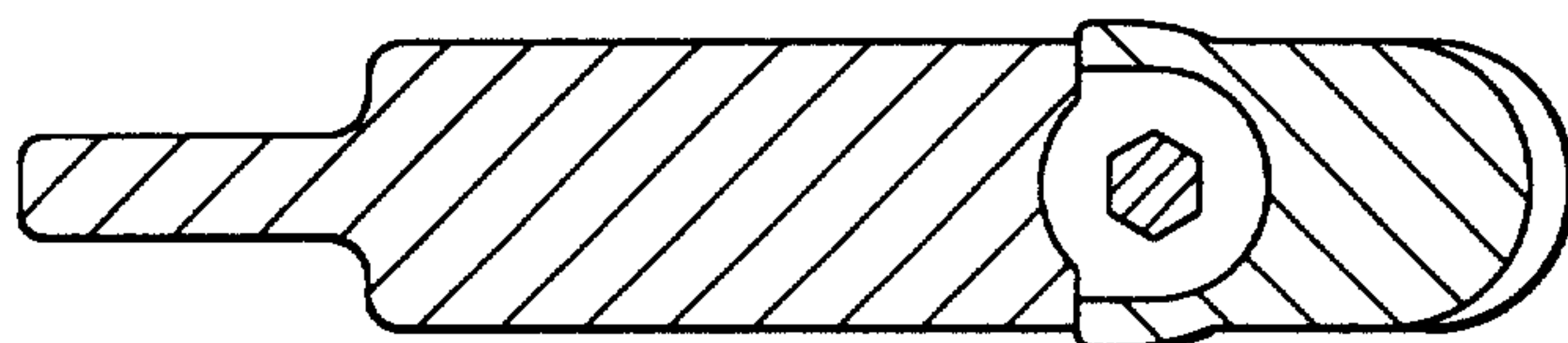
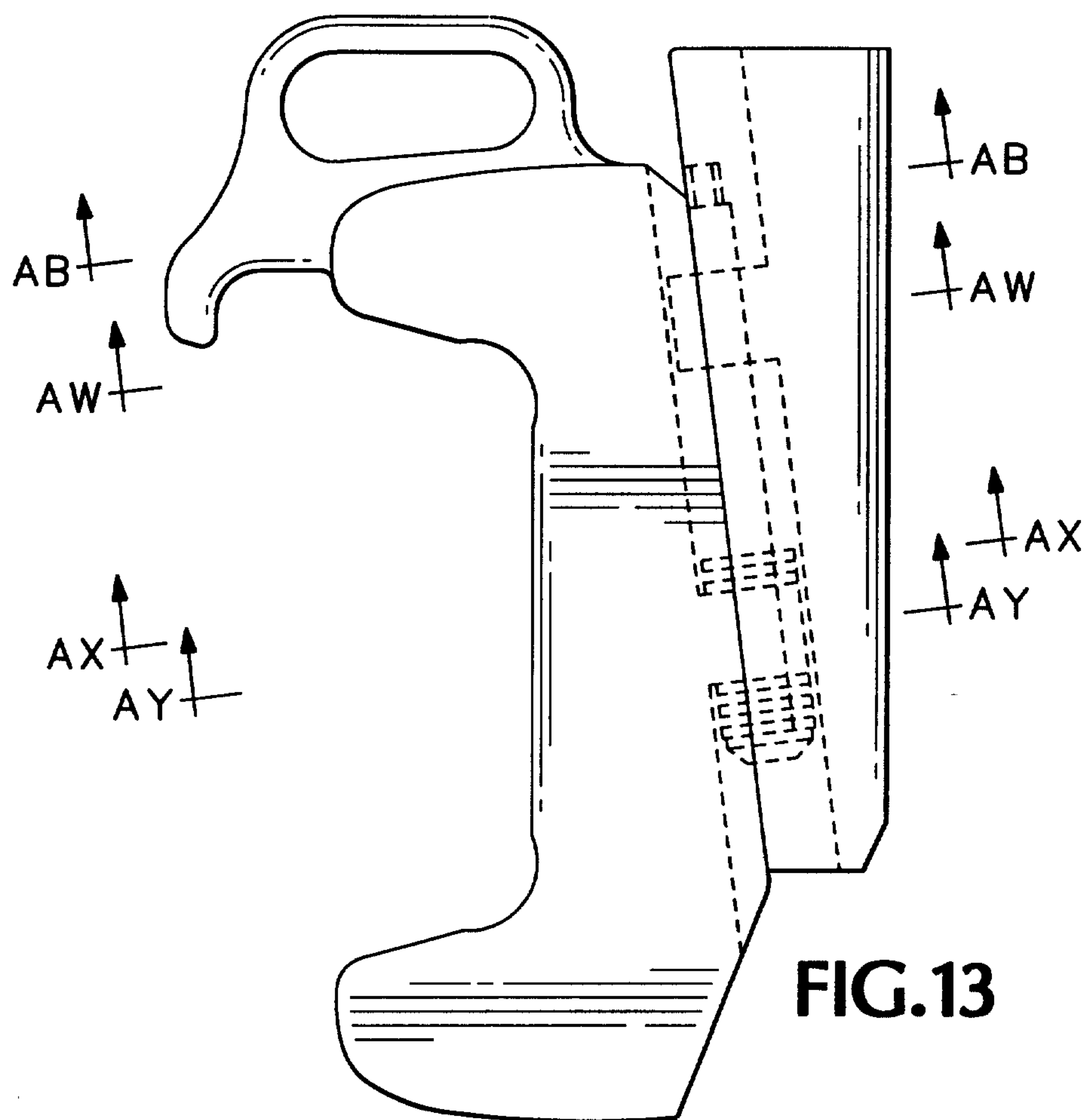
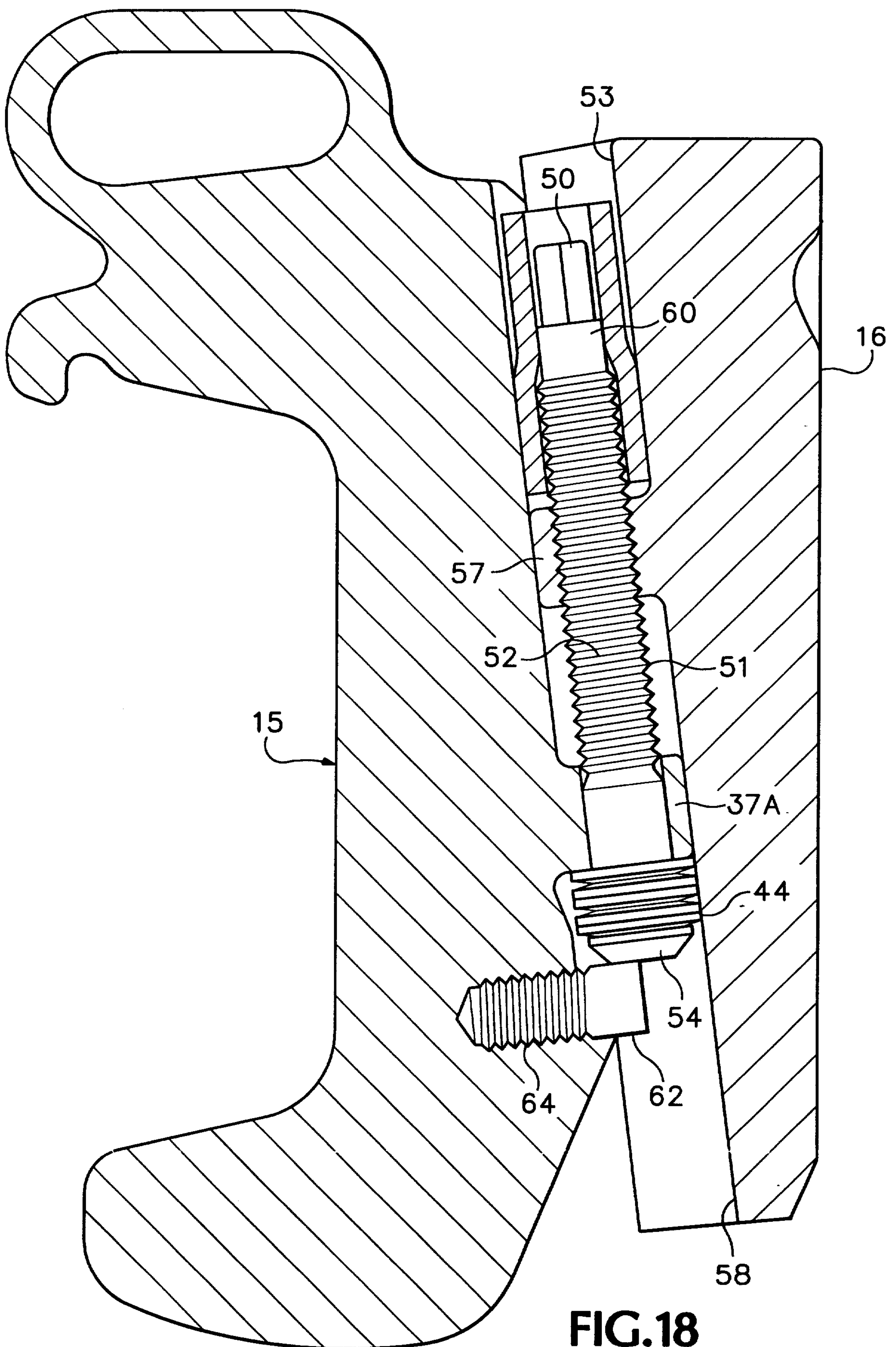


FIG.12





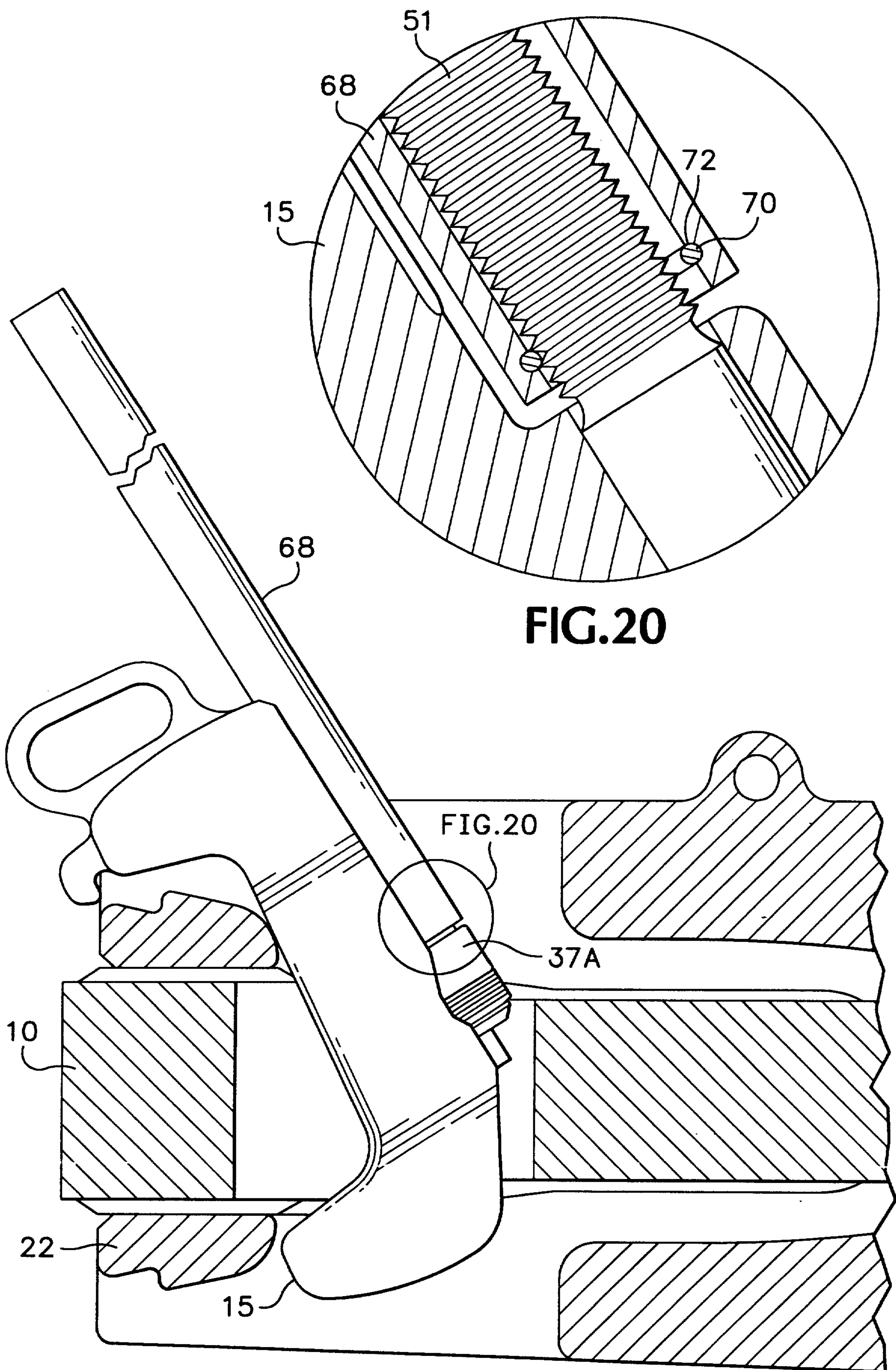
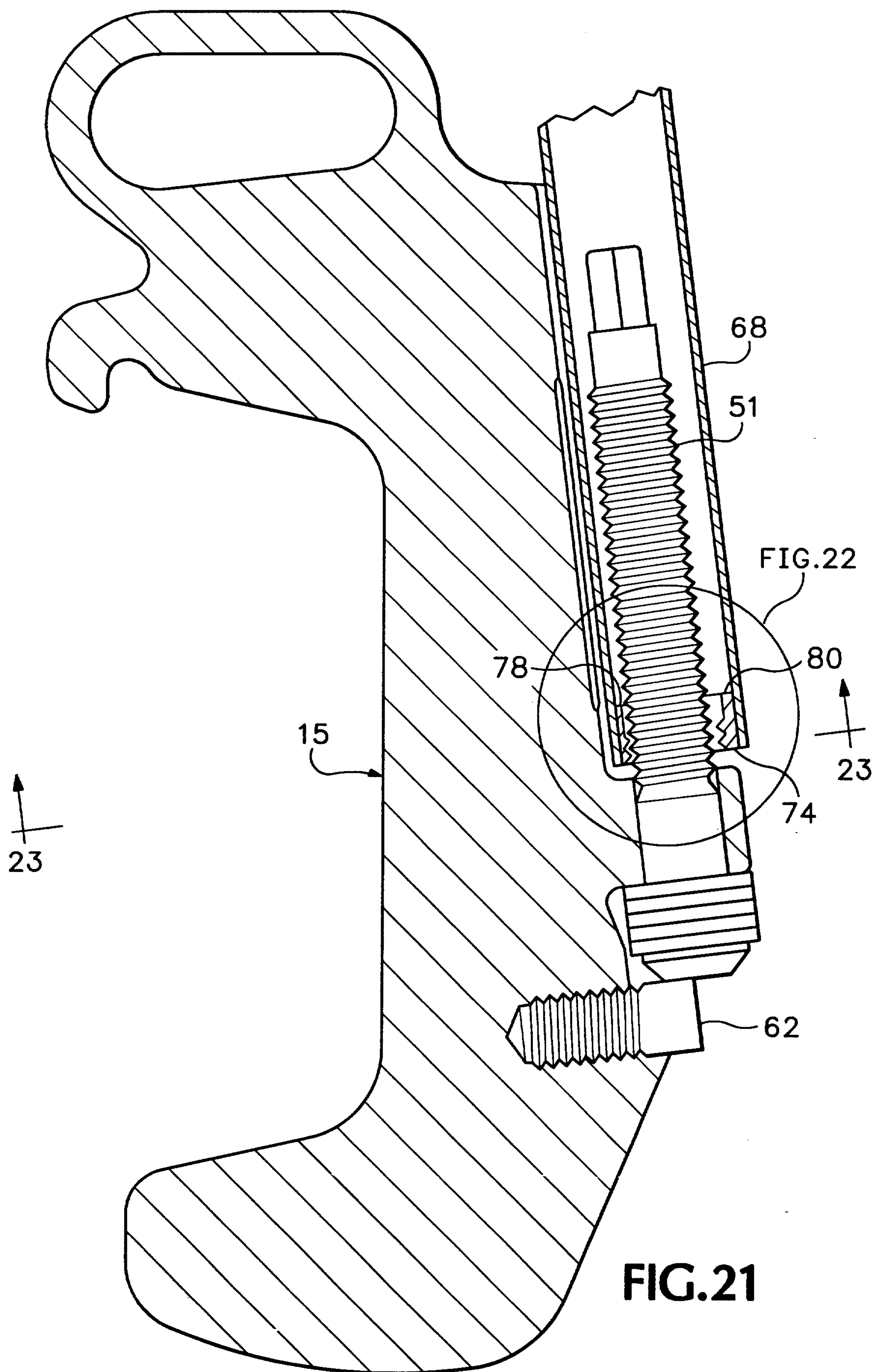


FIG.19



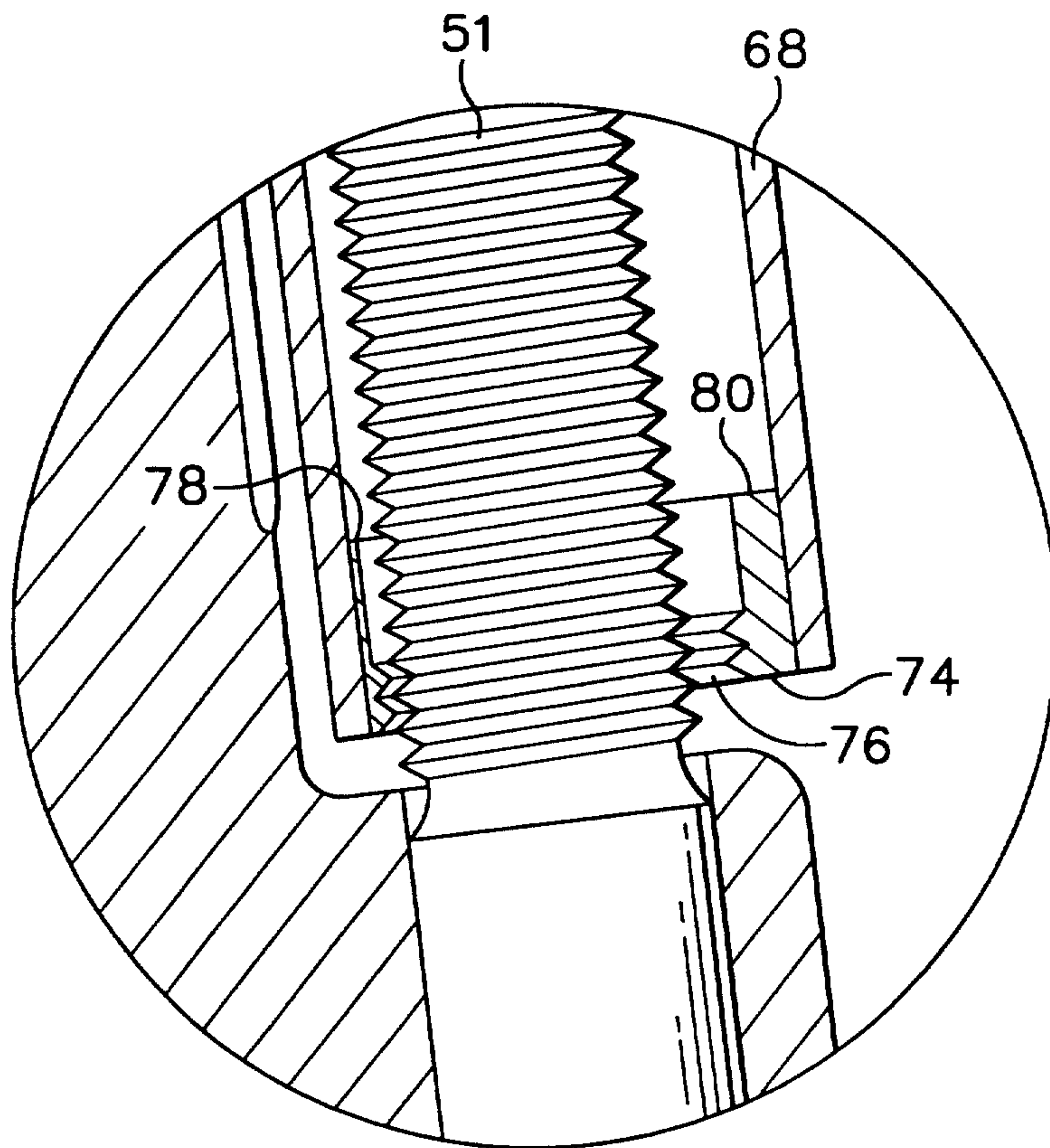


FIG.22

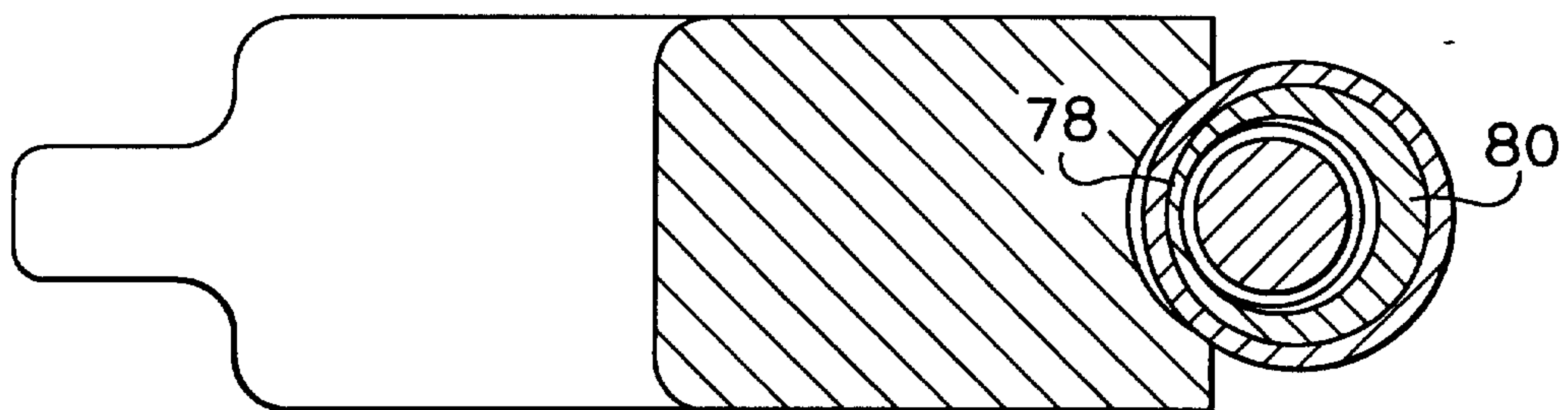


FIG.23

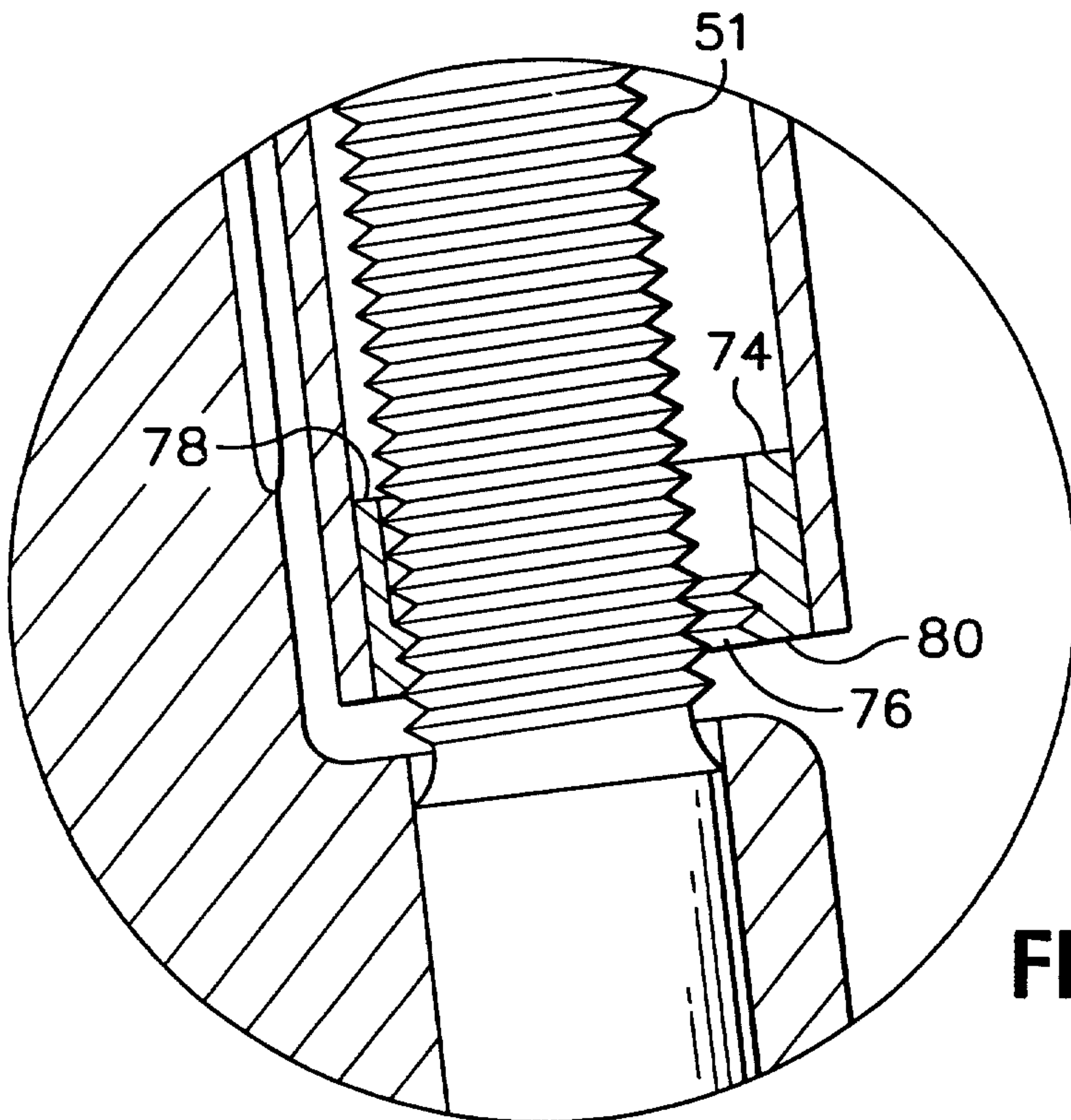


FIG. 24

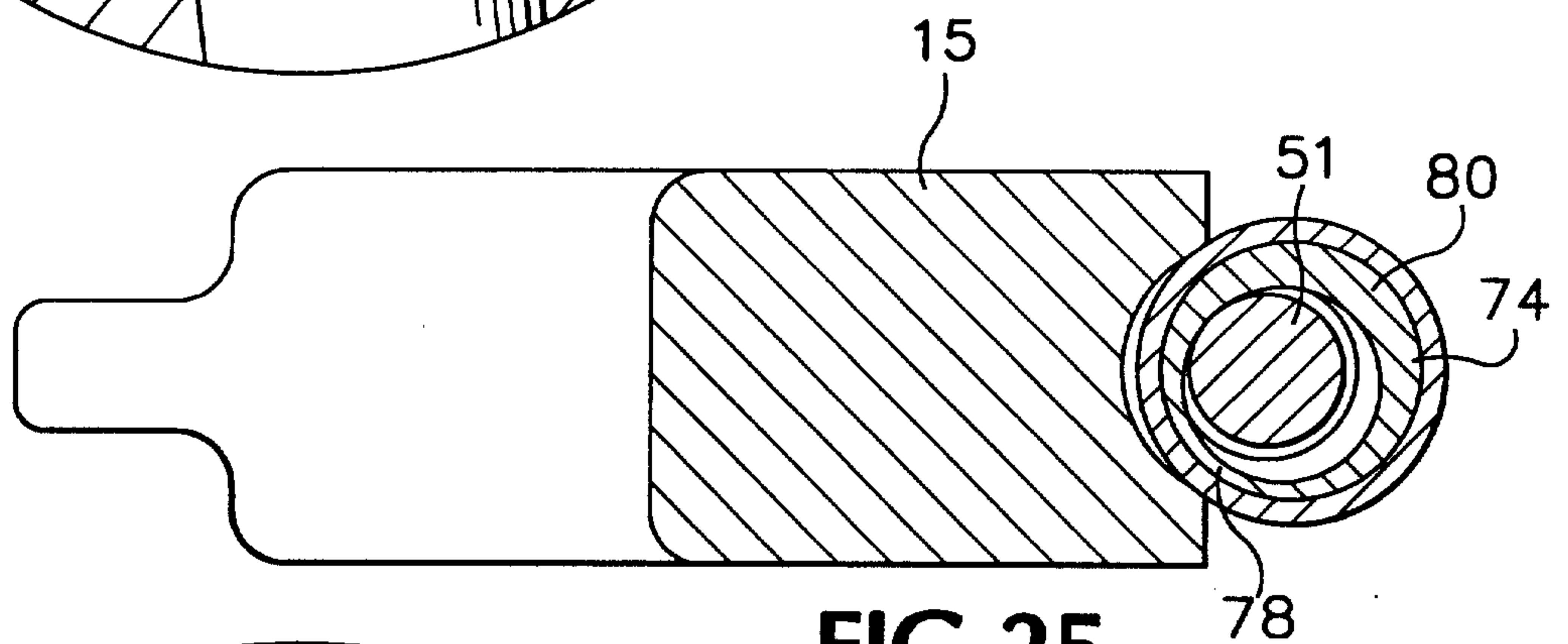


FIG. 25

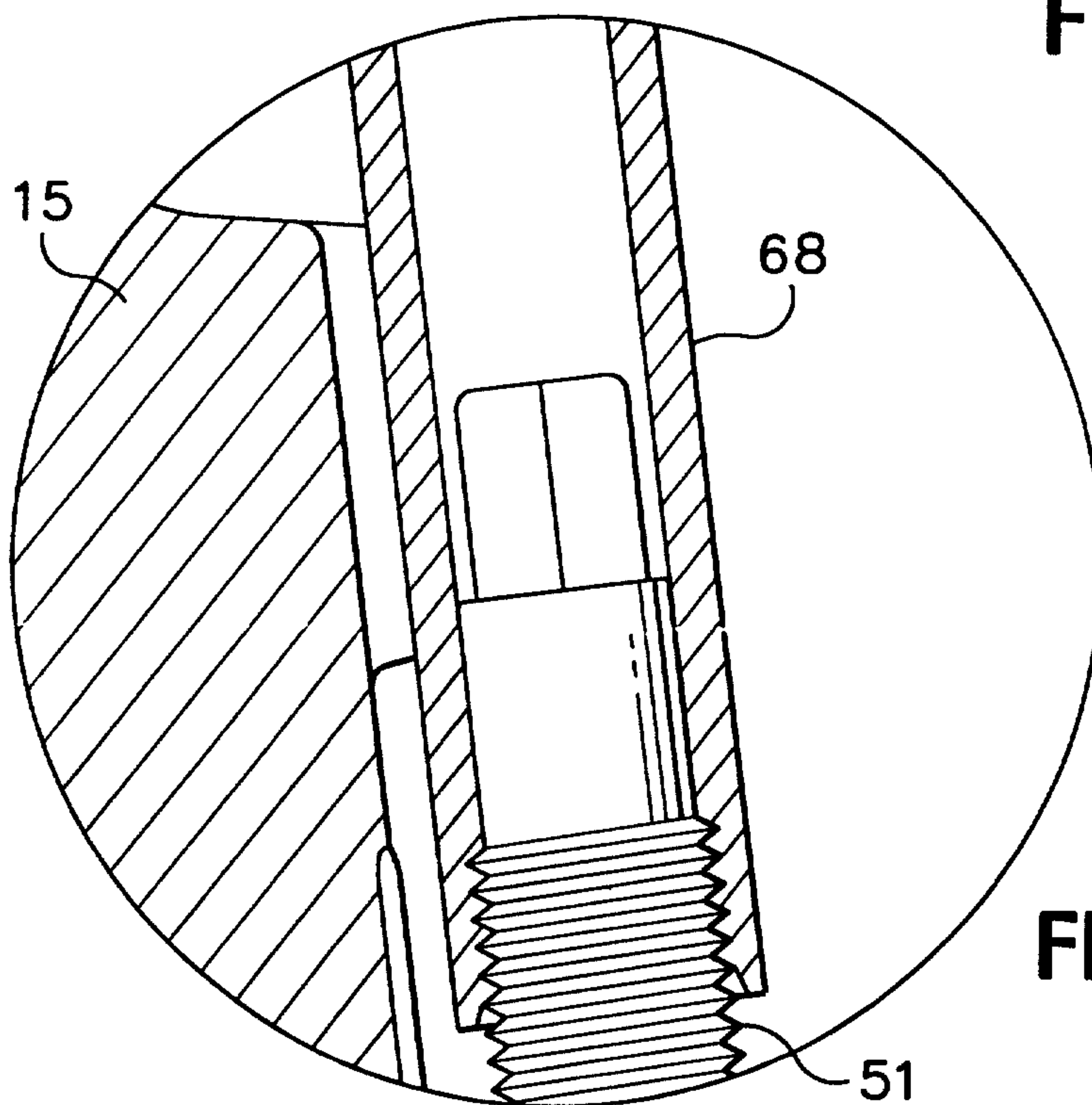


FIG. 26

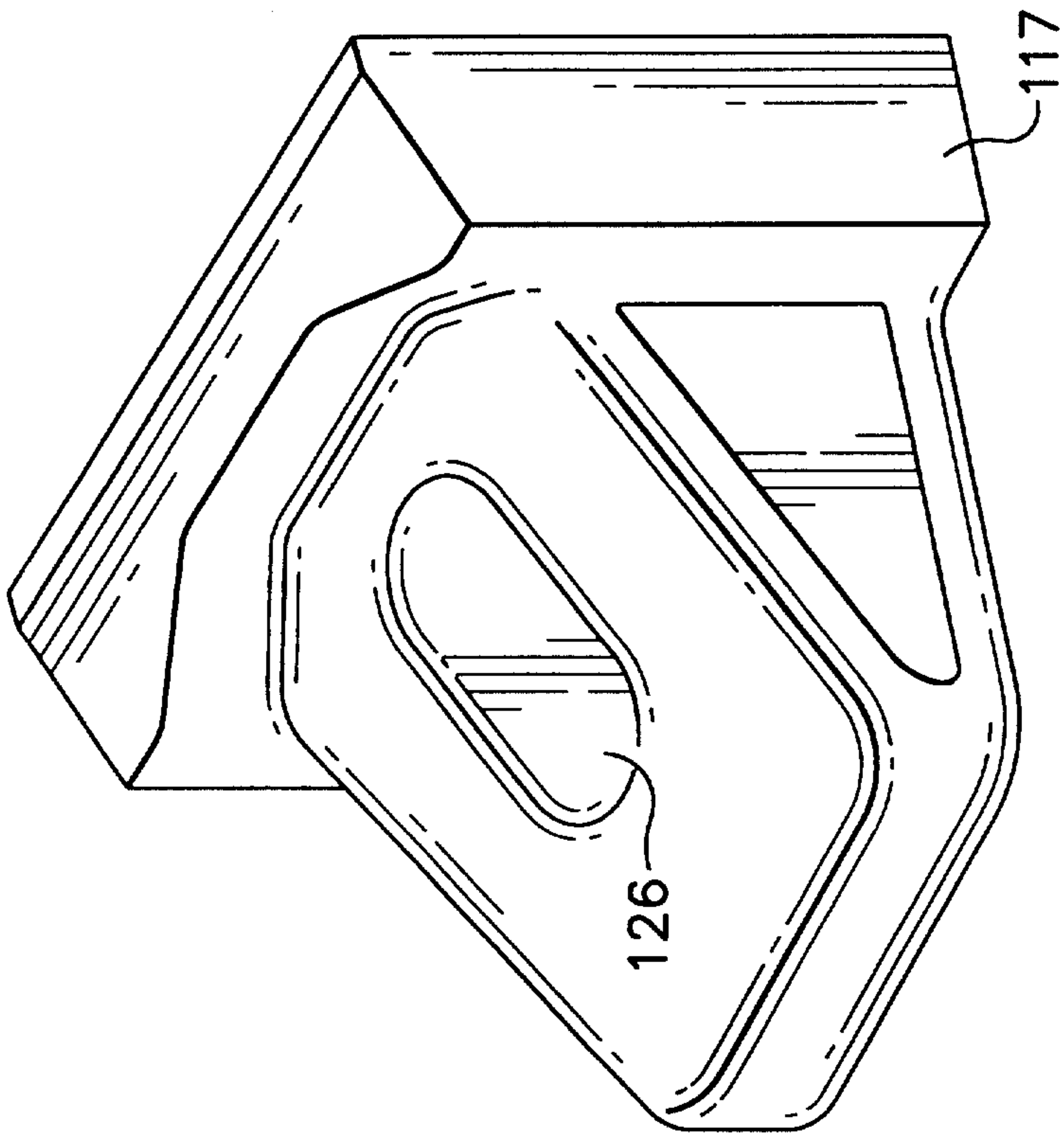
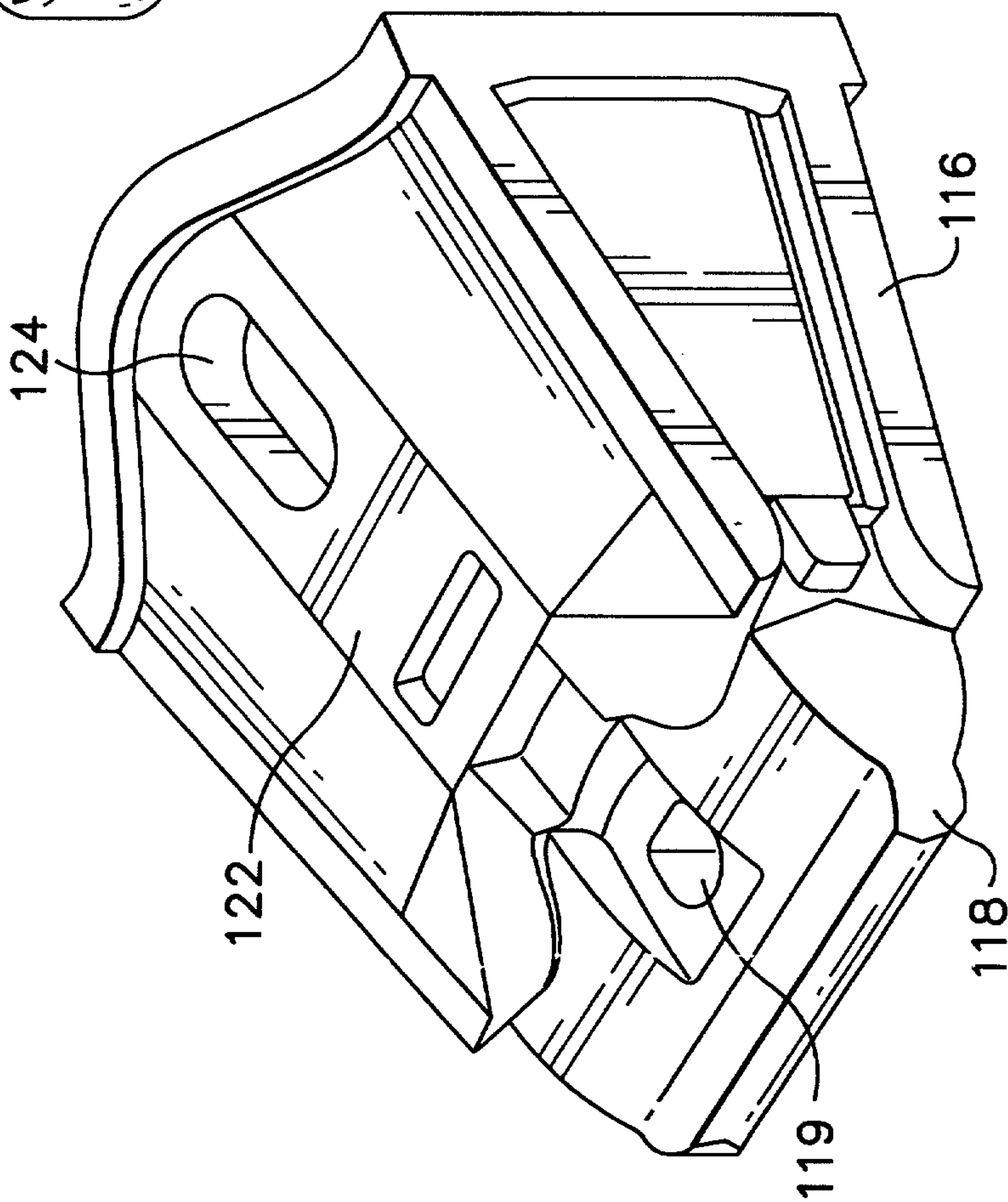


FIG. 27



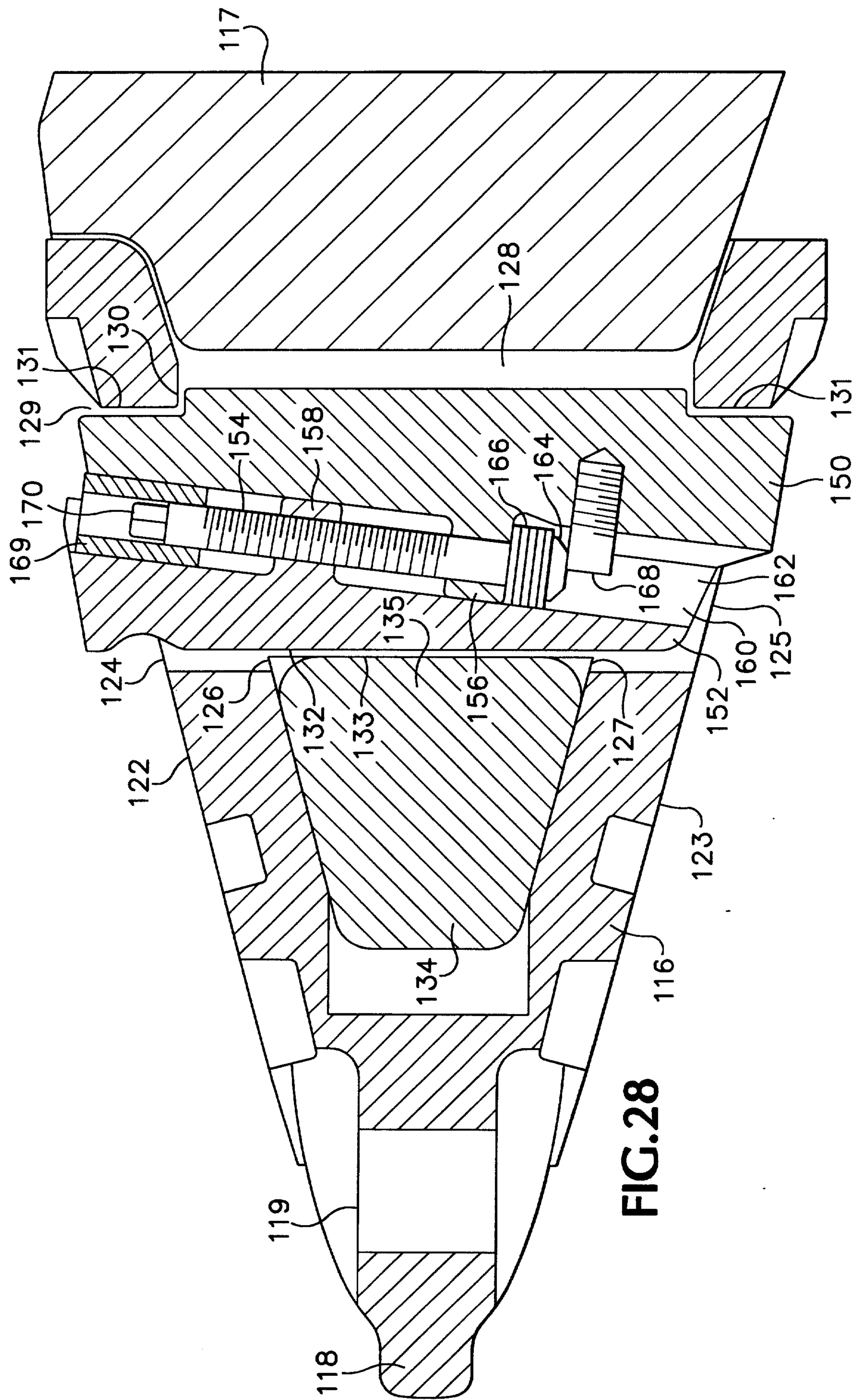
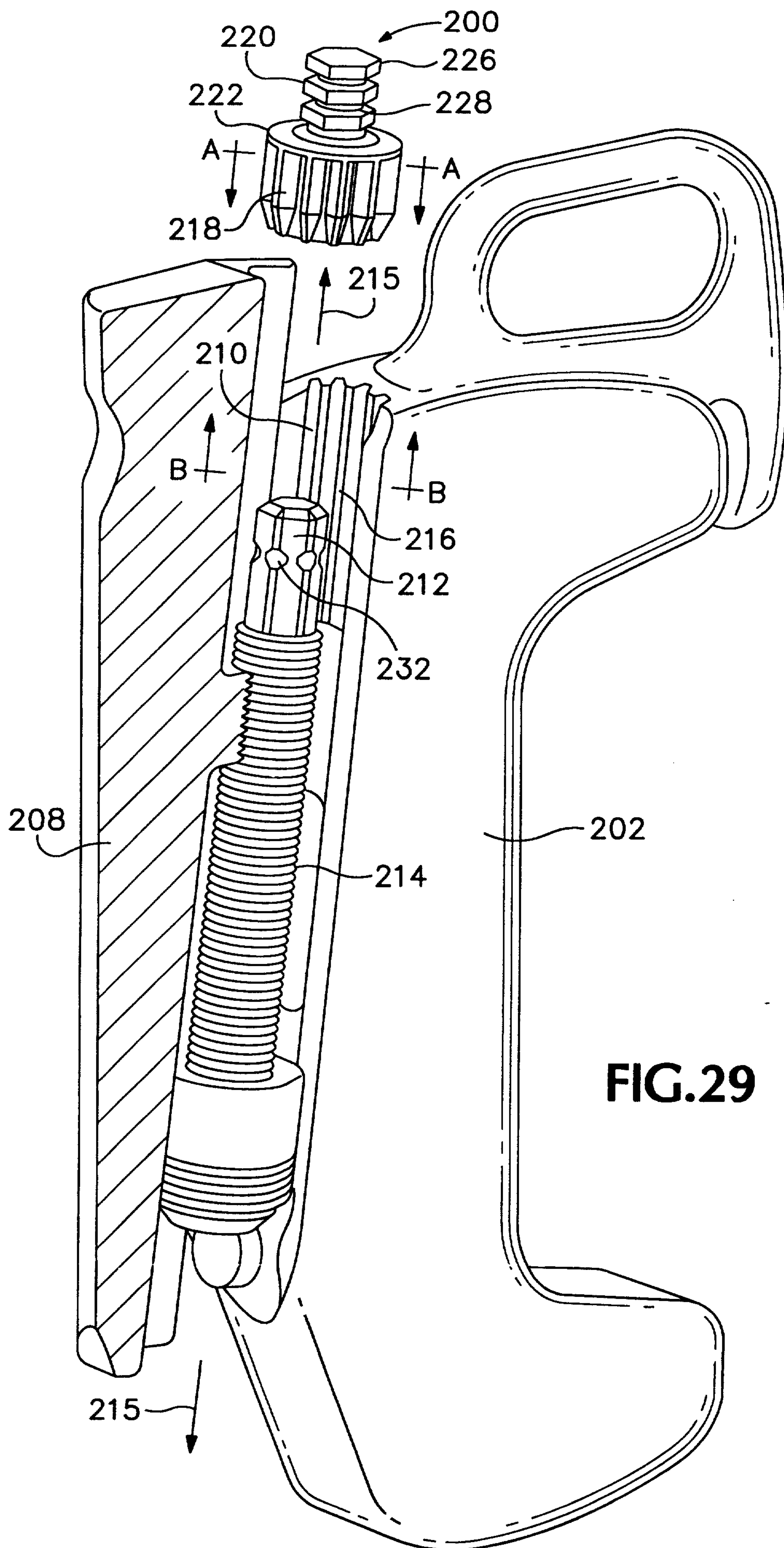
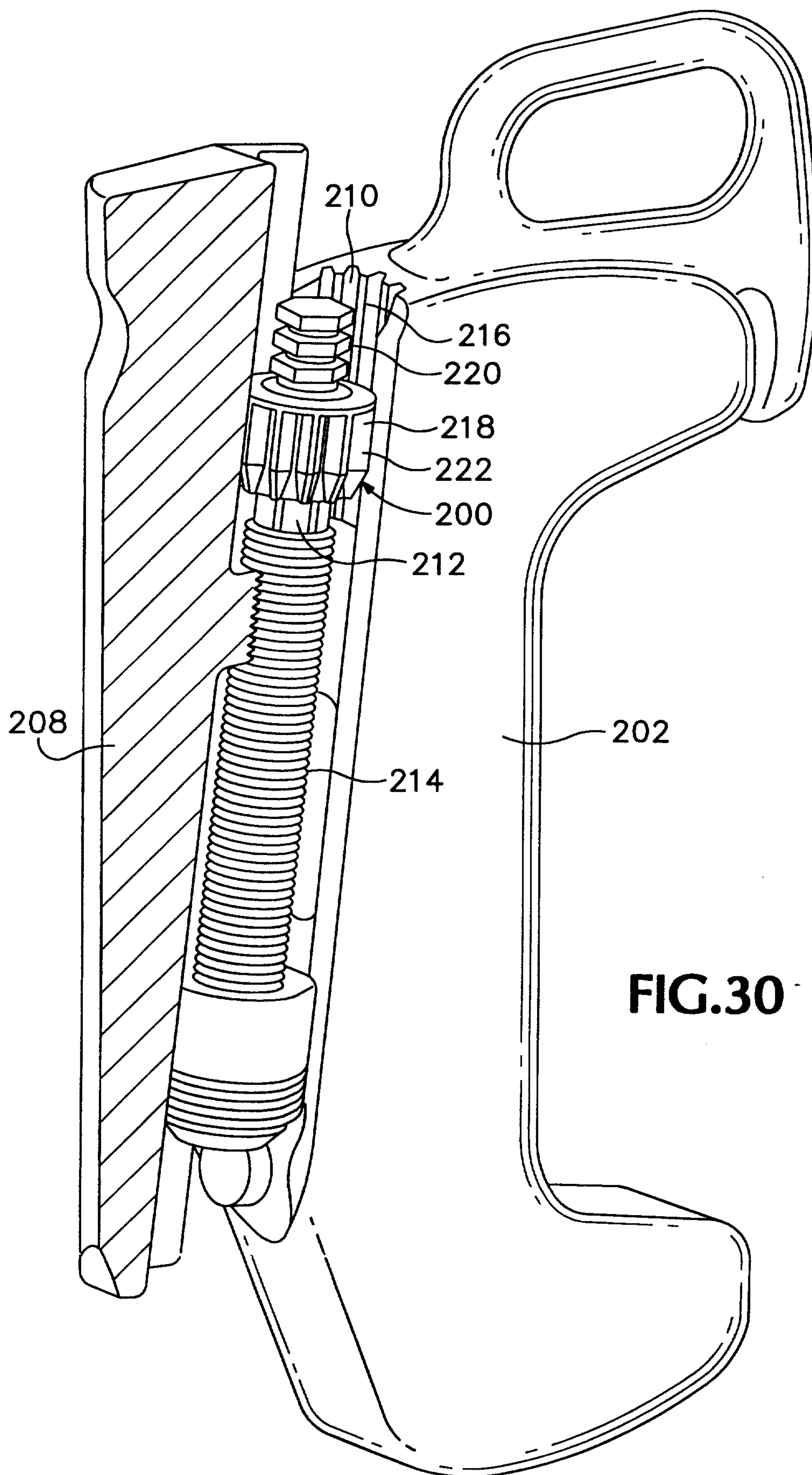


FIG.28





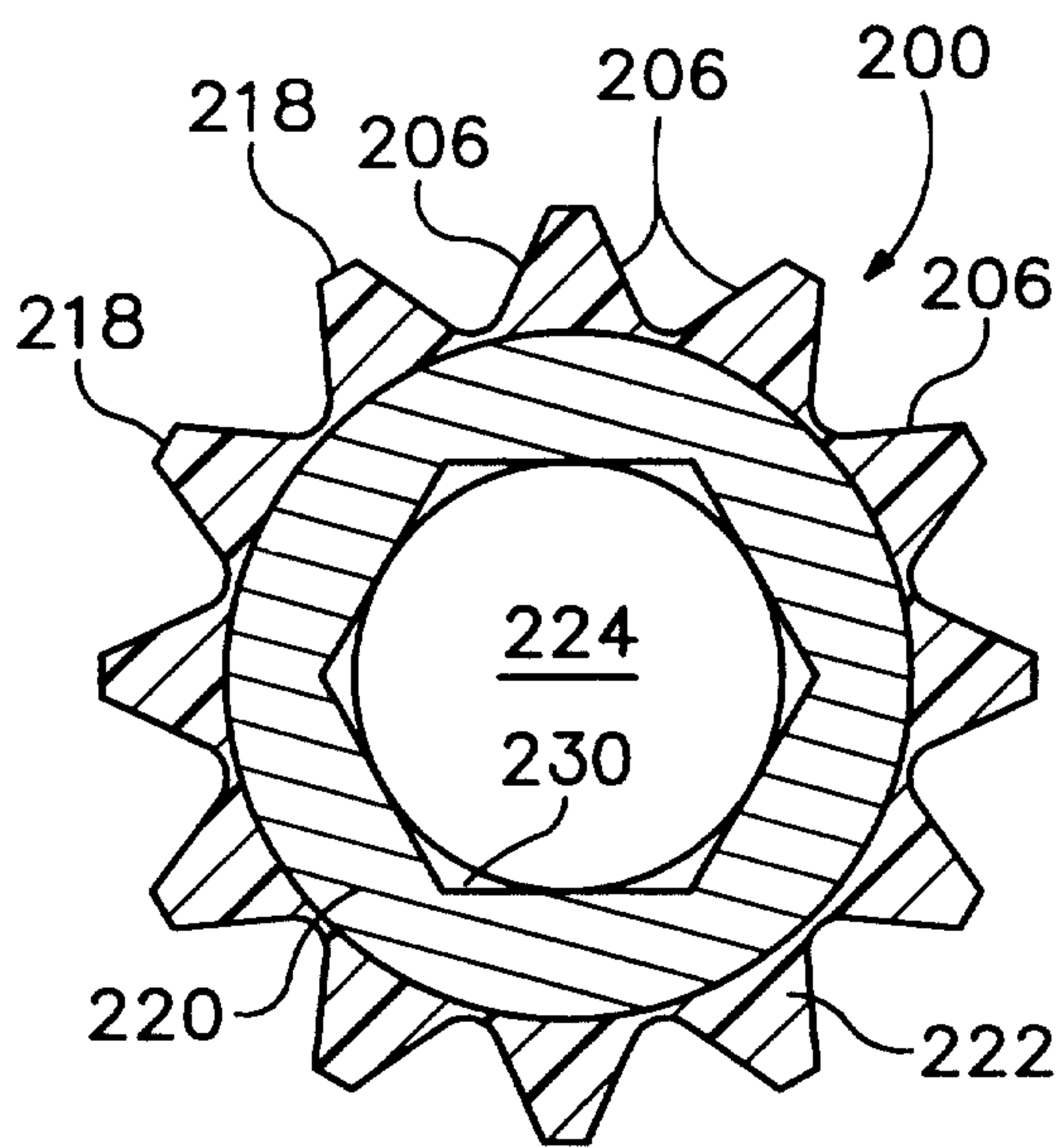


FIG. 31

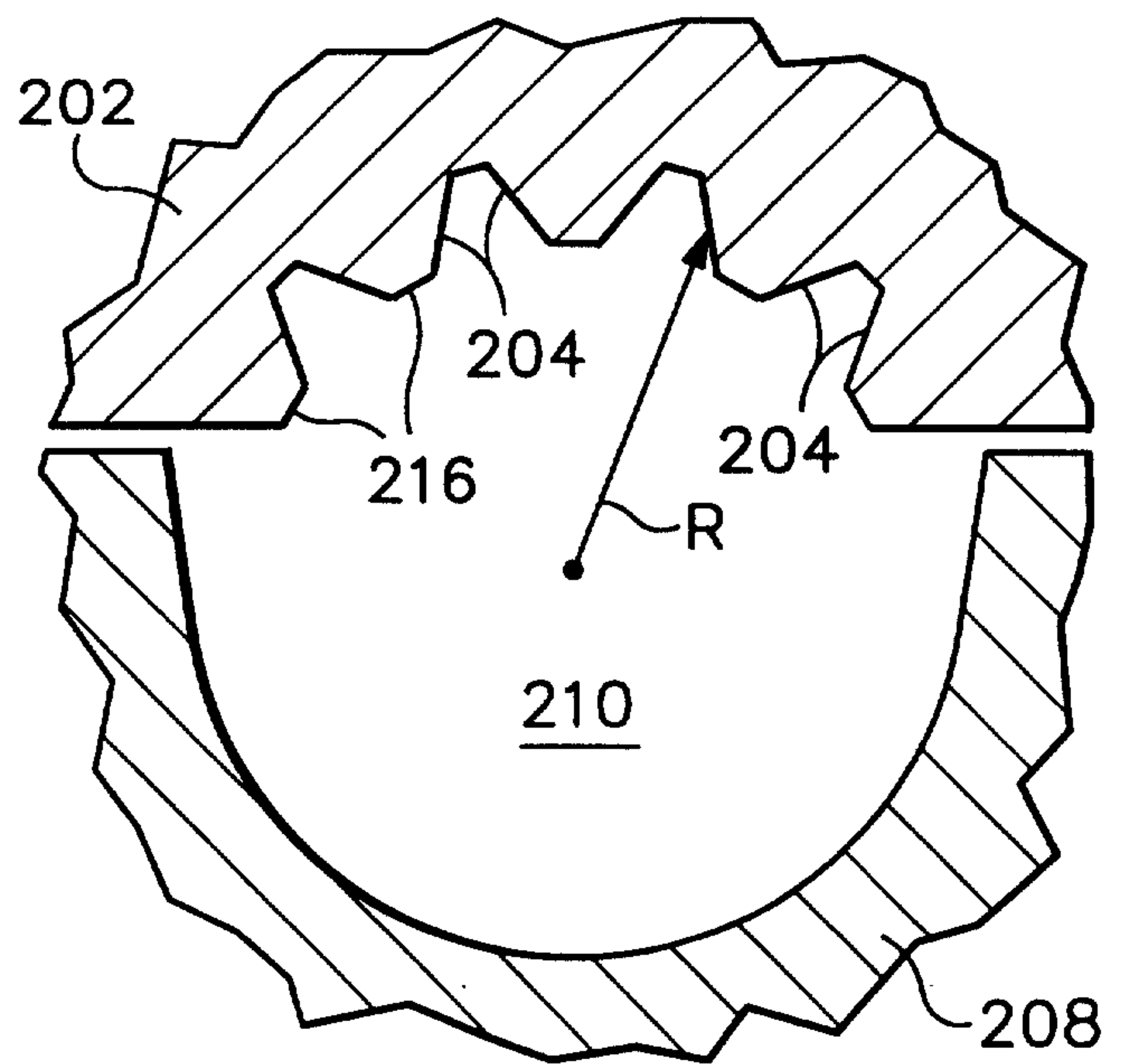


FIG. 32

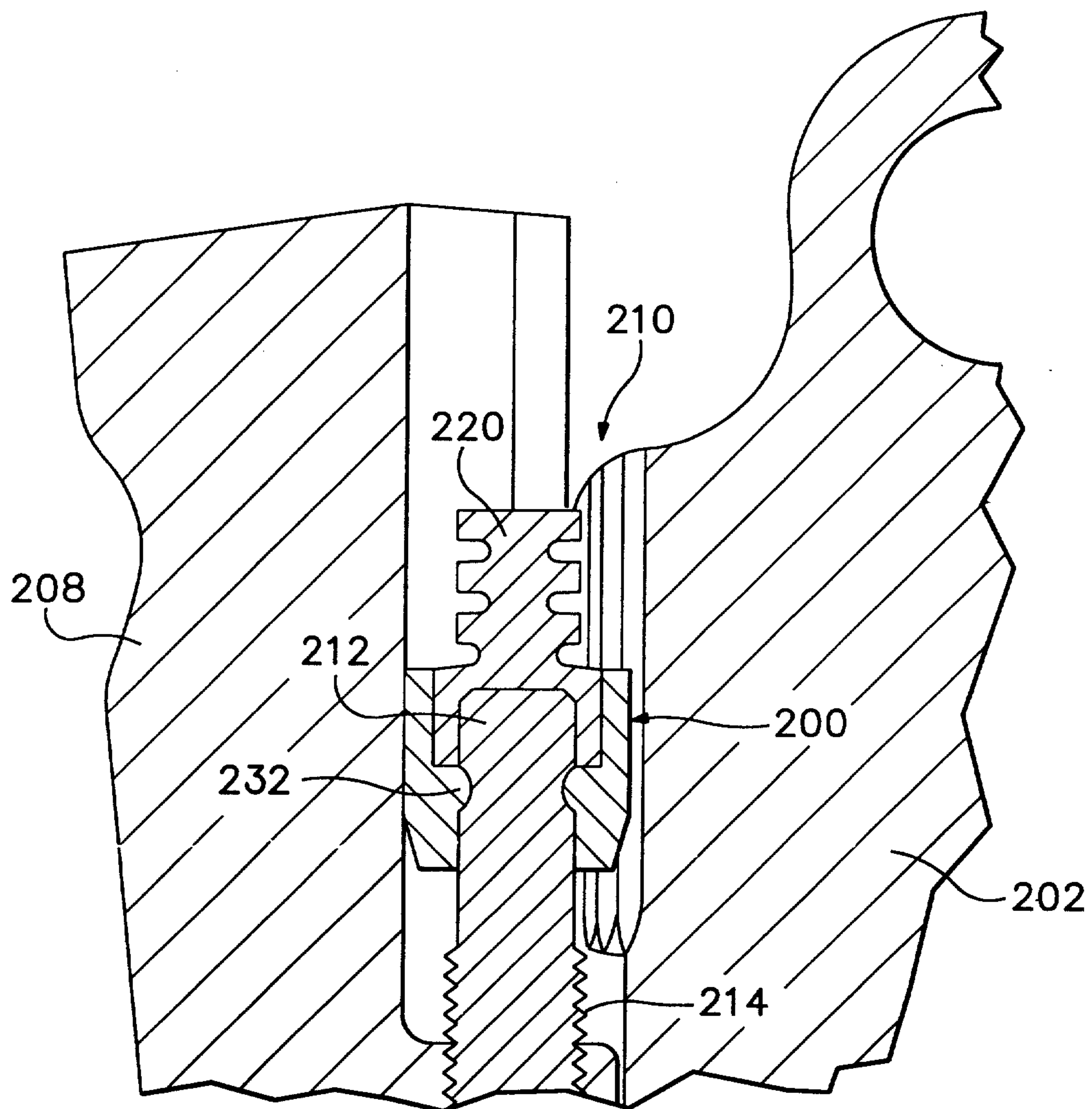


FIG. 33

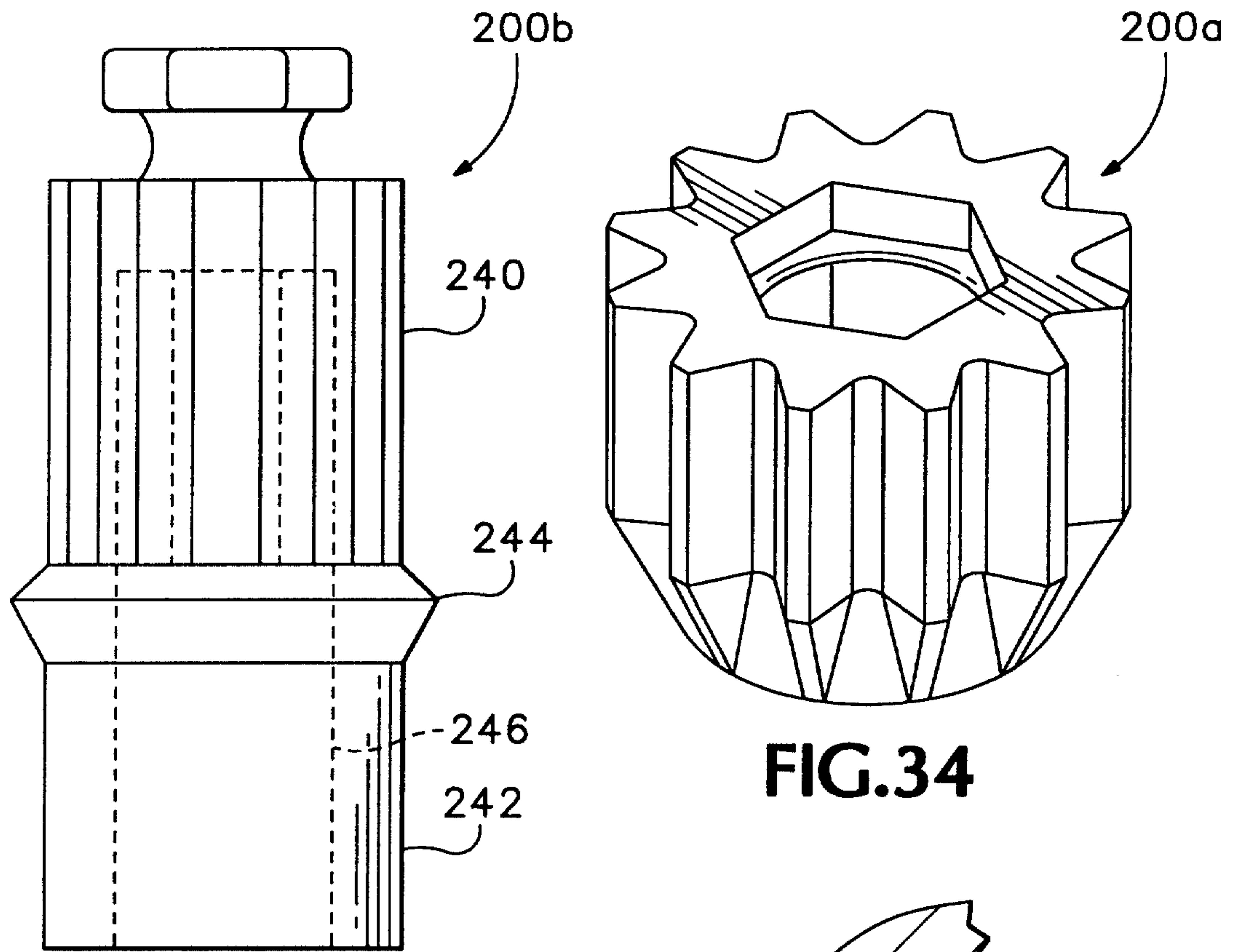


FIG.34

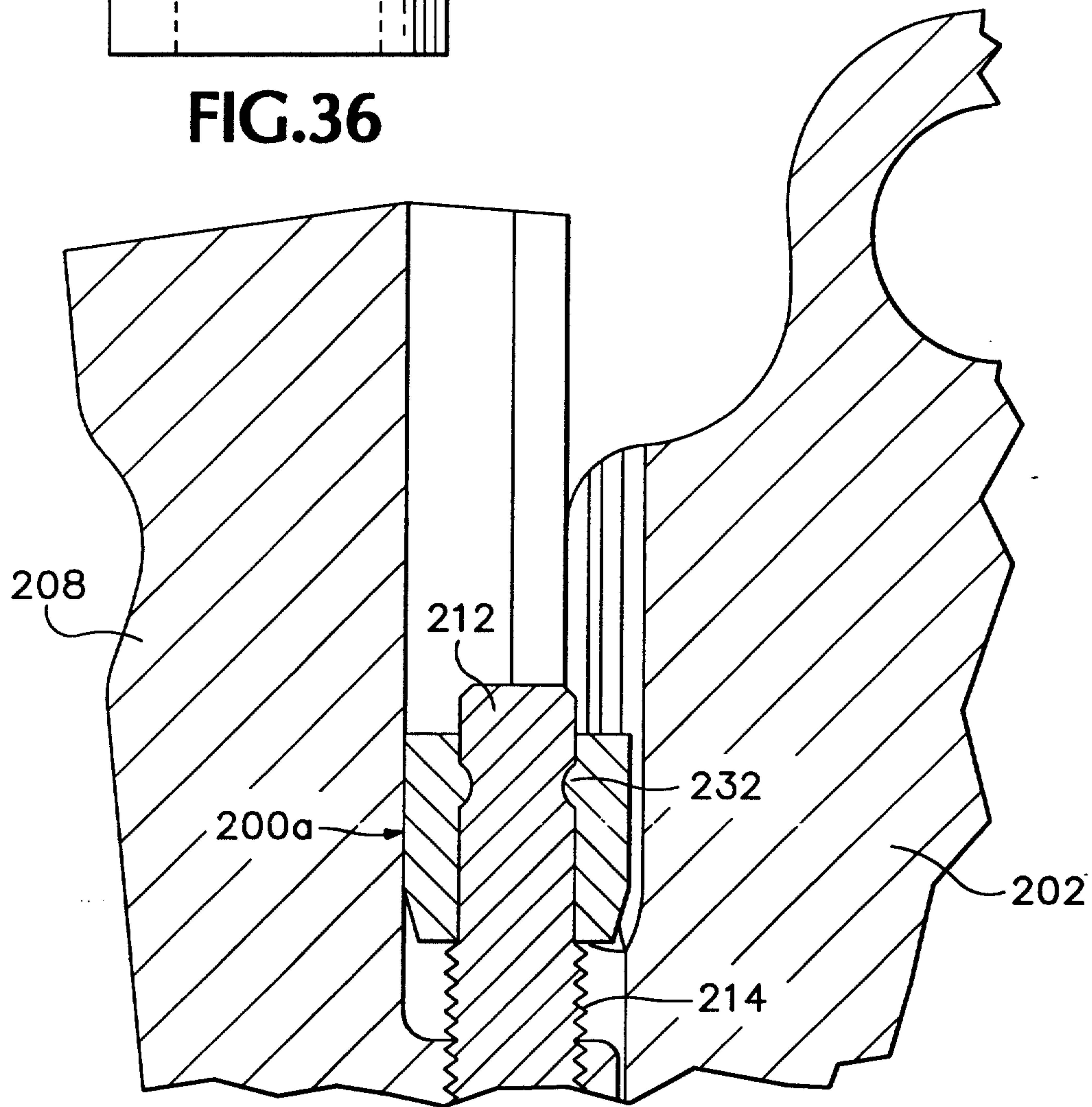


FIG.35

