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(54) Title: MULTI-LOBULAR LOCKBOLT AND SYSTEM

(57) **Abrégé/Abstract:**

A lockbolt (100, 200, 300) which includes a head portion (102) and a shaft (104, 302) which extends from the head portion (102). The shaft (104) includes at least a portion which is threaded and has a multi-lobular profile. A collar (120, 304) is swageable onto the multi-lobular threaded portion (104), and thereafter the lobes (114) provide that the collar (120, 304) does not tend to vibrate loose from the threading. The fact that the section which has a multi-lobular profile is also threaded provides that the collar (120, 304) (or a conventional threaded nut) can be selectively rotatably removed and re-installed on the lockbolt (100, 200, 300). Before swaging, the collar (120, 304) may initially include a cylindrical bore (130), or a bore (130) which is multi-faceted, preferably generally corresponding to the profile of the multi-lobular portion of the lockbolt (100, 200, 300). The lockbolt (100, 200) may include a frangible pintail (106, 202), wherein the multi-lobular threaded portion is disposed between the head portion of the bolt and the frangible pintail. Alternatively, the lockbolt (300) maybe pintail-less. A tool (310) for swagging a collar (304) onto a pintail-less lockbolt (300) is also described.

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MULTI-LOBULAR LOCKBOLT AND SYSTEM

Related Application (Priority Claim)

This application claims the benefit of United States Provisional Application Serial No. 60/605,704, filed August 30, 2004, United States Provisional Application
5 Serial No. 60/668,255, filed April 5, 2005, and United States Patent Application Serial No. 11/146,678, filed June 7, 2005.

Background

The present invention generally relates to lockbolts, and more specifically
10 relates to a multi-lobular lockbolt which is configured to be installed vis-a-vis a collar which is swaged onto the bolt.

Some conventional lockbolts include a frangible pintail while others do not. As shown in Figure 1, a typical lockbolt 10 which includes a frangible pintail 12 includes: a head 14, a threaded shaft 16 and a frangible pintail 12 having annular ribs 18,
15 wherein the head 14 is at one end 20 of the bolt 10, the frangible pintail 12 is at the other end 22 of the bolt 10, and the threaded shaft portion 16 is disposed between the head 14 and the frangible pintail 12. As shown in Figure 1, initially the frangible pintail 12 and threaded shaft 16 is inserted through apertures 24, 26 provided in two or more work pieces 28, 30, and a collar 32 is slid onto the bolt 10, positioned proximate
20 the threaded shaft 16. Then, as shown in Figure 2, an installation tool 40 is engaged with the collar 32 and the frangible pintail 12. Specifically, as shown in Figure 3, jaws 41 of the installation tool 40 grip and pull on the pintail 12 (as represented by arrow

42) while an anvil 43 of the installation tool 40 pushes down on the collar 32 (as represented by arrows 44), causing the collar 32 to swage down onto the bolt 10. The swaging causes the collar 32 to deform and generally grip onto the threaded shaft portion 16 of the bolt 10. Once the collar 32 has been swaged, the pintail 12 continues to be pulled until it breaks off, as shown in Figure 4, leaving the bolt 10 installed in the work pieces 28, 30, secured by the collar 32.

Such lockbolts and tools for installing such lockbolts are generally known in the art. For example, a typical tool for installing lockbolts with frangible pintails is disclosed in U.S. Patent No. 2,114,493, and includes an anvil for swaging the collar and jaws for gripping and pulling on the pintail.

The threads of some prior art lockbolts, such as that which is shown in Figures 1-4, are helical. Regardless of whether the lockbolt includes a frangible pintail or not, the helical threads provide that once the lockbolt has been installed (i.e., the collar has been swaged onto the bolt), the collar can be rotated off of the lockbolt, and thereafter can be threaded back on to the lockbolt (or a new nut threaded onto the lockbolt). A problem associated with providing a lockbolt having standard helical threads is that the collar, once swaged onto the lockbolt, is susceptible to vibrating loose.

U.S. Patent No. 2,531,048 discloses a lockbolt which tends to solve this problem. The lockbolt, instead of including standard helical threads, includes annular ribs. Being annular rather than helical provides that once a collar is swaged onto the ribs, the collar is not susceptible to vibrating loose. However, the lockbolt presents a new disadvantage: once a collar is swaged onto the ribs, the collar must be broken off

of the ribs, rather than be rotated off the ribs. As such, the collar cannot be removed and rotated back onto the lockbolt. In fact, due to the ribs being annular, even a new collar cannot be threaded onto the lockbolt. Instead, the swaging process must be repeated to re-secure the lockbolt.

5 As mentioned hereinabove, some lockbolts do not include a frangible pintail. An advantage of such a lockbolt system is that there is no salvage, i.e., there is no broken off pintail which must be discarded. A prior art system for installing such a lockbolt is disclosed in U.S. Patent No. 5,315,755. The system provides that a threaded nut is rotated onto the end of the threaded portion of the lockbolt, and the nut
10 pulls on the lockbolt as the collar is swaged. While the system eliminates the pintail which breaks off, the tool which is used to effect the swaging is complicated, includes a multitude of parts, is subject to failure, and requires significant maintenance. There exists a need for a more simple system and tool for effecting the swaging of a collar onto a lockbolt which does not have a frangible pintail.

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Objects and Summary

An object of an embodiment of the present invention is provide a lockbolt which provides that, after installation, a collar does not tend to vibrate loose, yet the collar can be selectively rotatably removed and re-installed on the lockbolt.

5 Briefly, and in accordance with at least one of the foregoing objects, an embodiment of the present invention provides a lockbolt which includes a head portion and a shaft which extends from the head portion. The shaft includes at least a portion which is threaded and has a multi-lobular profile. A collar is swageable onto the multi-lobular threaded portion, and thereafter the lobes or high points provide that
10 the collar does not tend to vibrate loose from the threading. The fact that the section which has a multi-lobular profile is also threaded provides that the collar can be selectively rotatably removed and re-installed on the lockbolt (or that a conventional threaded nut can be installed on the lockbolt once the swagged collar has been removed). Before swaging, the collar may initially include a cylindrical bore, or a
15 bore which is multi-faceted, preferably generally corresponding to the profile of the multi-lobular portion of the lockbolt. The lockbolt may also include a frangible pintail, wherein the multi-lobular threaded portion is disposed between the head portion of the bolt and the frangible pintail. The frangible pintail may be provided as having annular ribs. Alternatively, the frangible pintail may be provided as having the
20 same threading as the multi-lobular threaded portion of the lockbolt.

Alternatively, the multi-lobular lockbolt may be provided as not having a frangible pintail, in which case the threaded portion of the bolt is gripped and pulled to effect swagging of the collar onto the lockbolt. An embodiment of the present invention provides a system for effecting the swagging of a collar onto a pintail-less

5 lockbolt.

Brief Description of the Drawings

The organization and manner of the structure and operation of the invention, together with further objects and advantages thereof, may best be understood by reference to the following description, taken in connection with the accompanying
5 drawings, wherein like reference numerals identify like elements in which:

Figure 1 illustrates a prior art lockbolt having a head, a helically-threaded shaft portion and a frangible pintail, showing a collar positioned proximate the helically-threaded shaft portion, before swaging;

Figures 2 through 4 illustrate installation of the lockbolt shown in Figure 1;

10 Figures 5 through 7 illustrate installation of a lockbolt which is in accordance with an embodiment of the present invention;

Figure 8 provides a view (similar to a cross-sectional view) of the lockbolt and collar, before swagging, wherein the collar is provided as having a multi-faceted bore;

15 Figure 9 is similar to Figure 8, but shows the situation where the collar is provided as having a cylindrical bore;

Figure 10 provides a view (similar to a cross-sectional view) of the lockbolt and collar, after swagging;

Figure 11 is a perspective view of a lockbolt which is in accordance with an alternative embodiment of the present invention; and

20 Figures 12-16 illustrate the swaging of a collar onto a pintail-less lockbolt, using a system which is in accordance with an embodiment of the present invention.

Description

While the present invention may be susceptible to embodiment in different forms, there are shown in the drawings, and herein will be described in detail, embodiments thereof with the understanding that the present description is to be considered an exemplification of the principles of the invention and is not intended to limit the invention to that as illustrated and described herein.

Figures 5 through 7 illustrate a lockbolt 100 which is in accordance with an embodiment of the present invention. The lockbolt 100 is similar to the prior art lockbolt 10 shown in Figures 1 through 4 in that the lockbolt 100 includes a head 102, a threaded shaft 104 and a frangible pintail 106 having annular ribs 108, wherein the head 102 is at one end 110 of the bolt 100, the frangible pintail 106 is at the other end 112 of the bolt 100, and the threaded shaft portion 104 is disposed between the head 102 and the frangible pintail 106. The difference between the lockbolt 100 shown in Figures 5 through 7 and the prior art lockbolt 10 shown in Figures 1 through 4 resides in the fact that in the lockbolt 100 shown in Figures 5 through 7, the threaded shaft portion 104 is not merely helically threaded, but rather includes a threaded portion which is multi-lobular or multi-faceted, meaning that the thread includes high points 114 and low points 116 as shown in Figures 8-10.

For example, the threading may be provided as having five lobes or high points (such as is shown in Figures 8-10), such as an HP-5 thread as disclosed in U.S. Patent Nos. 3,875,780 and 3,935,785, both of which are incorporated herein by reference in their entirety. Alternatively, the threading may be provided as having a number of lobes which are more or less than five. For example, the threaded portion may be provided as being quad-lobular (i.e., having four high points), tri-lobular (i.e., having three high points), an oval (i.e., having two high points), etc.

Regardless, the fact that the threaded portion 104 of the lockbolt 100 is multi-lobular, having high points and low points, provides that a collar 120, once swaged onto the lockbolt 10, does not tend to vibrate off. This is because vibration alone is not enough to cause low points 122 of the swaged collar 120 (see Figure 10) to move past high points 114 of the multi-lobular portion 104 of the lockbolt 100.

Simultaneously, the fact that the threaded portion 104 is, in fact, threaded and multi-lobular, provides that a collar 120 can be intentionally rotated off the lockbolt 100, if desired, by using a tool to apply enough torque to the collar 120.

Figures 5 through 7 illustrate installation of the lockbolt 100. The installation process is quite similar to the installation process which is used to install the lockbolt 10 shown in Figures 1 through 4. To install the lockbolt 100 shown in Figures 5 through 7, Textron Fastening Systems' Hydro-Electric Power Tool, Model T30 73412-02000, along with Textron Fastening Systems' HydraPac Hydraulic Power Unit, Model HP21 73401-02000, Model HP41 73400-02000 or Model HP51 73404-02000, can be used. Alternatively, some other appropriate installation tool can be used.

Initially, the frangible pintail 106 and threaded shaft 104 is inserted through apertures 24, 26 provided in two or more work pieces 28, 30, and a collar 120 is placed on the lockbolt 100, proximate the multi-lobular threaded portion 104. As shown in Figure 8, the collar 120 can be provided as initially having a throughbore 130 which is multi-lobular or multi-faceted. Preferably, the collar 120 is provided as having a throughbore 130 which has a profile which corresponds to the profile of the multi-lobular portion 104 of the lockbolt 100. In other words, if the multi-lobular portion 104 of the lockbolt 100 is provided as having five lobes or high points (such as an HP-5 thread), preferably the collar 120 is provided as having a throughbore 130 which has five high points 131 as well. The fact that the collar 120 is provided as having a throughbore 130 which has a profile which corresponds to the profile of the multi-lobular portion 104 of the lockbolt 100 provides for uniform deformation of the collar 120 during swaging.

Additionally, the fact that the collar 120 is provided as having a throughbore 130 which has a profile which corresponds to the profile of the multi-lobular portion 104 of the lockbolt 100 provides that the collar 120 can assist with regard to installation. Specifically, the collar can be placed on the bolt and rotated slightly so that there is an interference fit between portion 104 and the throughbore 130 of the collar. Then, an installation tool can be brought into engagement with the pintail 106 and collar 120 to perform the swaging operation. Alternatively, as shown in Figure 9, the collar 120 can be provided as initially having a throughbore 130 which is cylindrical, or some other shape.

Regardless, as shown in Figure 5, an installation tool 140 is engaged with the collar 120 and the frangible pintail 106. Specifically, jaws 142 of the installation tool 140 grip and pull on the pintail 106 while an anvil 144 of the installation tool 140 pushes down on the collar 120, causing the collar 120 to swage down onto the bolt 100, as shown in Figure 6. The swaging causes the collar 120 to deform and generally lock down onto the multi-lobular threaded portion 104 of the bolt 100 (Figure 10 provides a view (similar to a cross-sectional view) of the collar 120 swaged down onto the multi-lobular portion 104 of the lockbolt 100.

Preferably, the installation tool 140 swages only a portion 150 of the collar 120 down onto the threaded portion 104 (see Figure 6) while the remaining portion 152 remains unswaged, as this renders the assembly easier to assemble and manufacture. Preferably, the portion 152 of the collar 120 which is not swaged includes a hex profiled surface 154 such that a standard hex tool can be used to subsequently remove the collar 120. Once the collar 120 has been swaged, the pintail 106 continues to be pulled until it breaks off, as shown in Figure 7, leaving the bolt 100 installed in the work pieces 28, 30, secured by the collar 120. Similarly, if the lockbolt is of the type which does not include a frangible pintail, the threaded portion of the bolt is gripped and pulled as the collar is swaged, and once the collar has been swaged, the bolt is released.

Once the collar 120 has been swaged on the lockbolt, and the lockbolt 100 fully installed, secured by the collar 120, the collar 120 will not tend to vibrate off, due to the multi-lobular profile of the threaded portion 104. Specifically, vibration alone will not tend to provide that low points 122 of the collar 120 can overcome high points 114 of the multi-lobular portion 104 of the lockbolt 100, as shown in Figure 10. In other words, the multi-lobular profile of portion 104 provides a certain amount of prevailing torque which tends to resist rotation in response to vibration. At the same time, the collar 120 can be intentionally removed merely by using a tool to apply enough torque (such as by using a hex tool to apply a torque to surface 154) such that the low points 122 of the collar 120 overcome the high points 114 of the multi-lobular portion 104 of the lockbolt 100.

Once the collar 120 has been swaged onto the lockbolt 100, intentional removal of the collar 120 (i.e., rotation of the collar 120 using a tool) causes a thread to be formed in the throughbore 130 of the collar. The thread which is formed in the collar 120 provides that the collar 120 can be easily rotated back onto the threaded portion 104 of the lockbolt 100 after the collar 120 has been intentionally removed therefrom. Subsequently, once the collar 120 has been rotated back onto the lockbolt 100, it is expected that the fact that the threaded portion 104 of the lockbolt is multi-lobular will result in the collar 120 not tending to vibrate off as much as if the threaded portion 104 of the lockbolt 100 were to be provided as being helically-threaded with standard helical threads, as is provided in the prior art (i.e., lockbolt 10 as shown in Figures 1-

4). In other words, there is a certain amount of prevailing torque which exists over and beyond what would be provided if portion 104 had a standard helical thread.

While it was discussed above that the collar 120 is preferably initially provided with a hex surface 154 to facilitate removal of the collar 120 with a hex tool, the collar 120 can also initially be provided without such a surface, and such a surface can be formed on the collar 120, by the anvil 144 of the installation tool 140 during the swaging operation.

Figure 11 illustrates a lockbolt 200 which is in accordance with an alternative embodiment of the present invention. The lockbolt 200 is very similar to the lockbolt 100 shown in Figure 5 through 7, the only difference being that the frangible pintail 202 does not include annular ribs, but rather provides a multi-lobular threaded profile similar to the multi-lobular portion 104 of the lockbolt 200 (or lockbolt 100). This way, both the portion 104 of the lockbolt which ultimately receives the collar and the pintail portion 202 can be threaded at the same time, using the same thread-forming process. Alternatively, the pintail can be provided as having a helical, non-lobular thread.

As discussed hereinabove, the lockbolt can be provided as not having a frangible pintail, in which case the threaded portion of the bolt is gripped and pulled as the collar is swaged, and once the collar has been swaged, the bolt is released. Figures 12-16 illustrate such a swagging operation, using a system which is in accordance with an embodiment of the present invention. It should be understood that preferably the lockbolt 300 shown in Figures 12-16 has a threaded portion 302 which is multi-lobular

or multi-faceted, as described above in connection with Figures 8-10. Additionally, preferably the collar 304 is provided as having a throughbore 306 which has a profile which corresponds to the profile of the multi-lobular portion 302 of the lockbolt 300.

Regardless, the system provides a nosepiece assembly 310 which includes a nosepiece 312 that has a recess 314 at its end 316 for receiving a bottom portion 318 of the collar 304 during the swaging operation. The nosepiece 312 is generally cylindrical and includes an internal throughbore 320. The throughbore 320 includes a first section 322 which is of larger internal diameter than a second section 324. An outer sleeve 326 is disposed in the first, larger internal diameter section 322, and the outer sleeve 326 is also generally cylindrical and includes an internal throughbore 328. An end 330 of the outer sleeve 326 includes internal threads 332 for threadably attaching to a piston (as represented by arrow 334 in Figure 12). Specifically, the outer sleeve 326 may be engaged with a piston of, for example, any of the tools identified previously hereinabove - i.e., Textron Fastening Systems' Hydro-Electric Power Tool, Model T30 73412-02000, along with Textron Fastening Systems' HydraPac Hydraulic Power Unit, Model HP21 73401-02000, Model HP41 73400-02000 or Model HP51 73404-02000, can be used. Alternatively, some other appropriate installation tool can be used.

An inner sleeve 336 is disposed inside the outer sleeve 326, and an end 338 of the inner sleeve 336 includes a bore 340 in which a spring 342 is disposed. The inner sleeve 336 is retained in the outer sleeve 326 by a snap ring 344, and the end 338 of the inner sleeve 336 contacts a set of three jaws 348. The jaws 348 include an enlarged shoulder portion 350 which is disposed in the inner sleeve 336, and the jaws 348 extend through an opening 352 in the end 354 of the outer sleeve 326 and into the second, smaller diameter section 324 of the throughbore 320 of the nosepiece 312. Each of the jaws 348 includes an end portion 356 which is internally threaded, preferably having threads 358 which correspond to the threading which is on the threaded portion 302 of the lockbolt 300. The jaws 348 are configured such that they can effectively translate relative to the nosepiece 312, but are non-rotatable relative to the nosepiece 312.

As shown, a pin 360 is disposed generally between the three jaws 348. Specifically, an enlarged head portion 362 of the pin 360 is retained generally in the bore 340 in the inner sleeve 336, and a shank portion 364 of the pin 360 extends through a space 366 provided between the three jaws 348. The head 362 of the pin 360 is generally retained in the inner sleeve 336 due to the fact that the space 366 between the jaws 348 proximate the end 368 of the jaws 348, proximate the head 362 of the pin 360, is too small to allow the head 362 of the pin 360 to travel into the space 366 between the jaws 348. Instead, the head 362 of the pin 360 is generally retained in the bore 340 in the inner sleeve 336 and can generally translate therein, subject to compressive forces provided by the spring 342.

In use, initially the nosepiece assembly 310 is in its fully open position as shown in Figure 12, wherein the jaws 348, pin 360 and both sleeves 326 and 336 are fully forward relative to the nosepiece 312. Then, as shown in Figure 13, the nosepiece assembly 310 is moved forward (as represented by arrow 380) relative to the lockbolt 300 and collar 304, and the pin 360 contacts the end 370 of the lockbolt 300, thereby moving the pin 360 backwards (relative to the end 316 of the nosepiece 312) and compressing the spring 342. At this time, the internal threaded portion 358 of the jaws 348 are positioned proximate the threaded portion 302 of the lockbolt 300.

As shown in Figure 14, when the tool to which the outer sleeve 326 is threadably engaged is actuated, the outer sleeve 326 moves backward (relative to the end 316 of the nosepiece 312), which causes the jaws 348 to move inward (i.e., toward each other) and clamp onto the threaded portion 302 of the lockbolt 300. As opposed to threading onto the threaded portion 302 of the lockbolt 300, the jaws 348 obtain a clamping engagement by coming together onto the threaded portion 302 of the lockbolt 300. The nosepiece 312 contacts the top 372 of the collar 304, which begins a push-pull action on the collar 304 and lockbolt 300, respectively (as indicated by arrows 382). As shown in Figure 15, the push-pull action continues (as indicated by arrows 382) until the outer sleeve 326 reaches a fully retracted position, which causes the collar 304 to become swaged onto the lockbolt 300, thereby clamping the two workpieces 374, 376 together. Preferably, the tool with which the nosepiece assembly 310 is engaged is configured to shut-off at a pre-determined clamp force which is controlled by cylinder pressure. As shown in Figure 16, after the desired clamp force

is reached, the tool reverses direction (as indicated by arrows 384) of the piston, causing the end 354 of the outer sleeve 326 to move toward the end 316 of the nosepiece 312. The action continues until the nosepiece 312 is in the fully open position, as shown in Figure 12, after which time the process can be repeated to swage
5 another collar onto another lockbolt.

As discussed above, U.S. Patent No. 5,315,755 discloses a tool for swaging a collar onto a lockbolt which does not have a frangible pintail. However, the tool is complicated, has too many parts, and is subject to failure. The nosepiece assembly 310 shown in Figures 12-16 is more simple, has fewer parts, and is therefore not as
10 subject to failure. Furthermore, the tool shown in U.S. Patent No. 5,315,755 is not configured for use with a lockbolt which has a threaded portion which is multi-lobular or multi-faceted. In contrast, the nosepiece assembly 312 shown in Figures 12-16 can be used with such a lockbolt as well as with a standard lockbolt.

While embodiments of the present invention are shown and described, it is
15 envisioned that those skilled in the art may devise various modifications of the present invention without departing from the spirit and scope of the disclosure.

What is claimed is:

1. A pintail-less lockbolt characterized by: a head portion; and a shaft which extends from the head portion, wherein the shaft includes at least a portion which is threaded and has a multi-lobular cross-sectional profile.

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2. A pintail-less lockbolt as recited in claim 1, characterized in that the portion of the shaft which is threaded and has a multi-lobular cross-sectional profile includes a plurality of high points.

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3. A pintail-less lockbolt as recited in claim 1, characterized in that the portion of the shaft which is threaded and has a multi-lobular cross-sectional profile includes five high points.

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4. A pintail-less lockbolt as recited in claim 1, characterized in that the lockbolt is configured such that a collar is swageable onto the portion of the shaft which is threaded and has a multi-lobular cross-sectional profile, and thereafter high points on the shaft provide that the collar does not tend to vibrate loose from the shaft.

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5. A pintail-less lockbolt as recited in claim 4, characterized in that the portion of the shaft which is threaded is configured to provide that the collar is selectively rotatably removable and re-installable on the lockbolt.

6. A pintail-less lockbolt as recited in claim 4, characterized in that the portion of the shaft which is threaded is configured to provide that a threaded nut is installable on the lockbolt once the swagged collar is removed from the shaft.

5 7. A lockbolt system characterized by: a pintail-less lockbolt which includes a head portion and a shaft which extends from the head portion, wherein the shaft includes at least a portion which is threaded and has a multi-lobular cross-sectional profile; and a collar which is swageable onto the portion of the shaft of the lockbolt which is threaded and has a multi-lobular cross-sectional profile.

10 8. A lockbolt system as recited in claim 7, characterized in that the portion of the shaft which is threaded and has a multi-lobular cross-sectional profile includes a plurality of high points.

15 9. A lockbolt system as recited in claim 7, characterized in that the portion of the shaft which is threaded and has a multi-lobular cross-sectional profile includes five high points.

20 10. A lockbolt system as recited in claim 7, characterized in that the portion of the shaft which is threaded is configured to provide that the collar is selectively rotatably removable and re-installable on the lockbolt.

11. A lockbolt system as recited in claim 7, characterized in that the portion of the shaft which is threaded is configured to provide that a threaded nut is installable on the lockbolt once the swagged collar is removed from the shaft.

5 12. A lockbolt system as recited in claim 7, characterized in that the collar includes a throughbore which is cylindrical.

13. A lockbolt system as recited in claim 7, characterized in that the collar includes a through bore which is multi-faceted, corresponding to the portion of the
10 shaft which is threaded and which has a multi-lobular cross-sectional profile.

14. A lockbolt system as recited in claim 7, characterized in that the shaft of the lockbolt and the collar are configured such that only a portion of the throughbore of the collar swages onto the lockbolt.

15 15. A method of installing a pintail-less lockbolt, said method characterized by: providing the pintail-less lockbolt which comprises a head portion and a shaft which extends from the head portion, wherein the shaft includes at least a portion which is threaded and has a multi-lobular cross-sectional profile; and non-rotatably
20 gripping and pulling the threaded portion of the shaft while swaging a collar onto the lockbolt.

16. A method as recited in claim 15, characterized in that the step of non-rotatably gripping and pulling the threaded portion of the shaft comprises using a plurality of jaws to non-rotatably grip and pull the threaded portion of the shaft.

5 17. A method as recited in claim 16, characterized in that the step of using a plurality of jaws to non-rotatably grip and pull the threaded portion of the shaft comprises using a tool which includes said jaws, further comprising providing said tool, wherein said tool comprises a nosepiece that has a recess configured to receive a portion of the collar during a swaging operation, an outer sleeve disposed in the
10 nosepiece and configured for engagement with a moveable piston, wherein each of the jaws includes a portion which is internally threaded, and wherein the jaws are configured such that translate relative to the nosepiece, but are non-rotatable relative to the nosepiece.

15 18. A method as recited in claim 17, characterized in that the step of providing said tool comprises providing an inner sleeve which is disposed in the outer sleeve, a pin which is disposed at least partially in said inner sleeve and which extends between the jaws, and providing a spring which is disposed in said inner sleeve and engages said pin.

20

19. A method as recited in claim 17, characterized in that the step of providing said tool comprises providing that each of said jaws has internal threads which correspond to threading which is on the threaded portion of the lockbolt.

5 20. A tool for swagging a collar onto a pintail-less lockbolt having a head portion and a shaft which extends from the head portion, wherein the shaft includes at least a portion which is threaded, said tool characterized by: a nosepiece that has a recess configured to receive a portion of the collar during the swaging operation; an outer sleeve disposed in the nosepiece and configured for engagement with a
10 moveable piston; a plurality of jaws retained at least partially in the outer sleeve, wherein each of the jaws includes a portion which is internally threaded, and wherein the jaws are configured to non-rotatably grip and pull on the threaded portion of the lockbolt and wherein the tool is configured such that the jaws translate relative to the nosepiece, but are non-rotatable relative to the nosepiece.

15

21. A tool as recited in claim 20, further characterized by an inner sleeve which is disposed in the outer sleeve, a pin which is disposed at least partially in said inner sleeve and which extends between the jaws, and a spring which is disposed in said inner sleeve and engages said pin.

20

22. A tool as recited in claim 20, characterized in that each of the jaws has internal threads which correspond to threading which is on the threaded portion of the lockbolt.

5 23. A tool as recited in claim 20, characterized in that the nosepiece includes an internal throughbore, wherein the throughbore includes a first section which is of larger internal diameter than a second section, wherein the outer sleeve is disposed in the first, larger internal diameter section, and the outer sleeve is generally cylindrical and includes an internal throughbore, wherein an end of the outer sleeve includes
10 internal threads for threadably attaching to the moveable piston.

24. A tool as recited in claim 21, characterized in that the jaws include an enlarged shoulder portion which is disposed in the inner sleeve, and the jaws extend through an opening in the end of the outer sleeve and into the second, smaller diameter
15 section of the throughbore of the nosepiece.

25. A tool as recited in claim 21, characterized in that an enlarged head portion of the pin is retained generally in a bore in the inner sleeve, and a shank portion of the pin extends through a space provided between the three jaws, wherein the head of the pin is generally retained in the inner sleeve due to the space between the jaws proximate the end of the jaws, proximate the head of the pin, is too small to allow the head of the pin to travel into the space between the jaws, wherein the head of the pin is generally retained in the bore in the inner sleeve and can generally translate therein, subject to compressive forces provided by the spring.

10 26. A tool as recited in claim 21, characterized in that the inner sleeve is retained in the outer sleeve by a snap ring, and the end of the inner sleeve contacts the jaws.

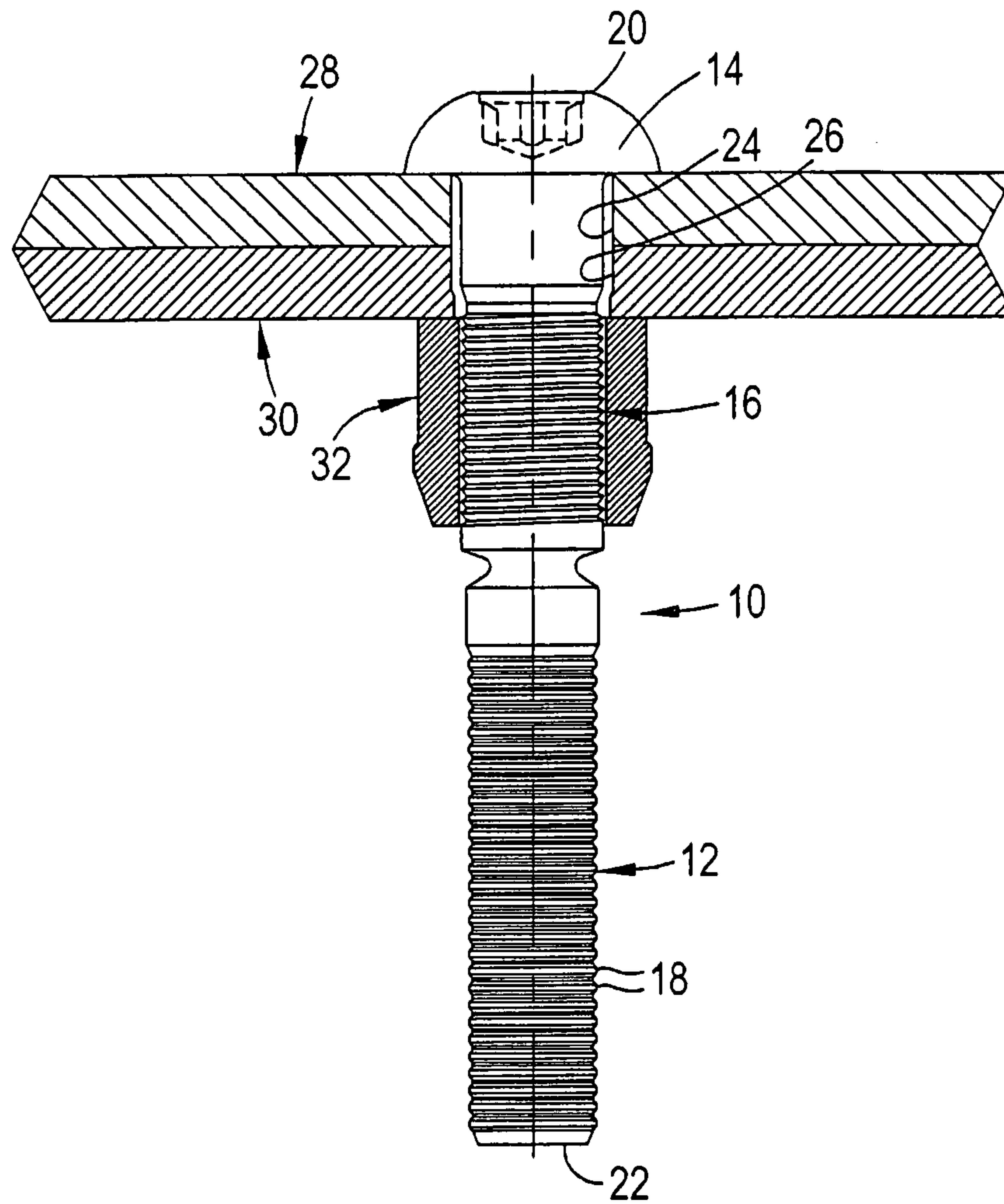


FIG. 1

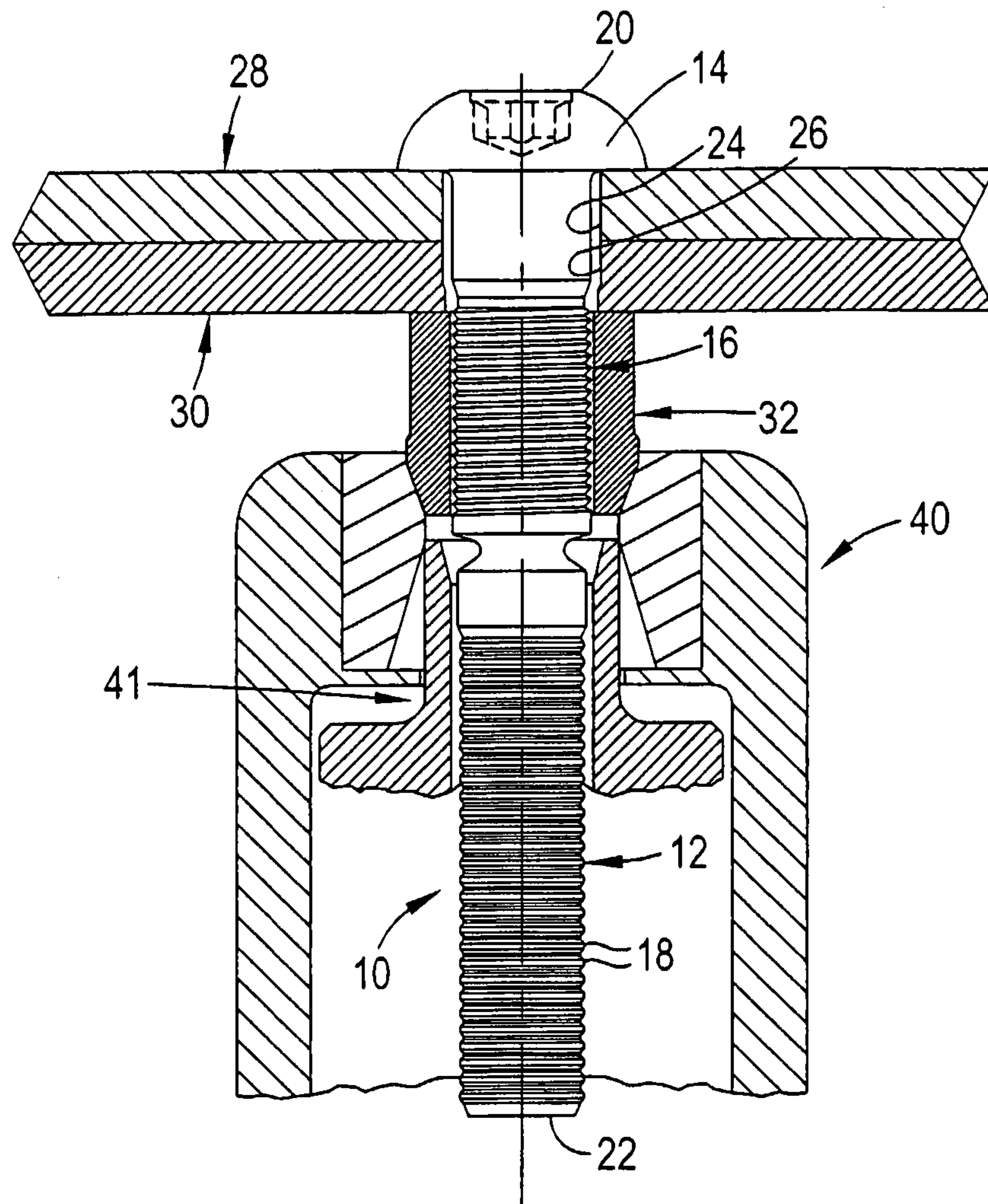


FIG. 2

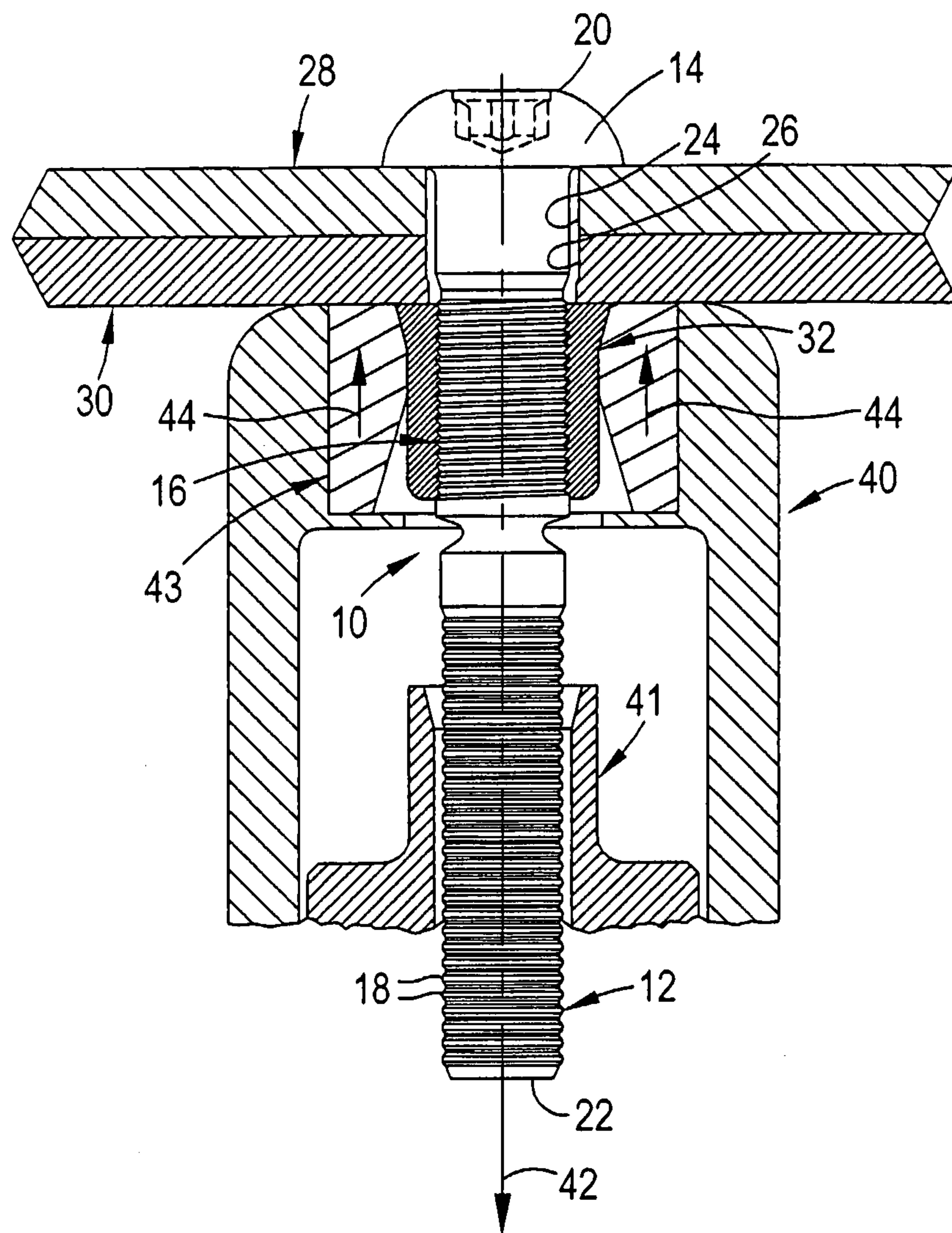


FIG. 3

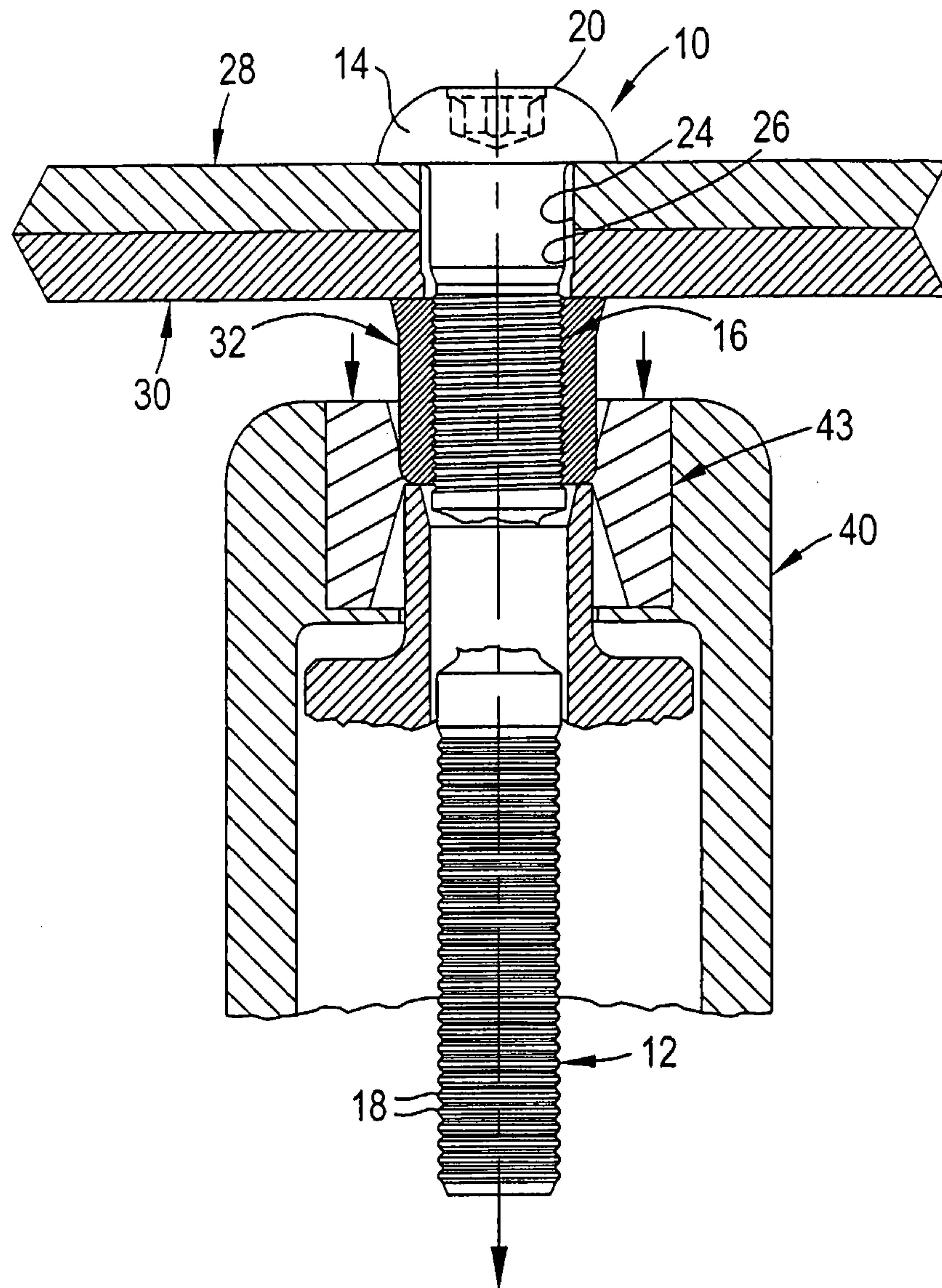
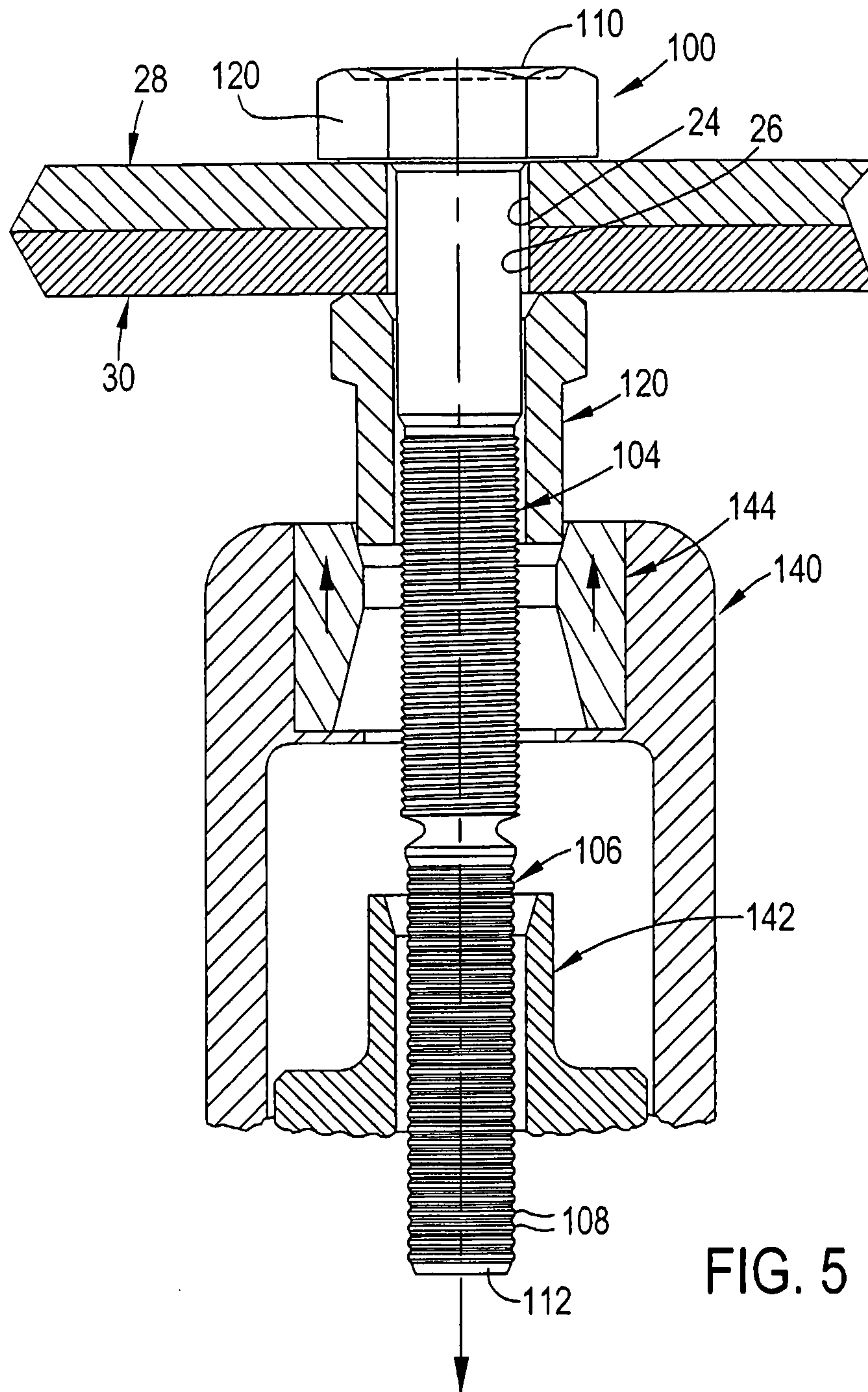
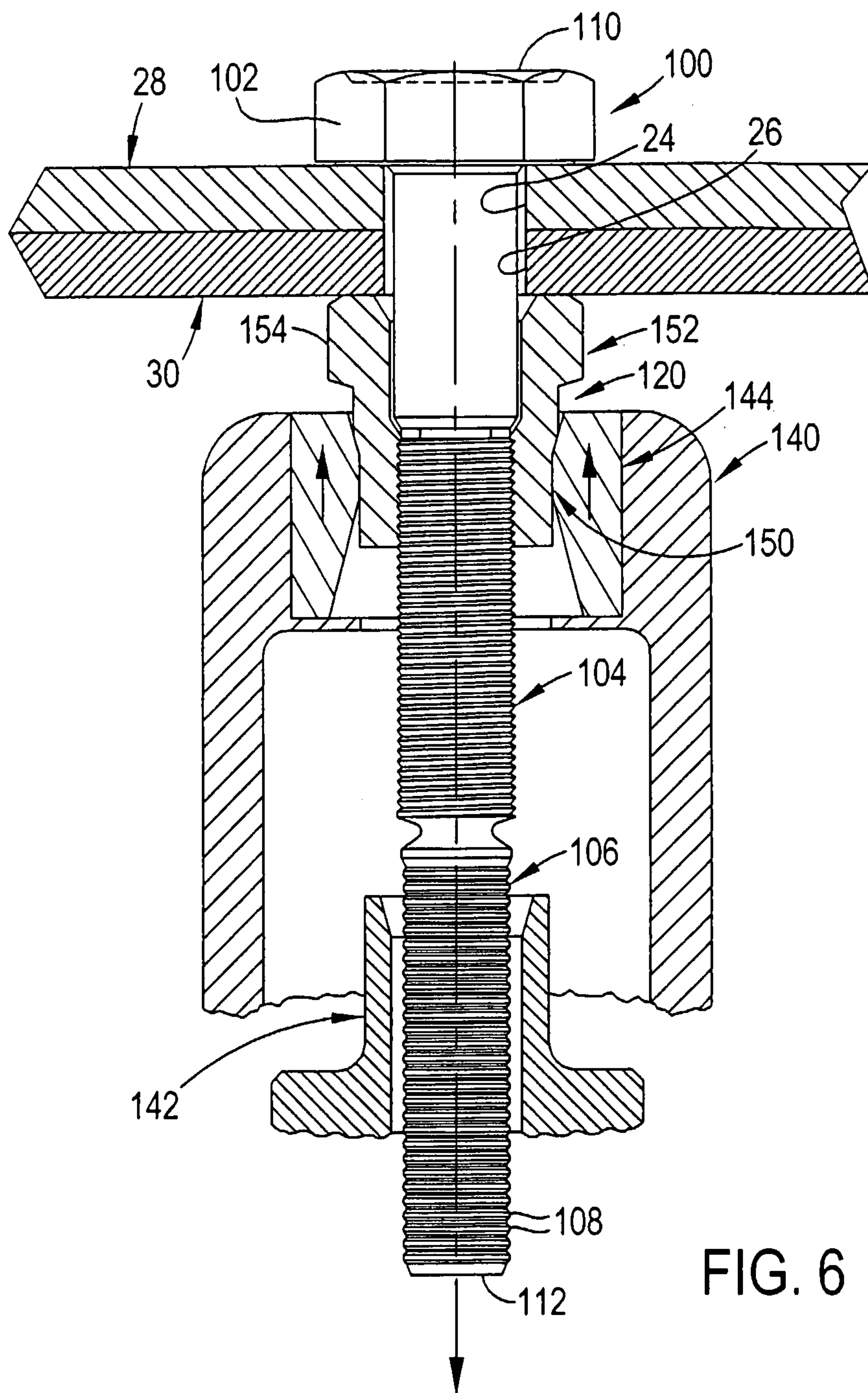


FIG. 4





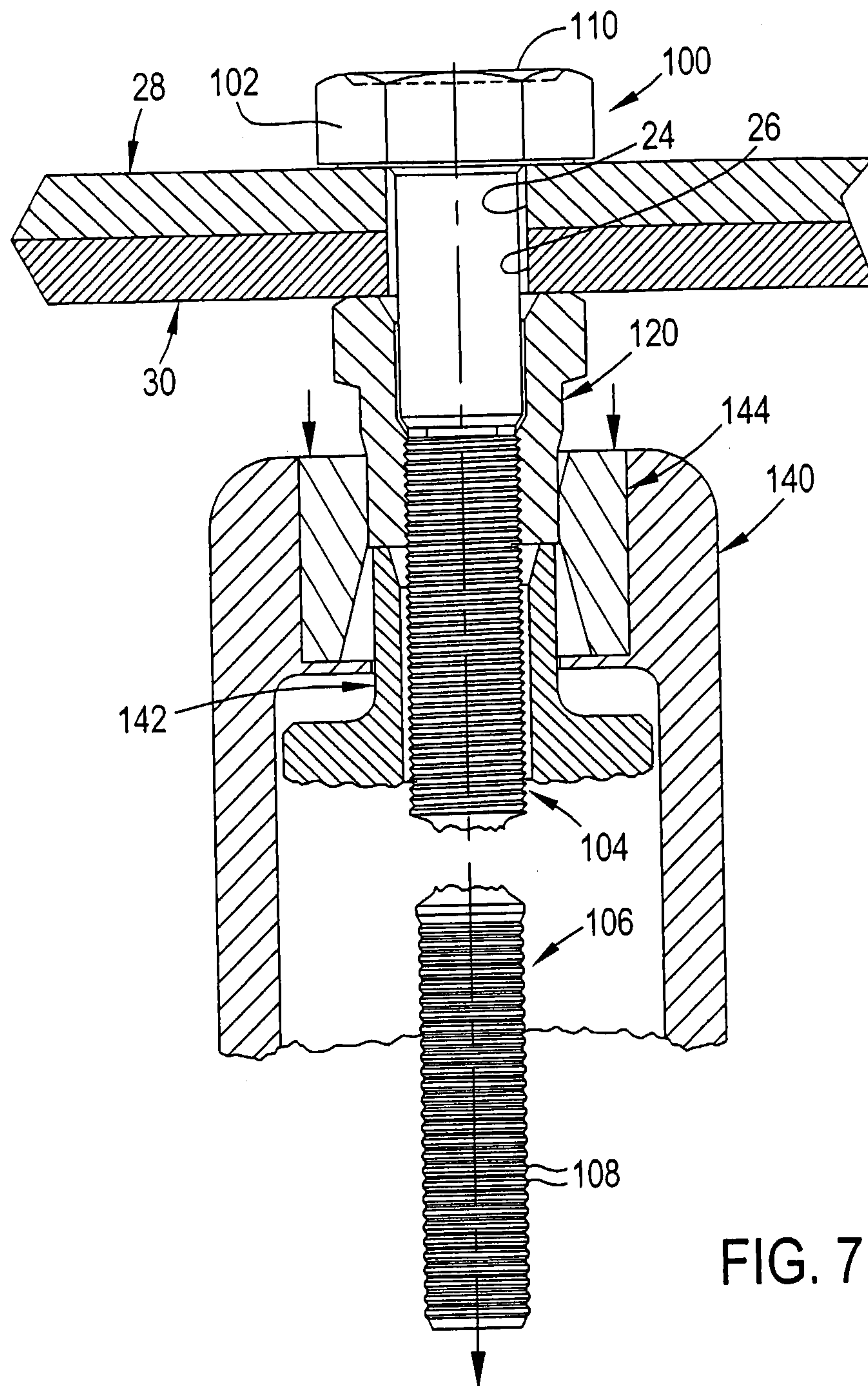
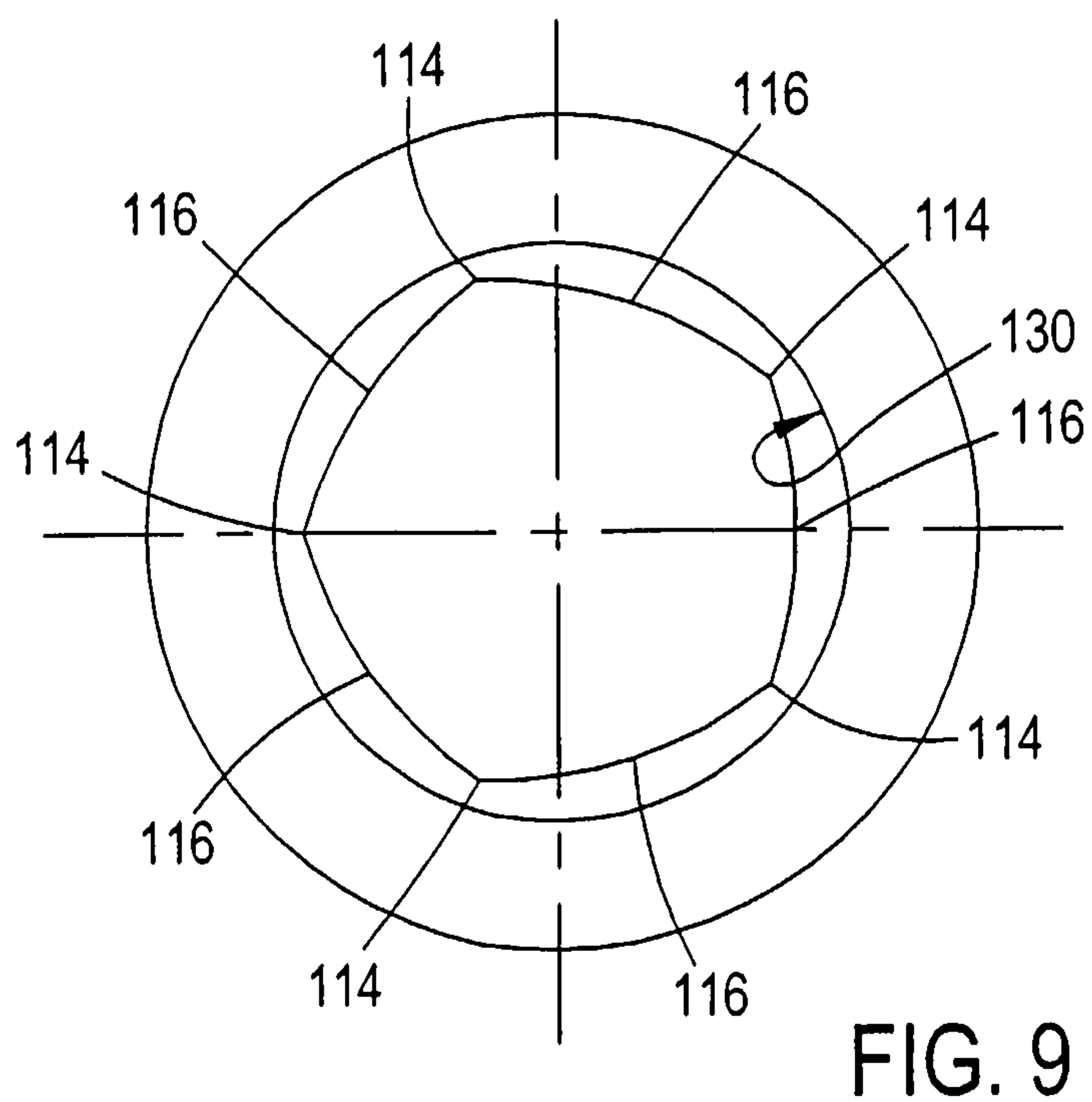
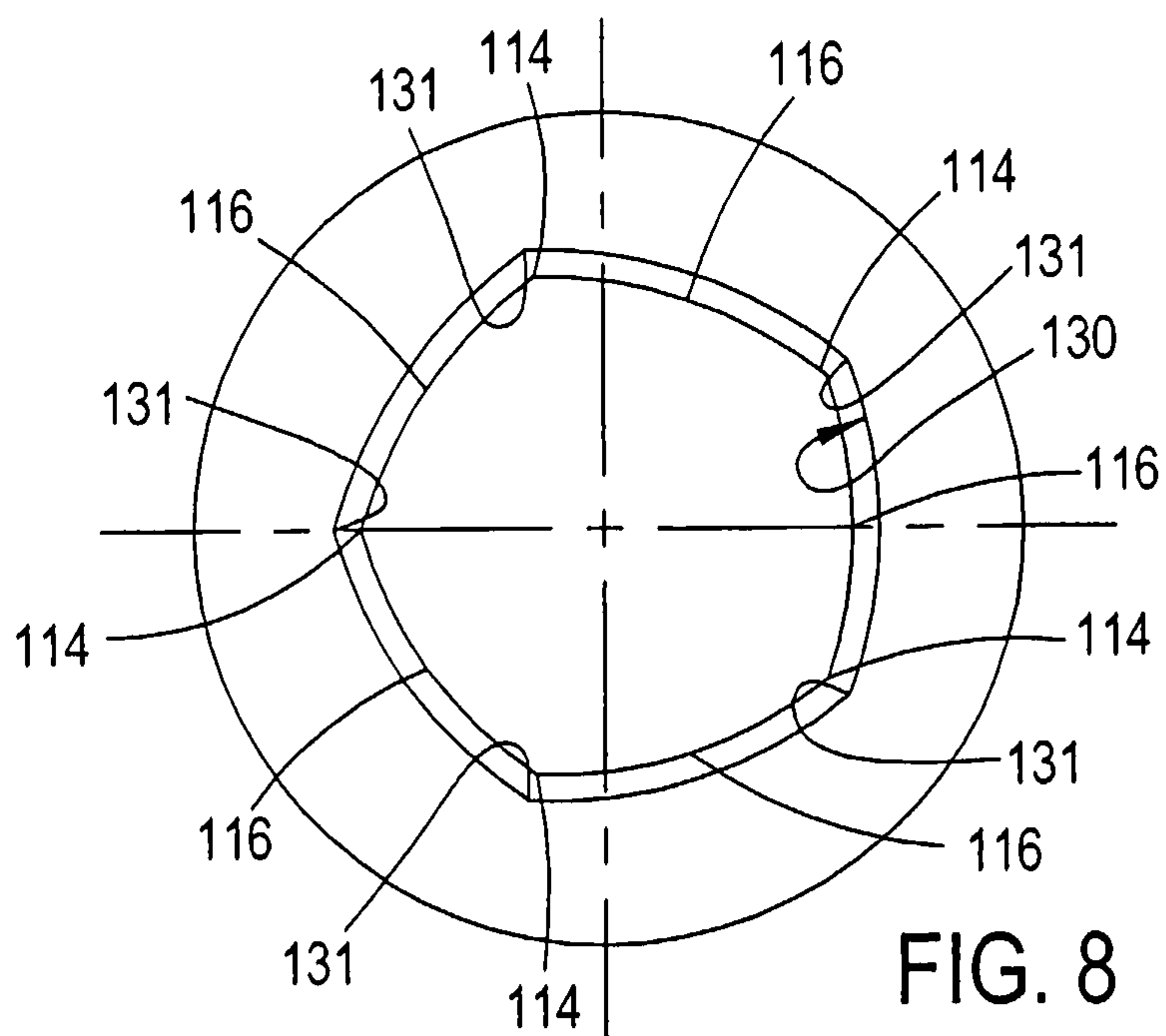


FIG. 7



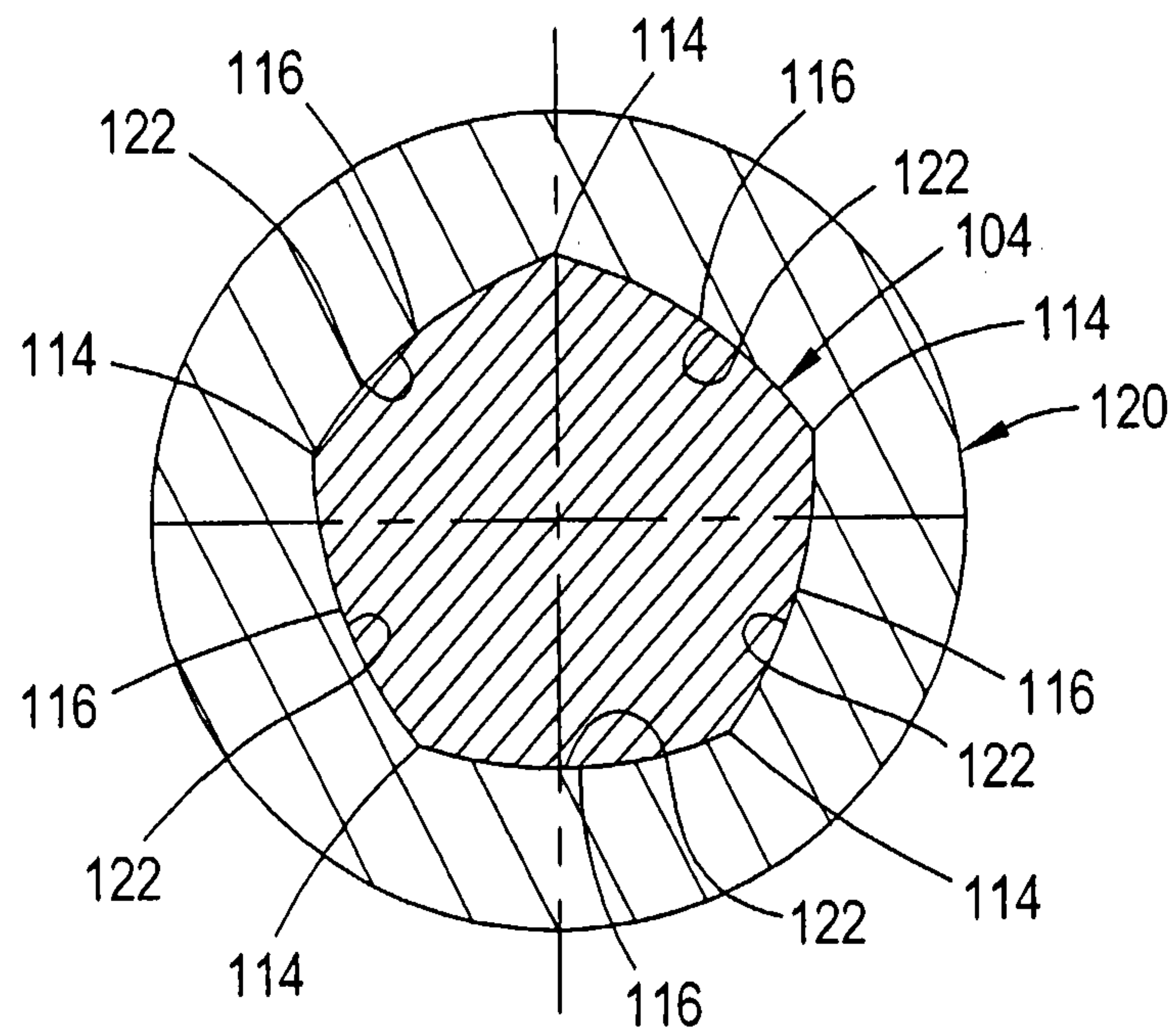


FIG. 10

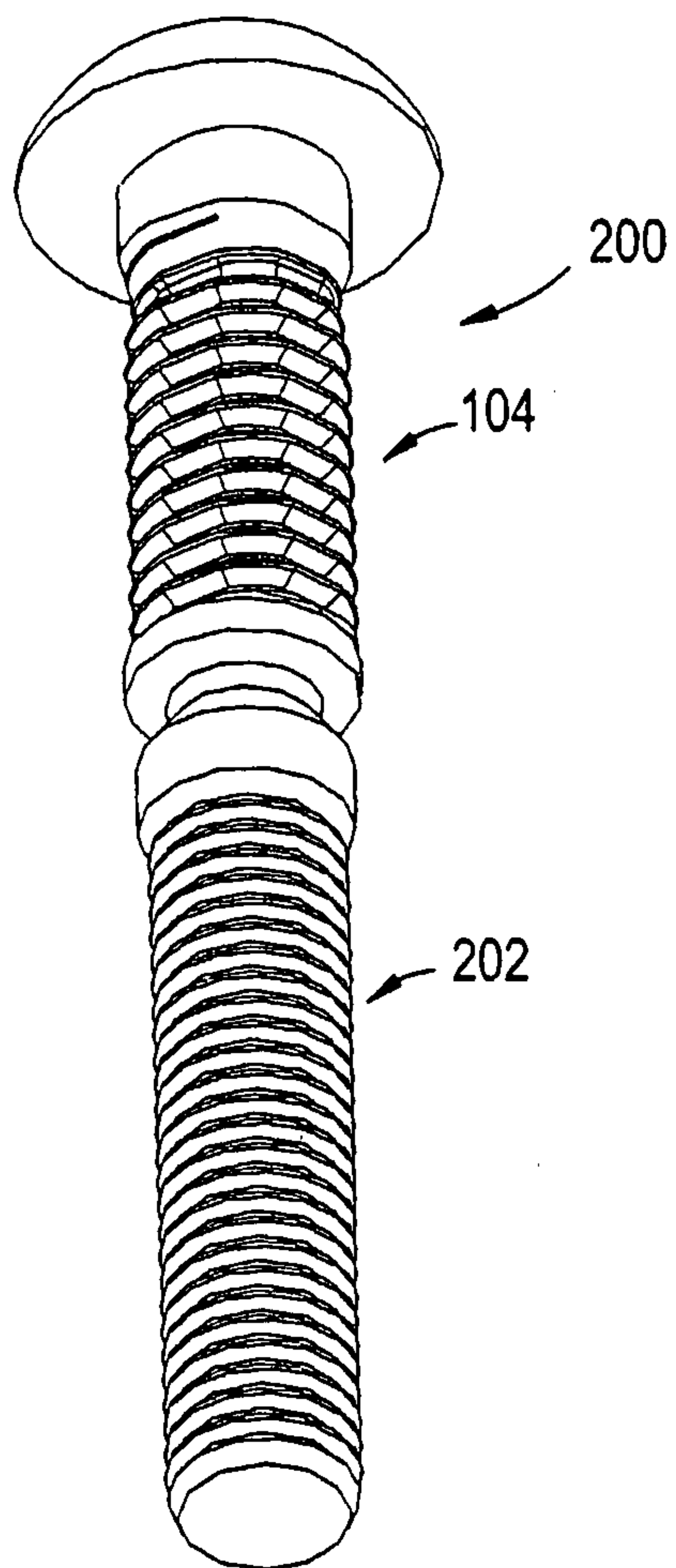


FIG. 11

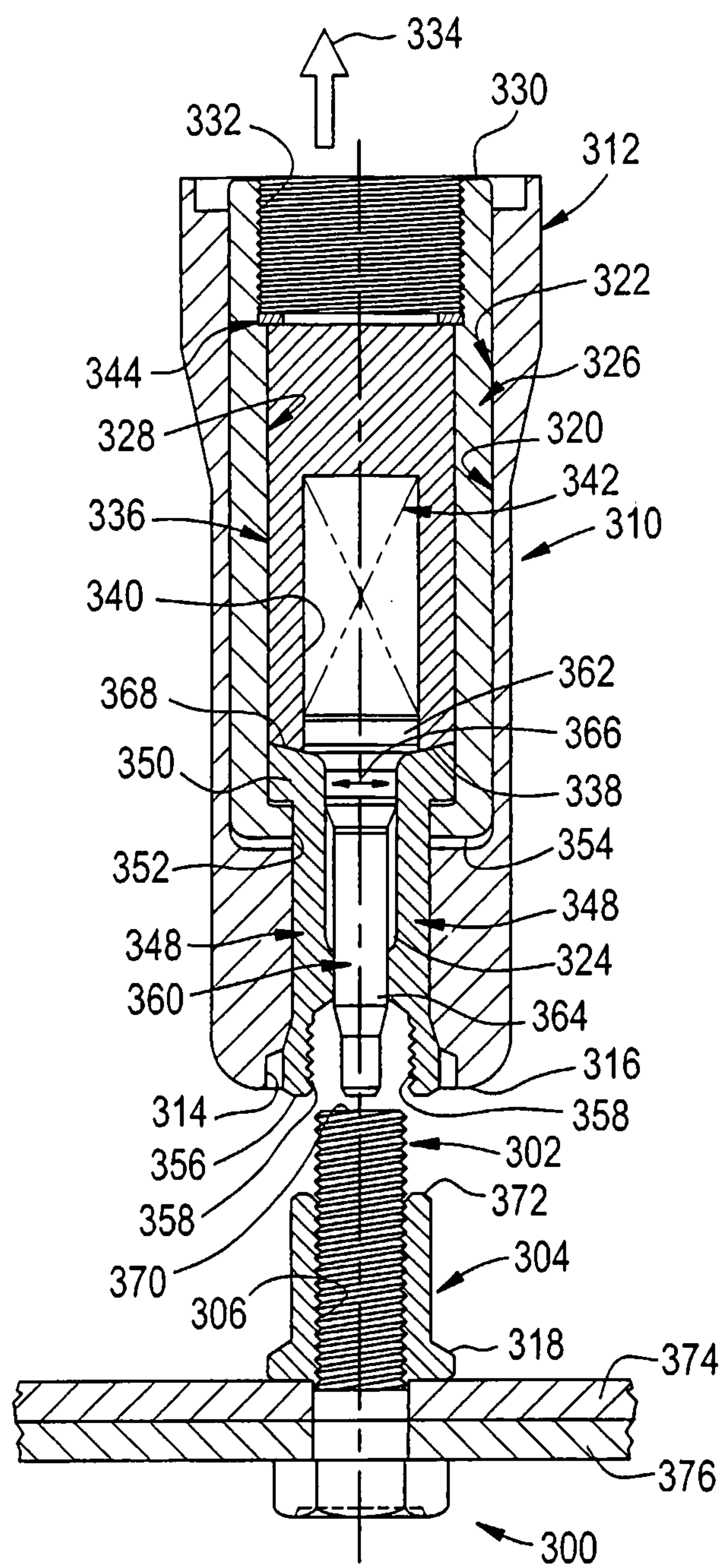


FIG. 12

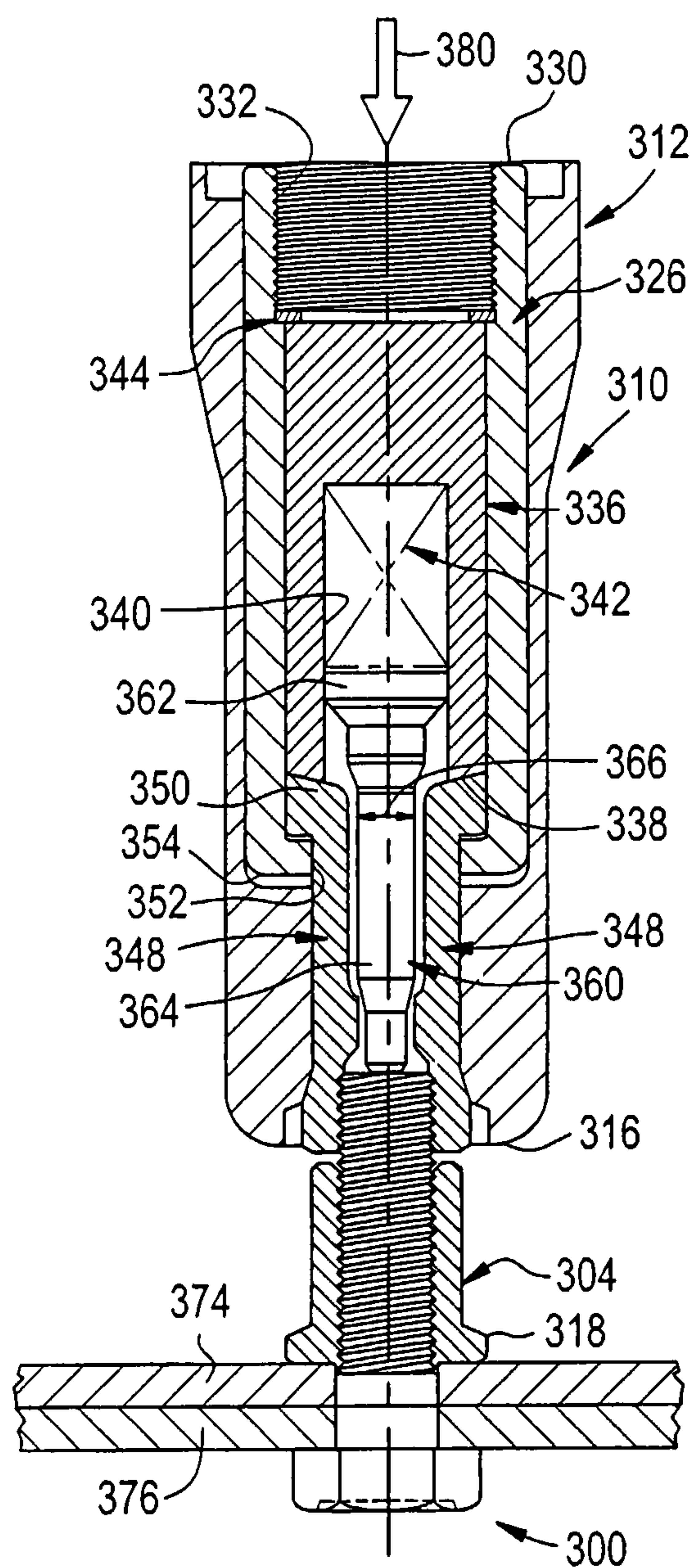


FIG. 13

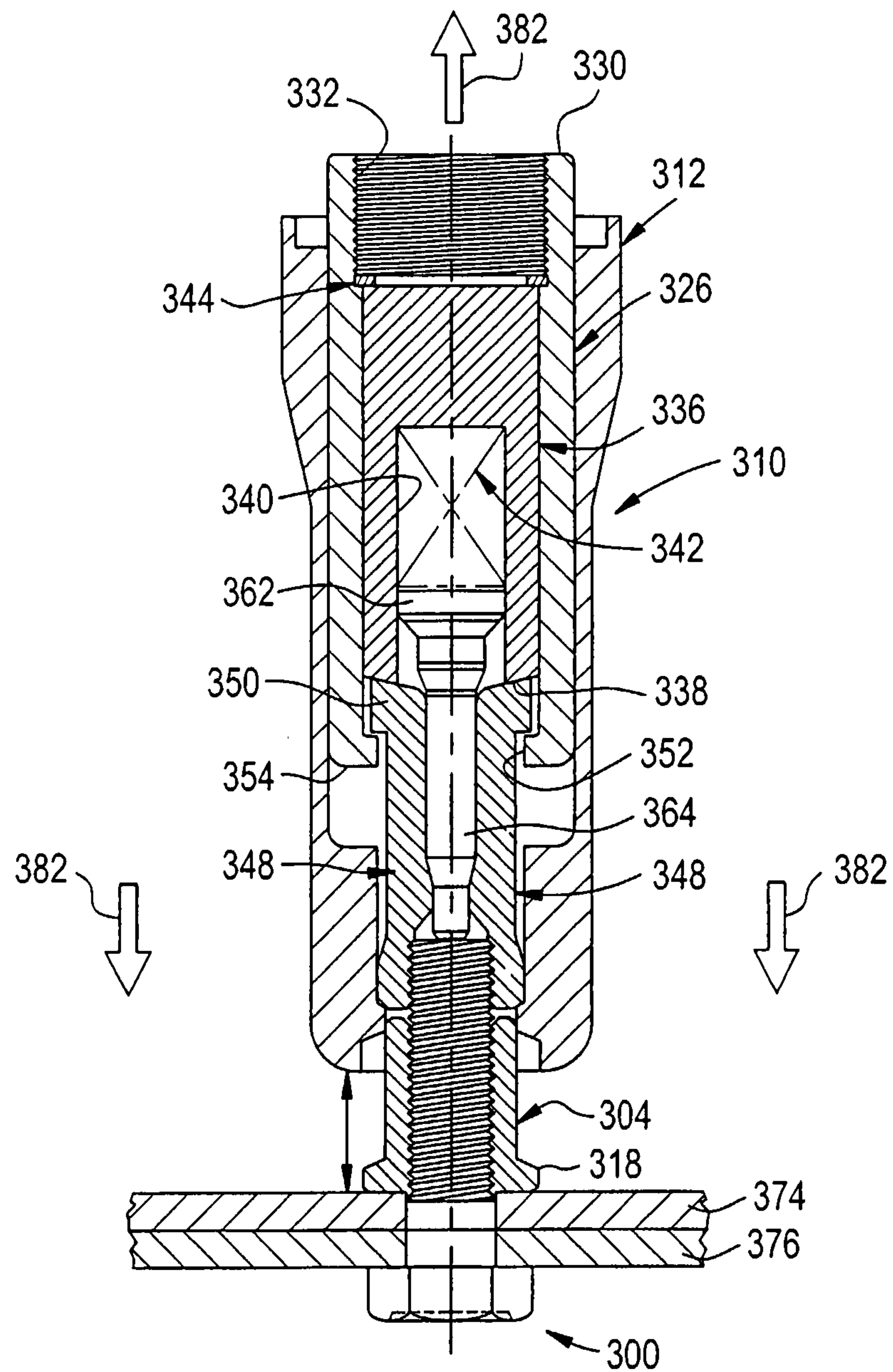


FIG. 14

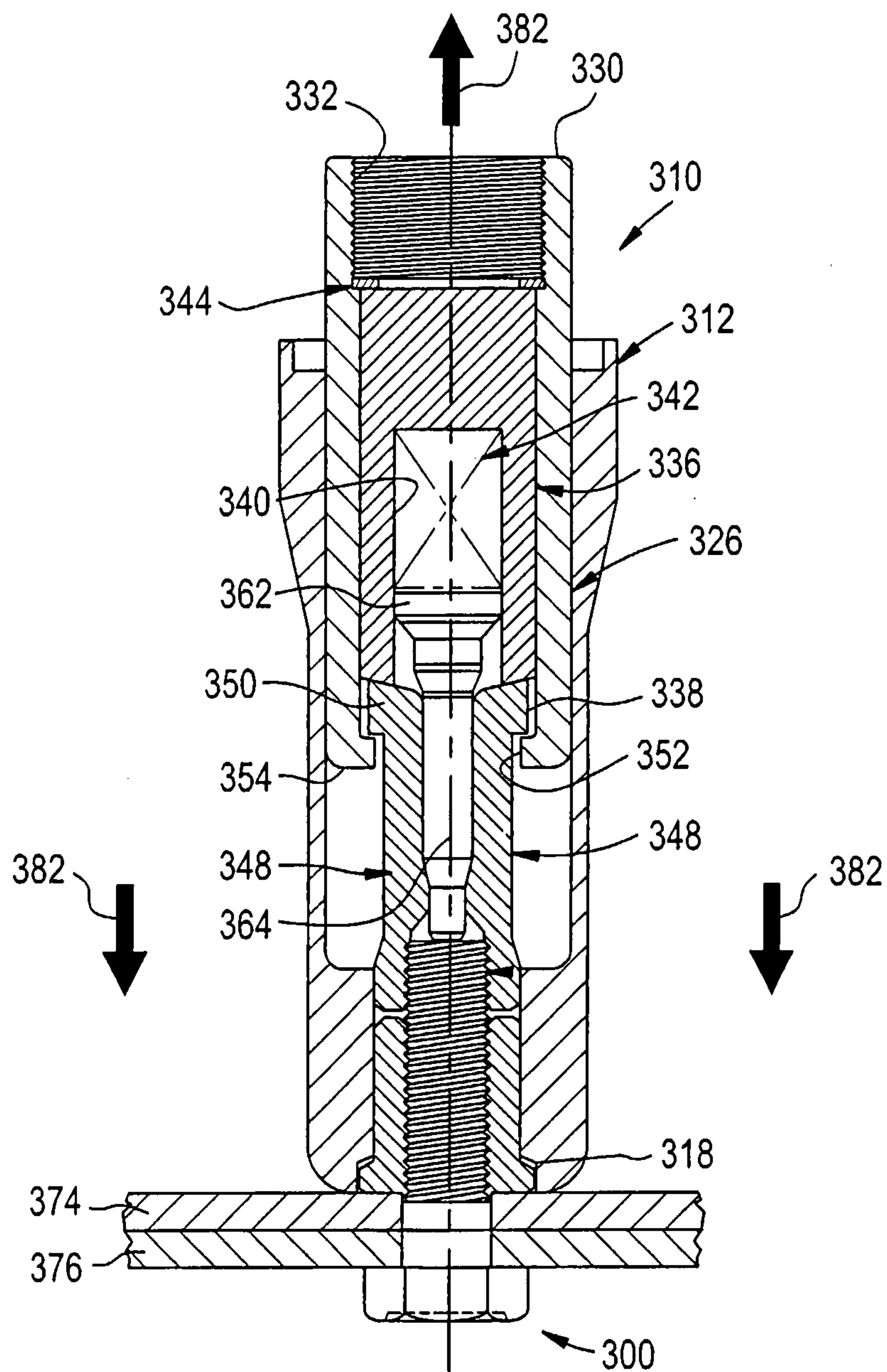


FIG. 15

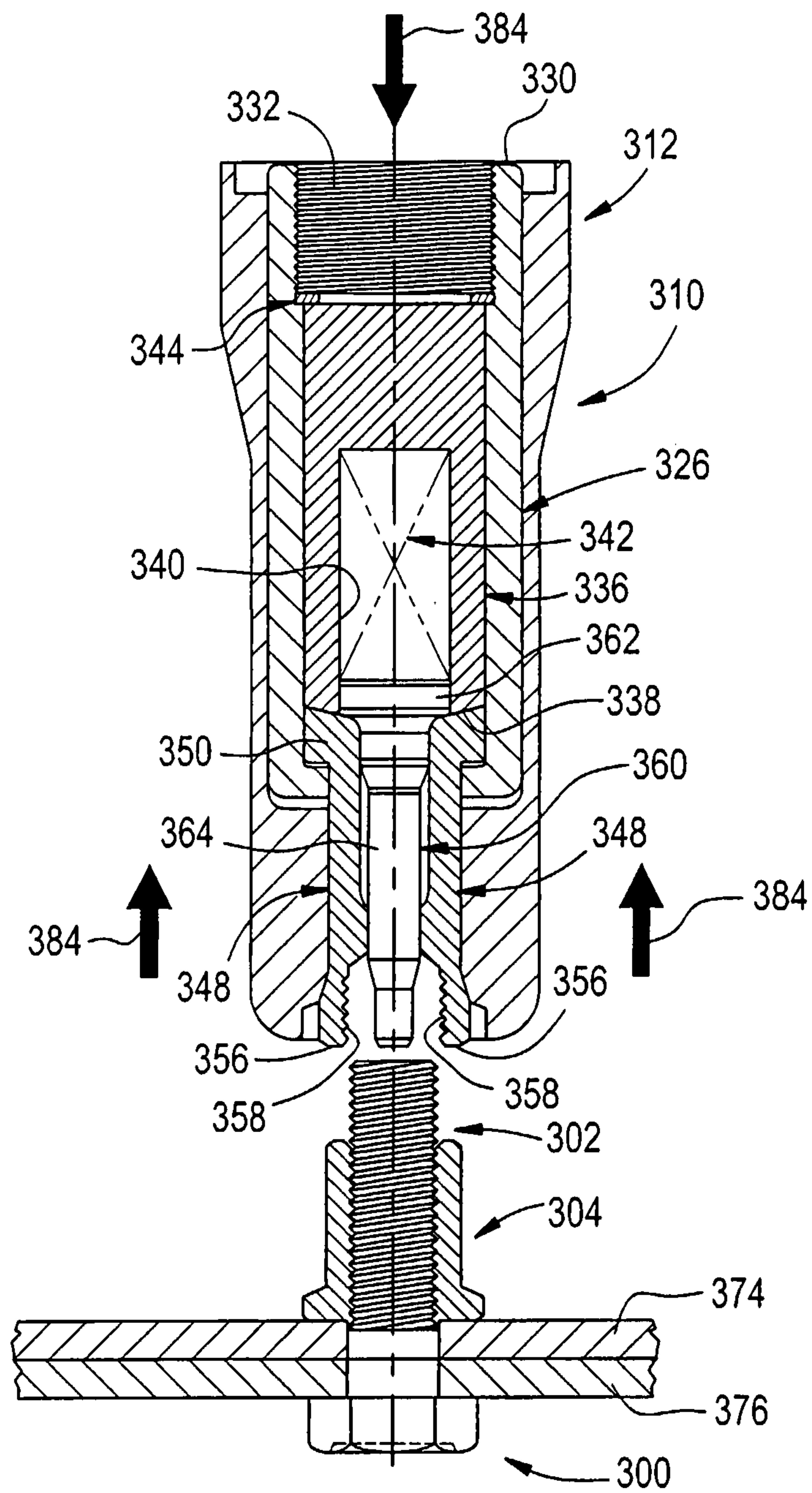


FIG. 16