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(54) **BLIND FASTENER**

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(57) **ABSTRACT**

A blind fastener for installation in a workpiece comprising a plurality of members thereby to secure them together, which fastener comprises first securing means whereby the fastener may be subject to a first part of an installation process in the workpiece to provide a controlled lower level of clamp force in the workpiece, whereby the workpiece members are initially coupled together but may be laterally adjusted relative to each other, and second securing means whereby the fastener may be subject to a second part of the installation process to provide a high level of clamp force in the workpiece, thereby to lock the workpiece members together.

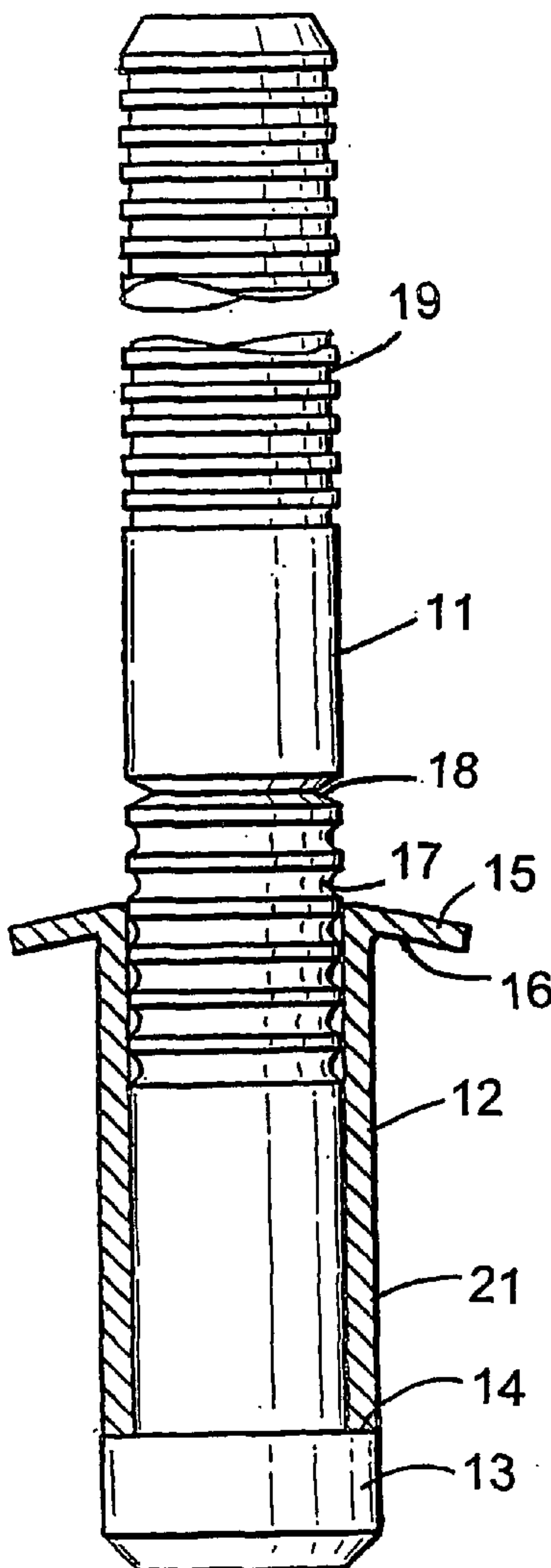
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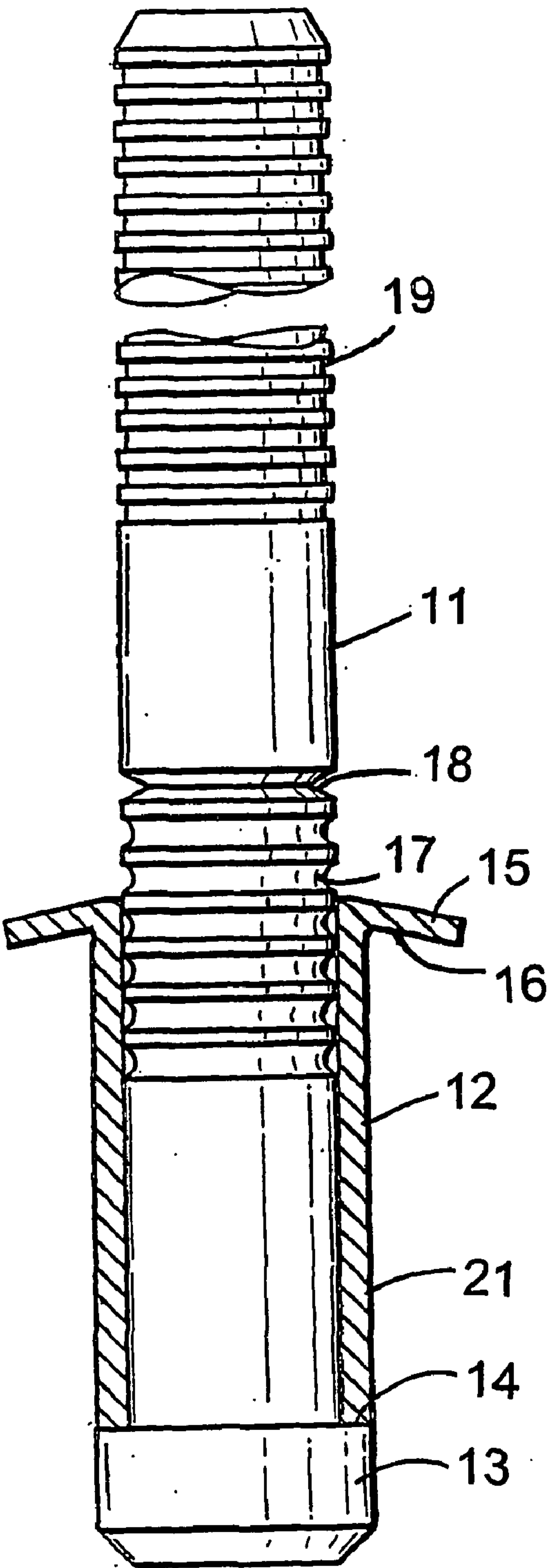


Fig.1A

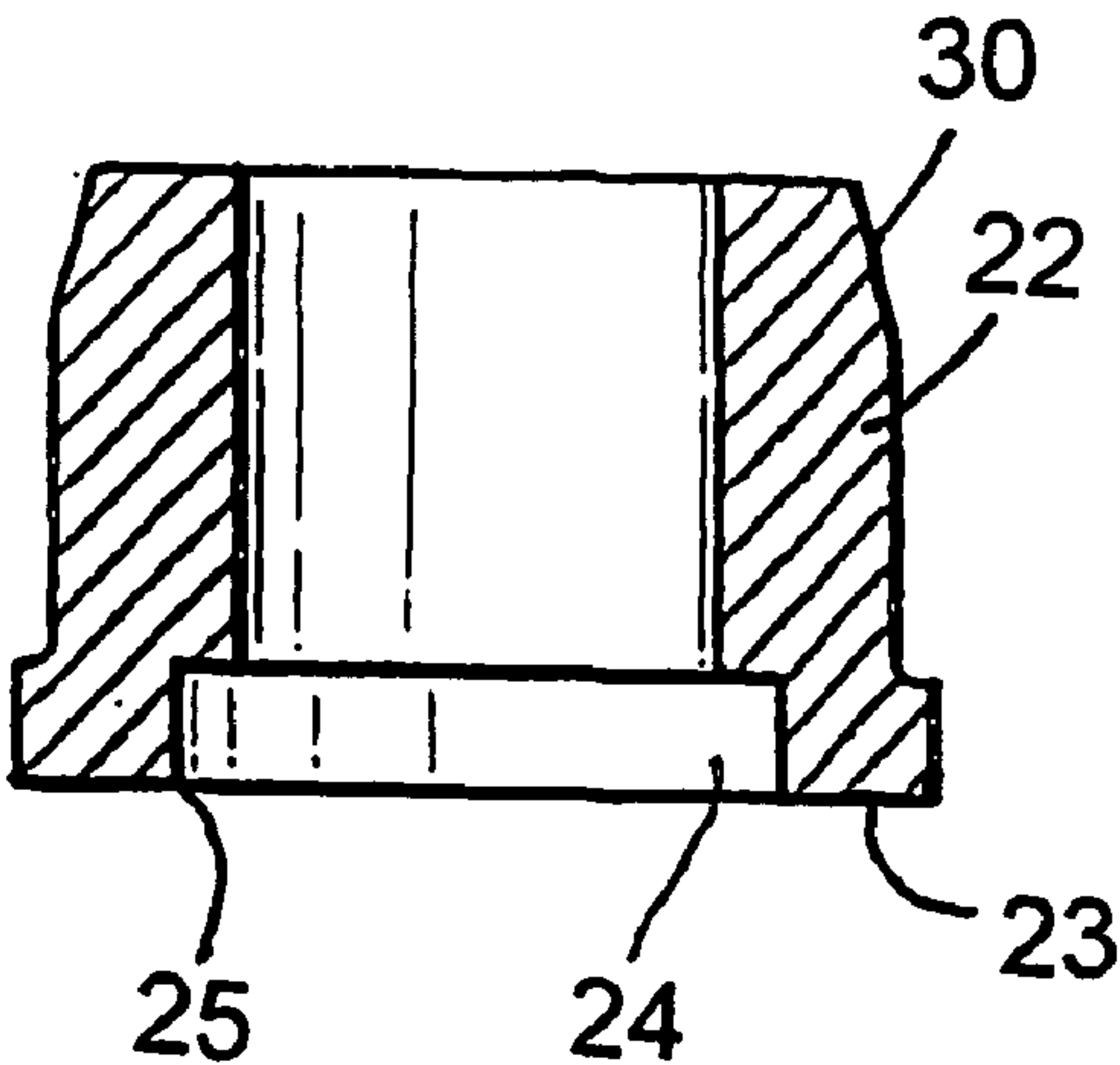
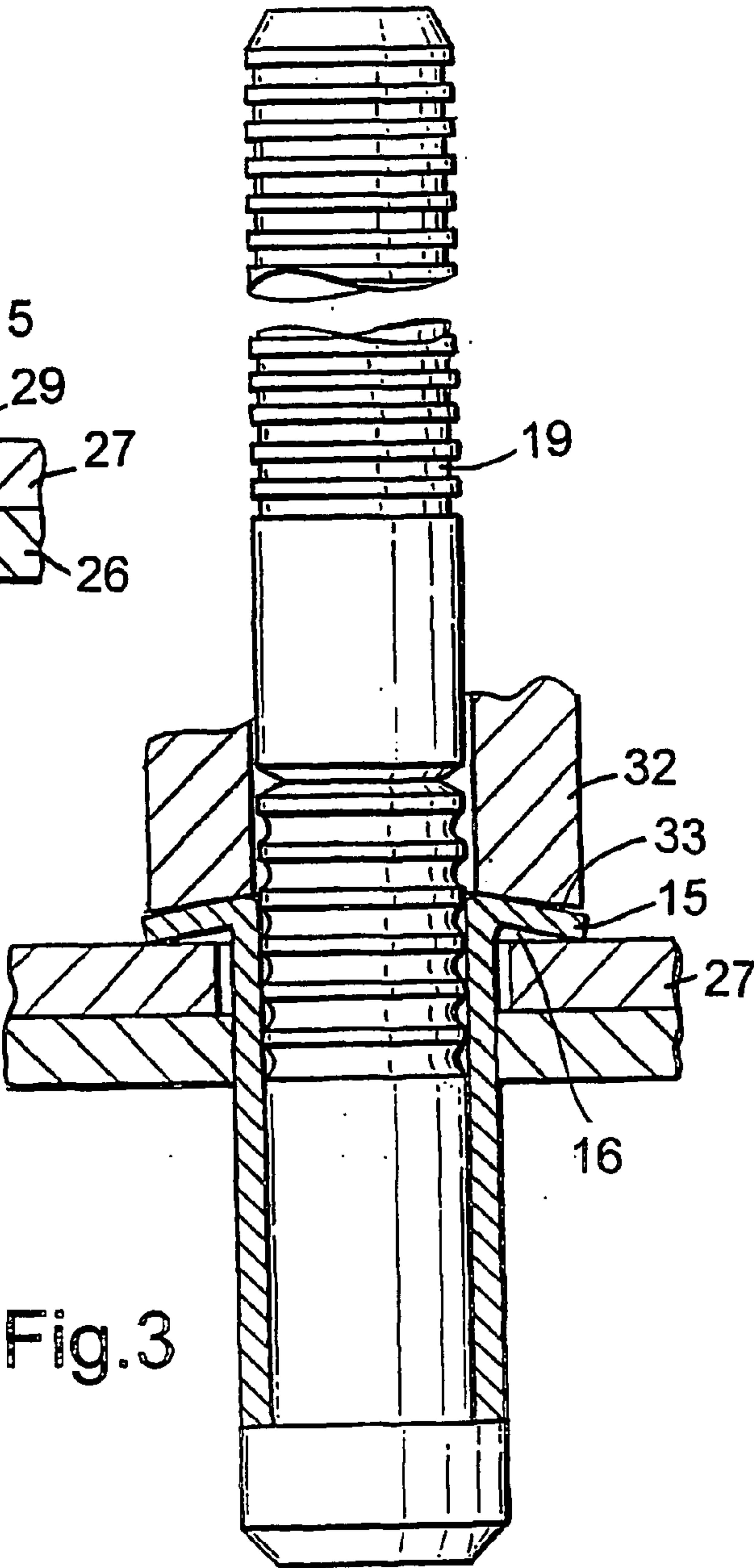
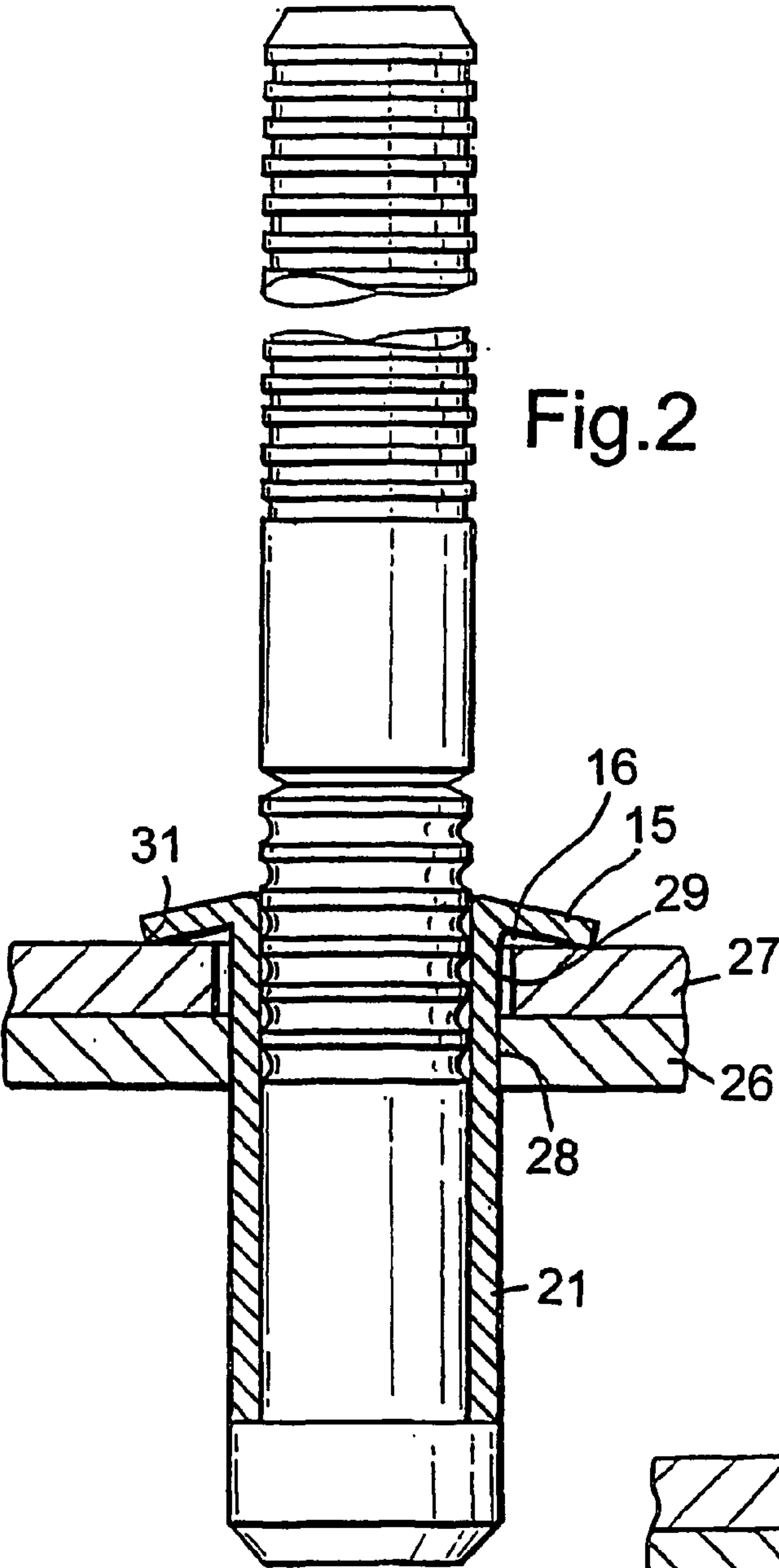
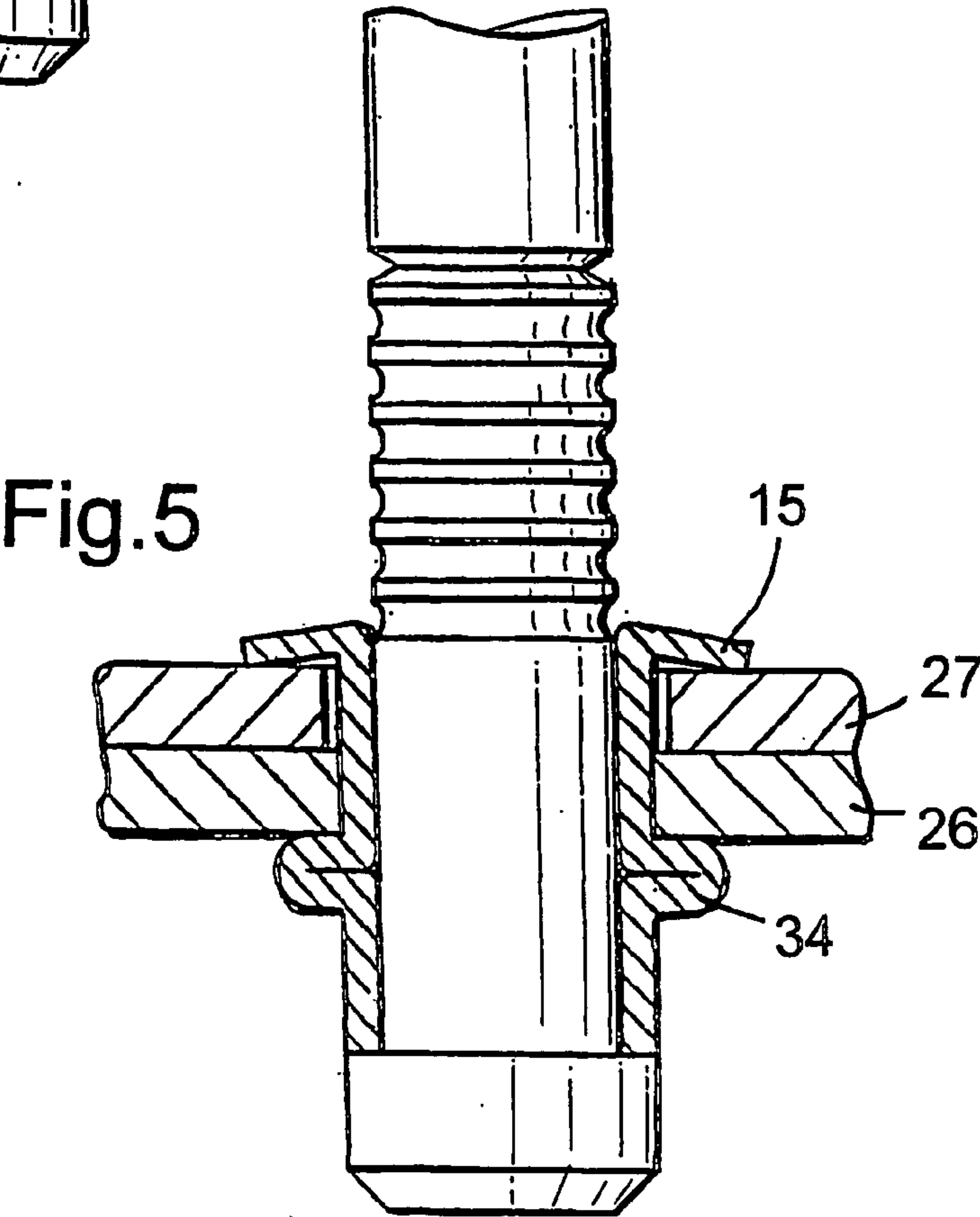
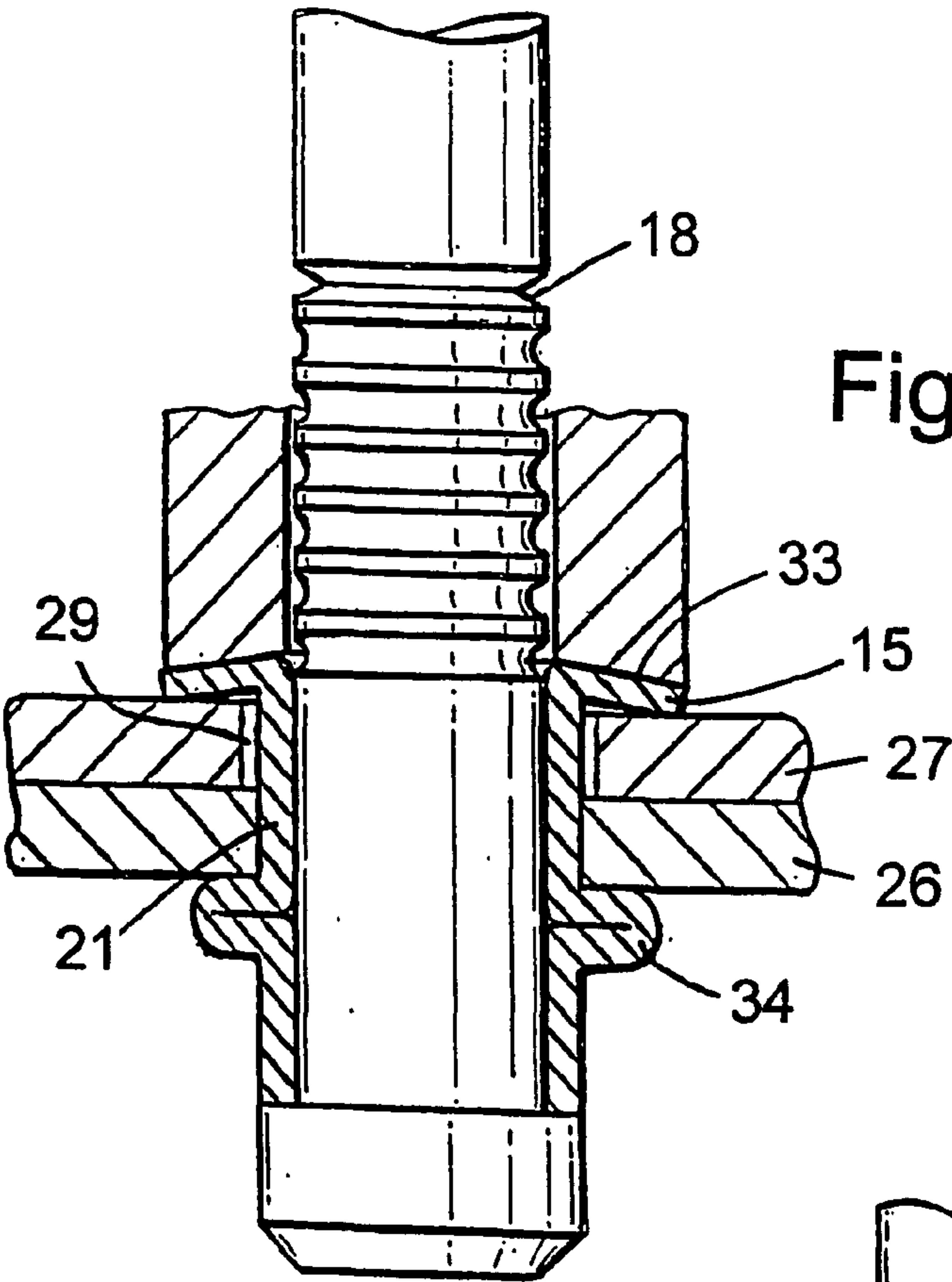


Fig.1B





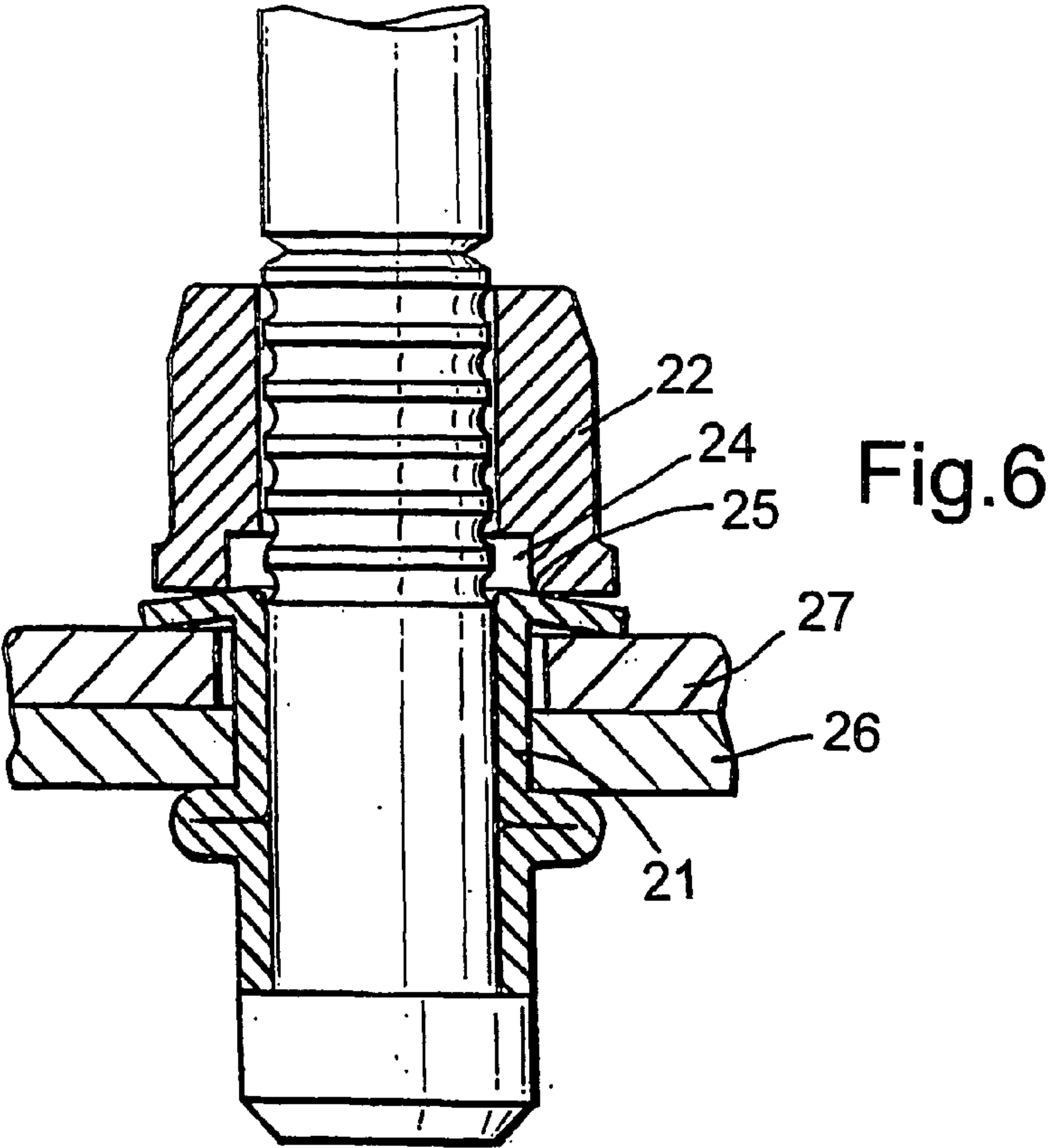
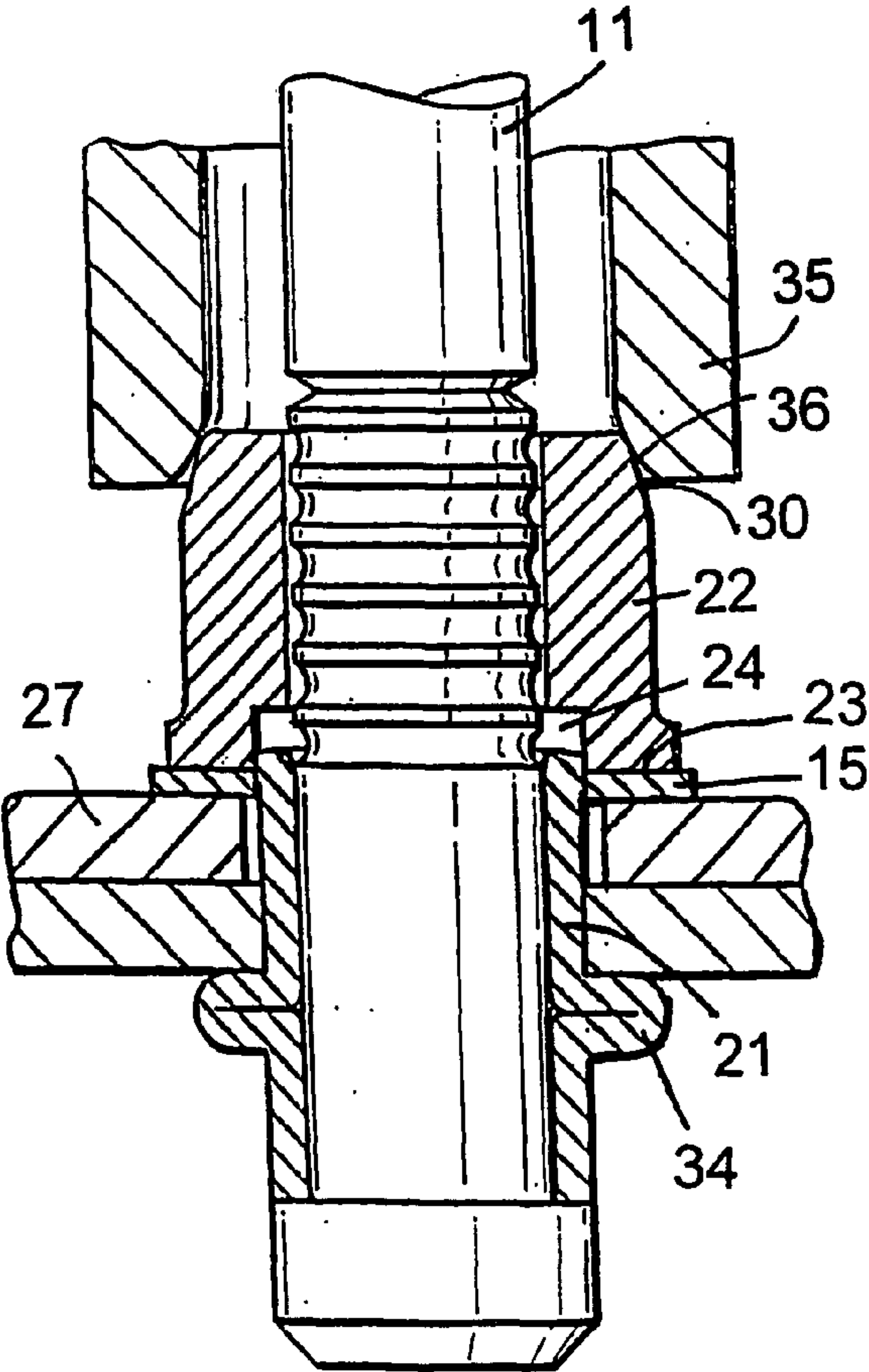


Fig. 7



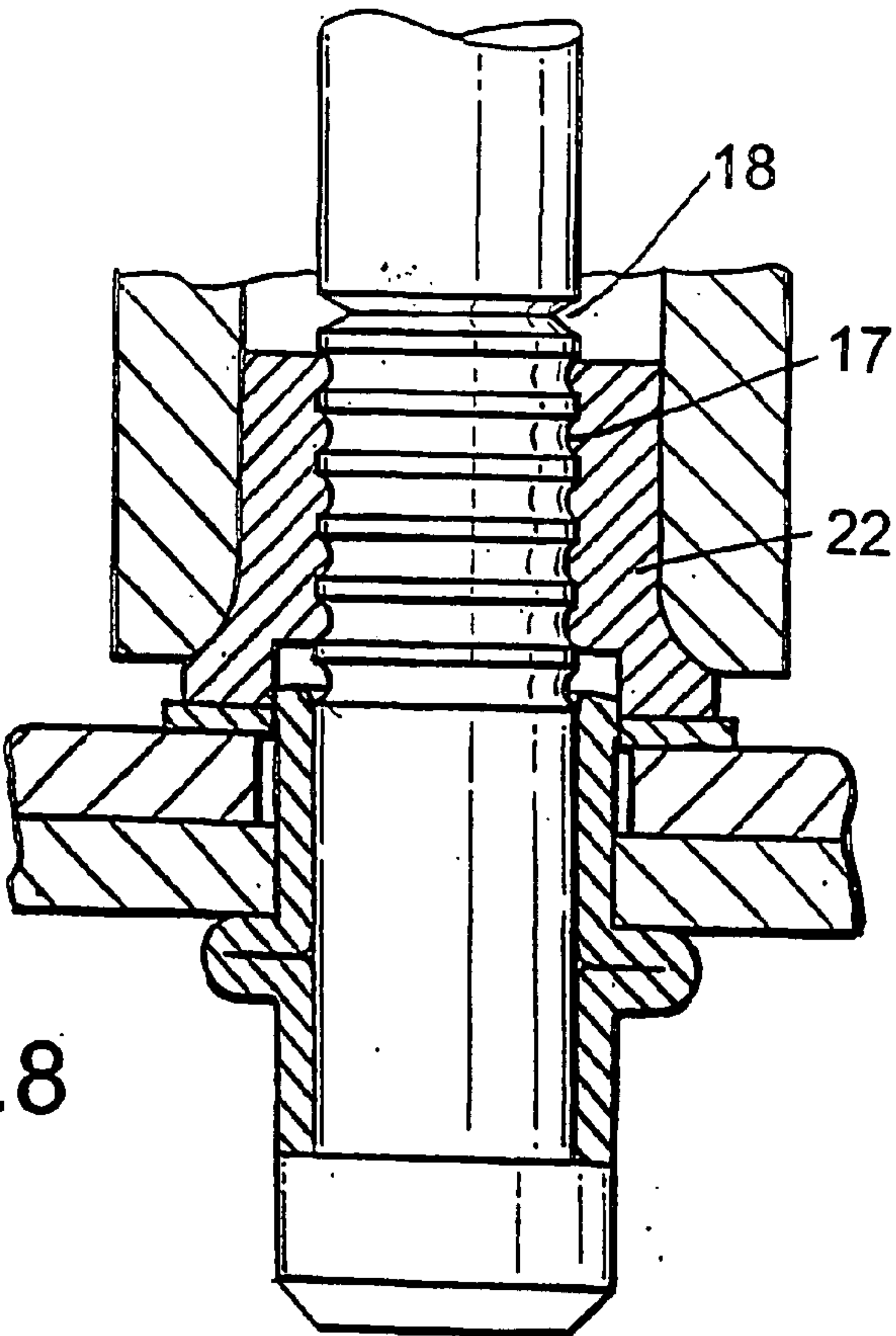


Fig.8

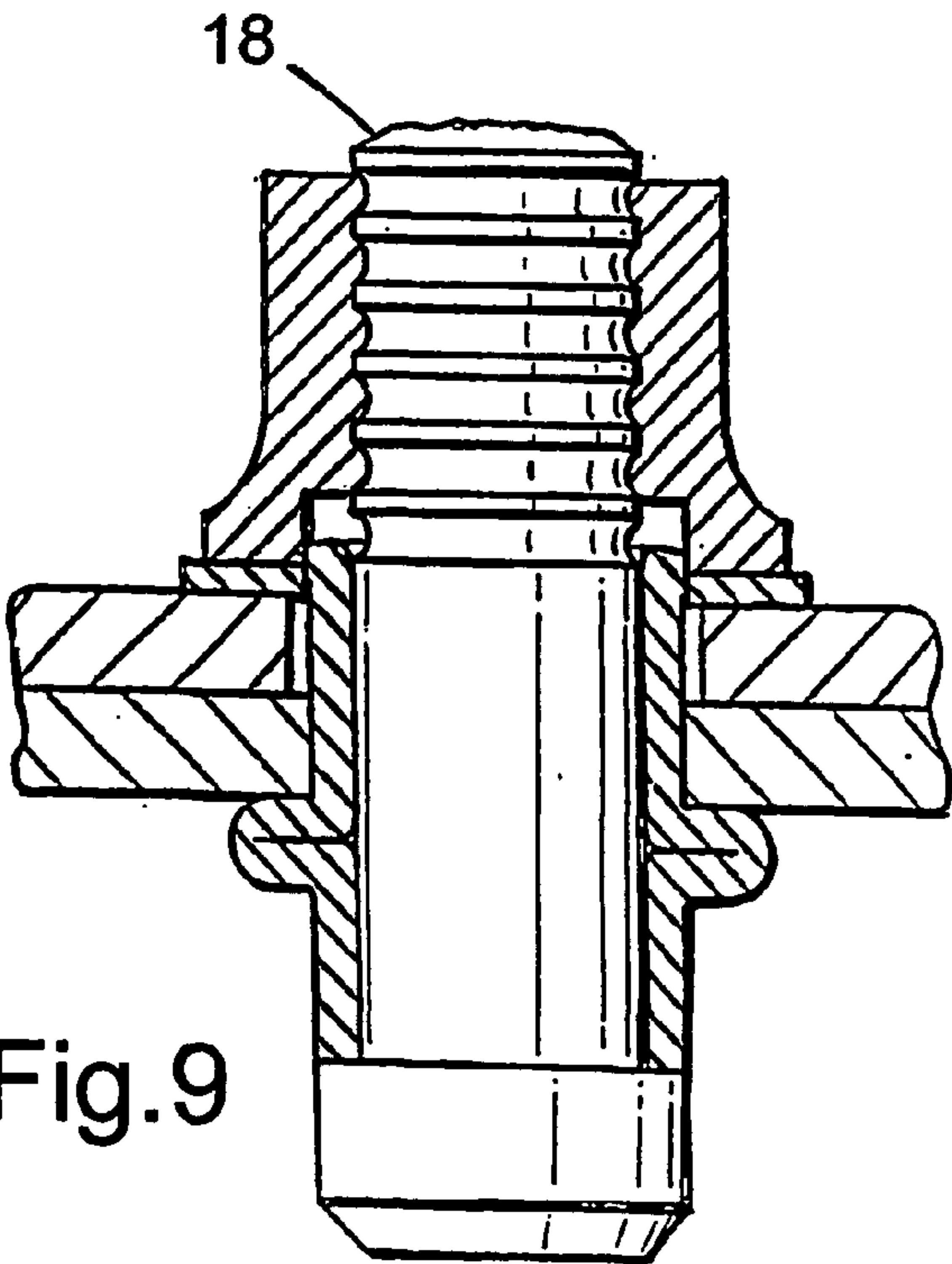


Fig.9

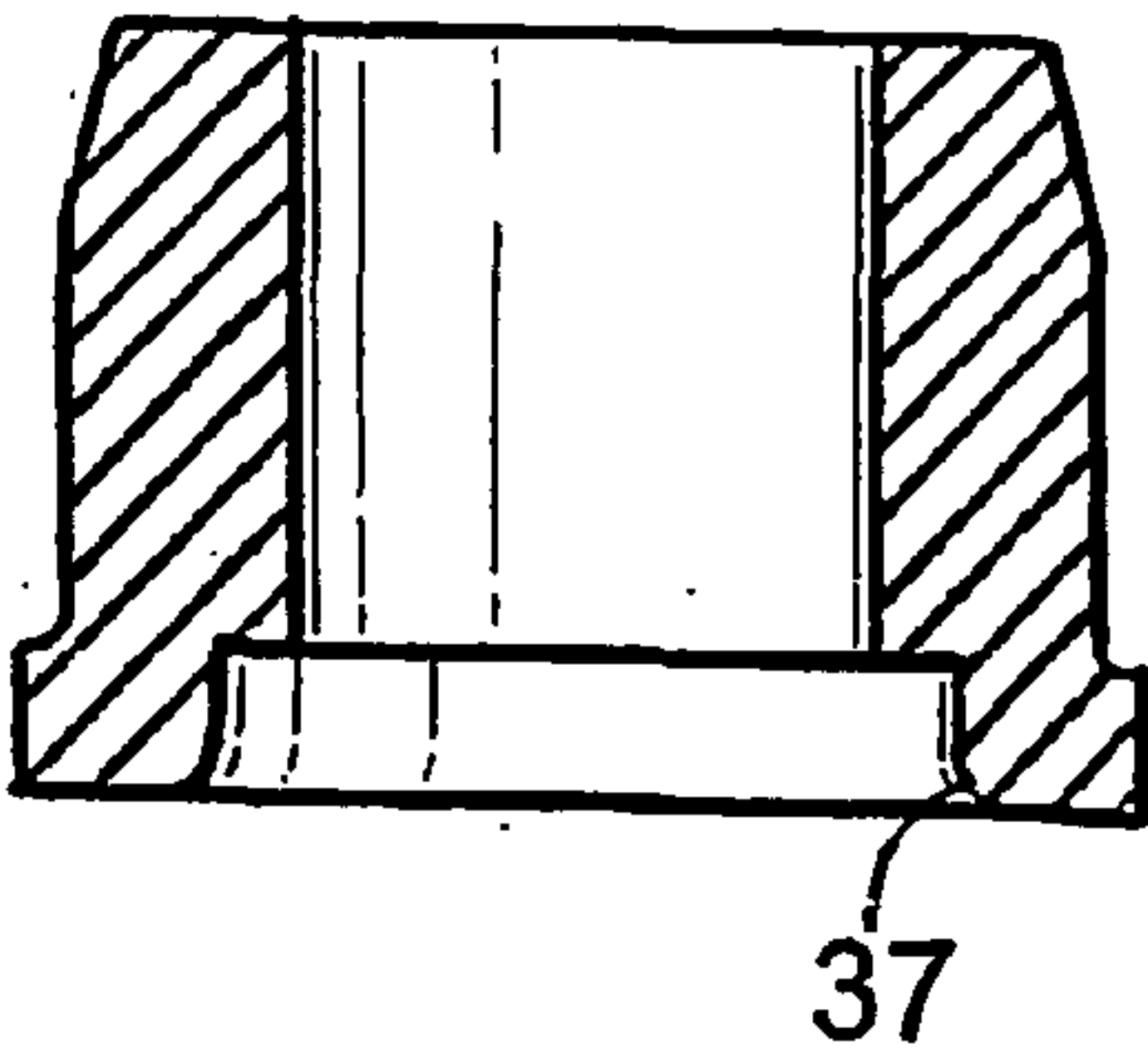
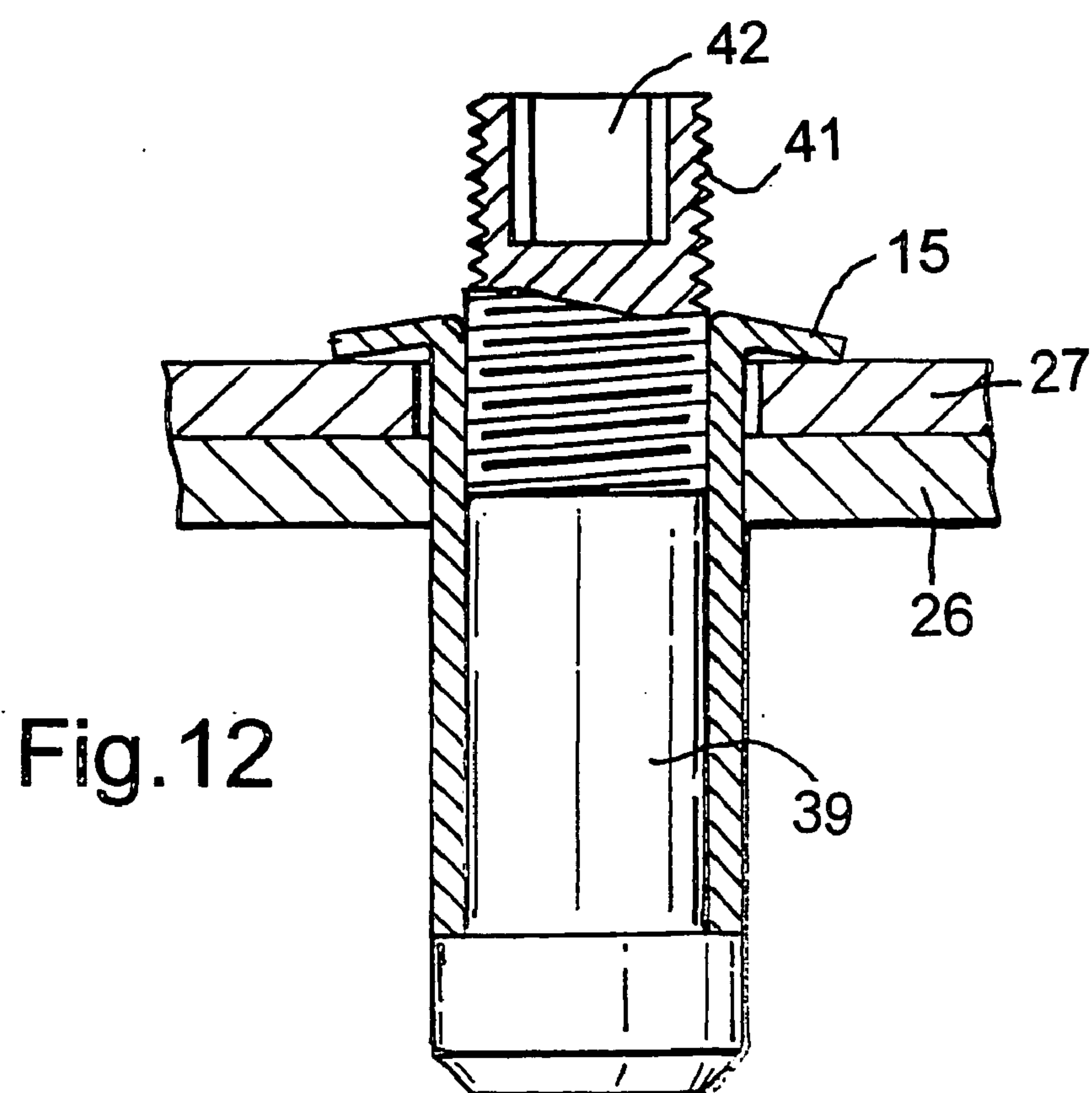
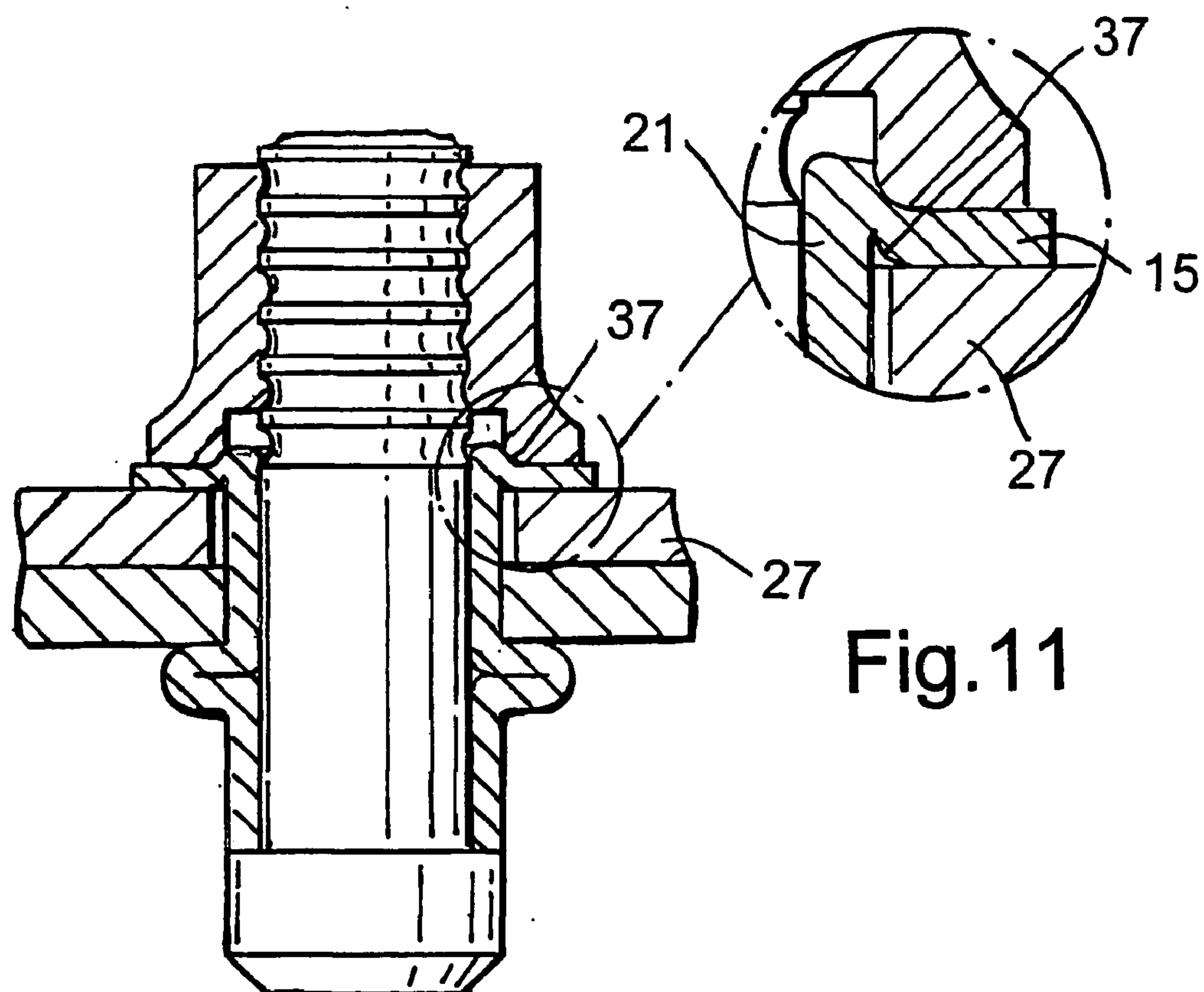


Fig.10



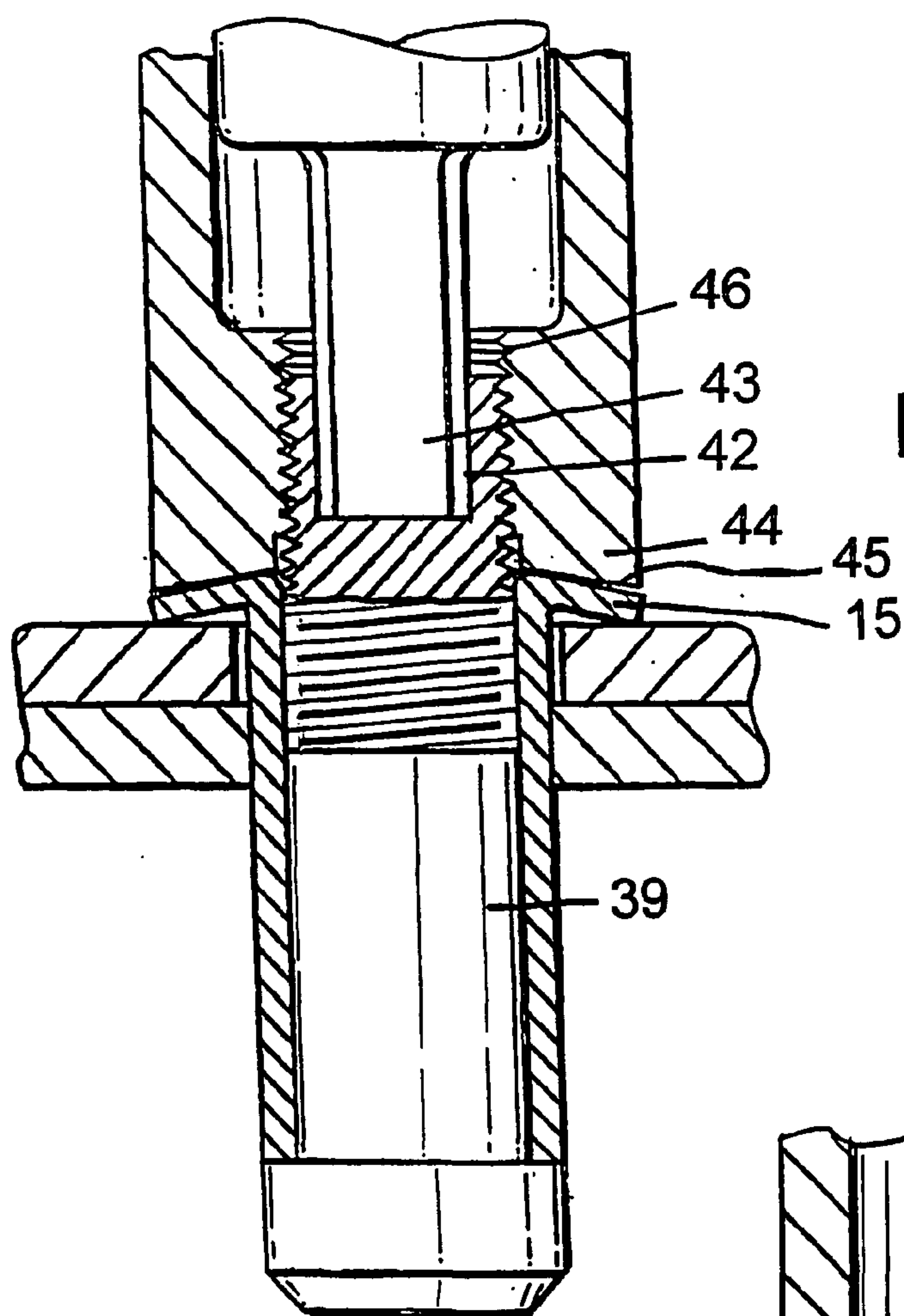
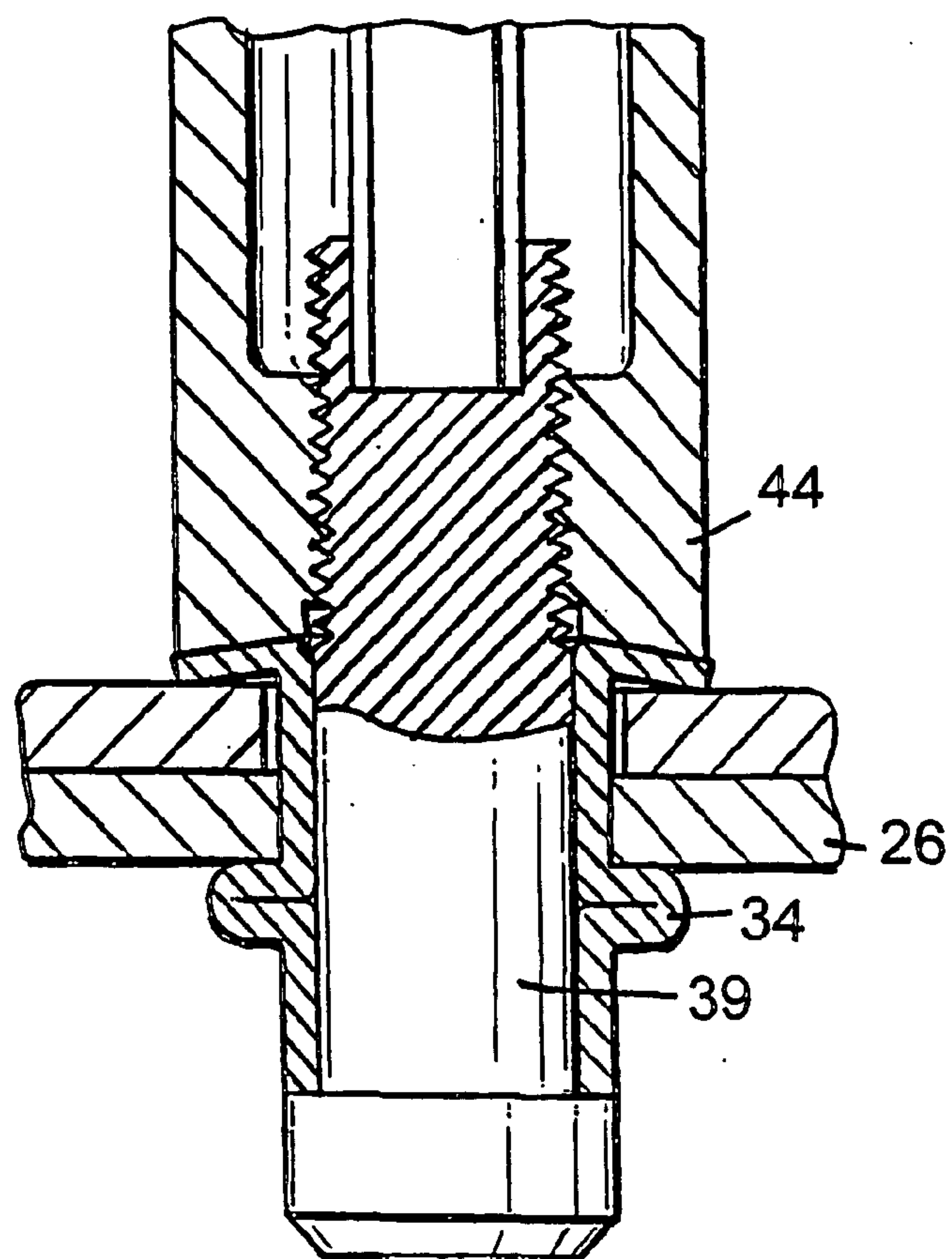
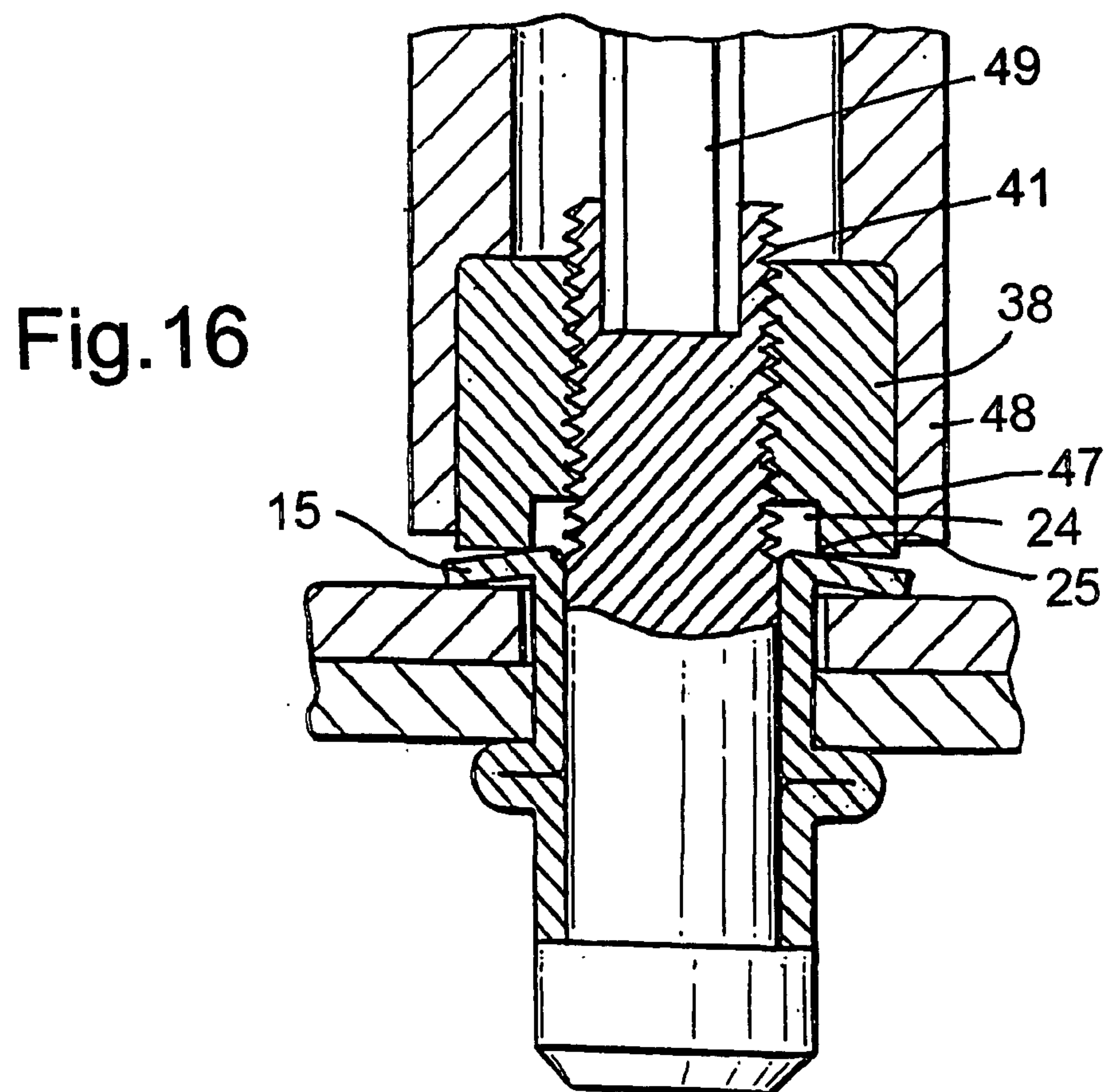
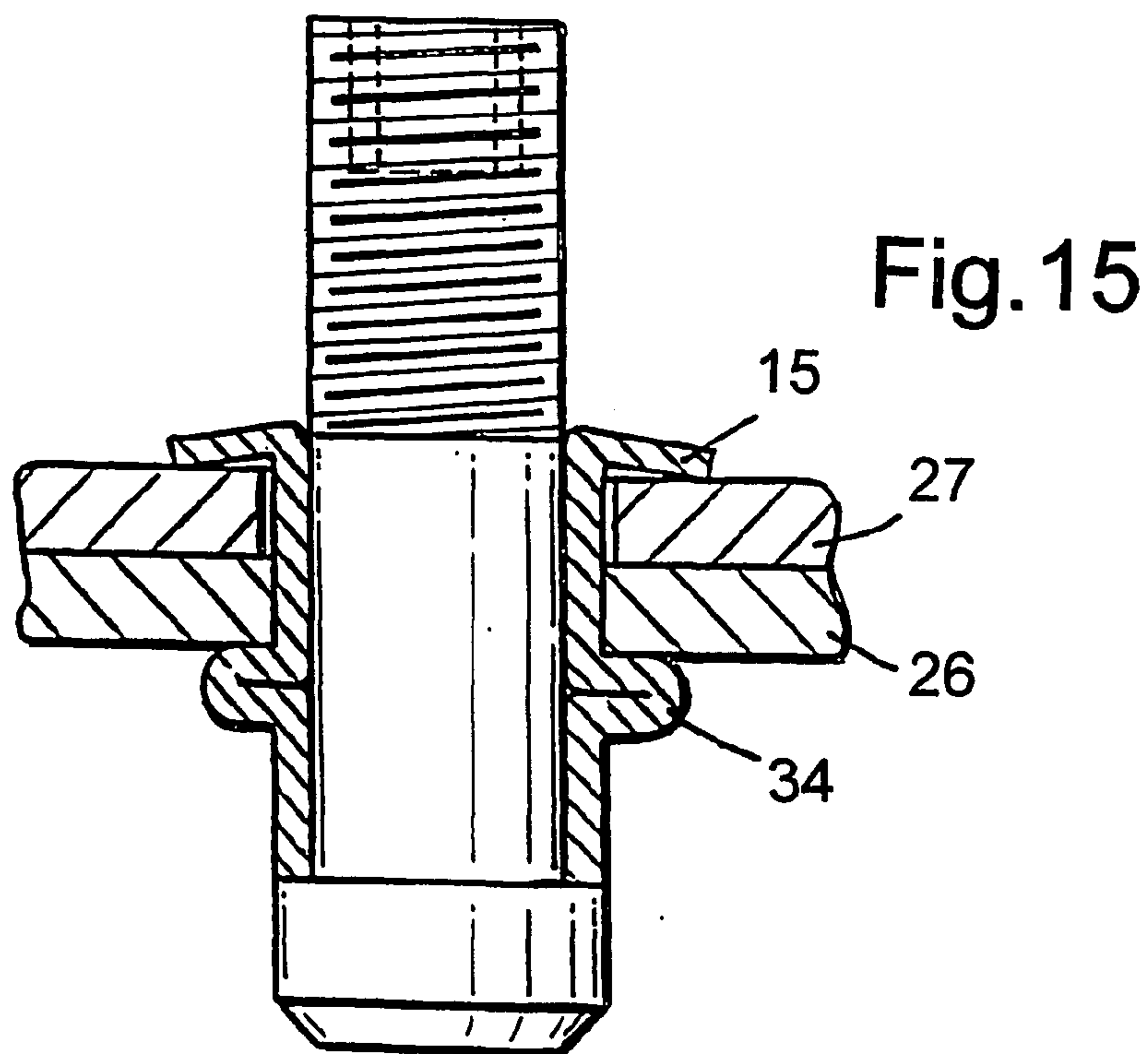


Fig.13

Fig.14





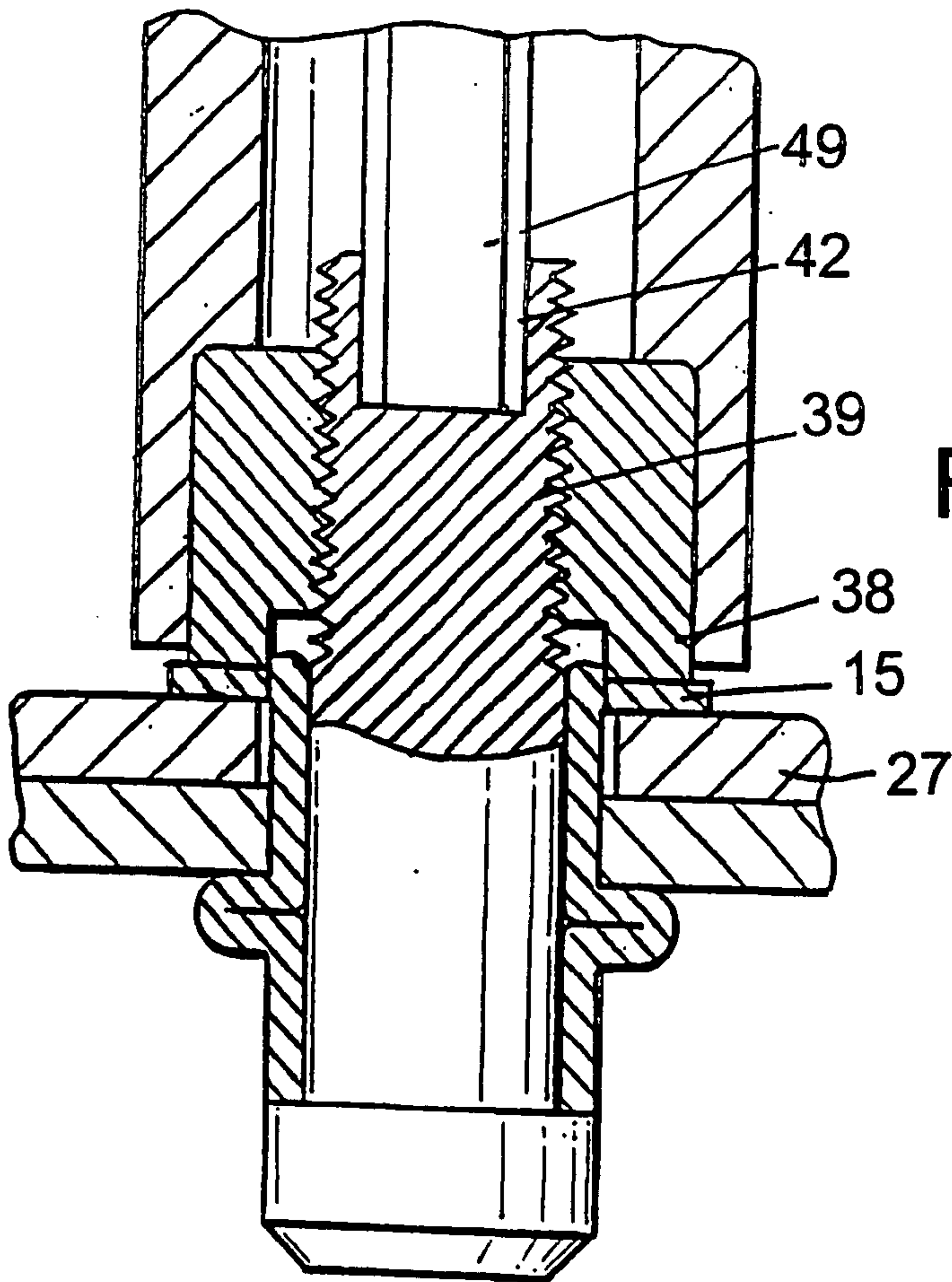


Fig.17

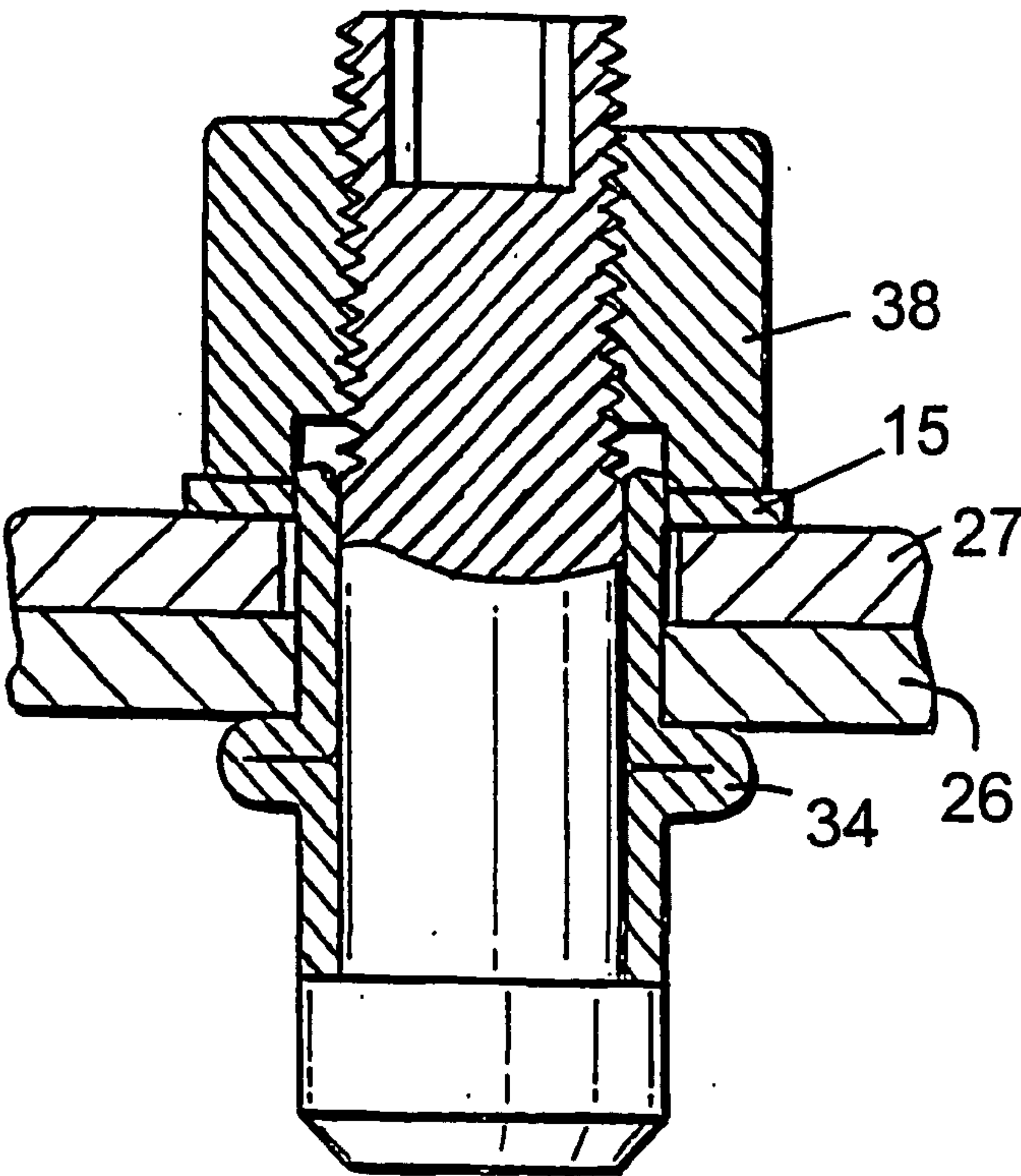


Fig.18

BLIND FASTENER

[0001] The invention relates to a blind fastener.

[0002] The invention provides, in one of its aspects, a blind fastener as hereinafter defined in claim 1 of the accompanying claims

[0003] Further preferred features of the invention are set out in the succeeding claims.

[0004] Two specific embodiments of the invention, including a modification of one of them, will now be described by way of example and with reference to the accompanying drawings, in which:

[0005] **FIGS. 1A and 1B** show a first example in which the locking member is a collar;

[0006] **FIGS. 2 to 9** show successive stages in the installation of the fastener of **FIGS. 1A and B**;

[0007] **FIGS. 10 and 11** show a modification of the fastener of **FIGS. 1A and 1B**; and

[0008] **FIGS. 12 to 18** show successive stages in the installation of a second example in which the locking member is a nut.

[0009] The first example fastener comprises a pin, a body and a collar. The pin **11** is shown in **FIG. 1A** in elevation and is pre-assembled in the tubular body **12** which is shown in axial section. The pin has a radially enlarged head **13** which abuts the tail end face **14** and is of the same external diameter whereas, the other end of the body being formed with a radially enlarged head **15**. The head **15** is of dished or shallow conical shape and has a shallow conical space **16** under the head. The tail portion of the pin **11** protrudes from the head end of the body, and is provided with locking grooves **17**, a breaker groove **18** and tool jaw-engaging gripping grooves **19**.

[0010] It will be apparent to those skilled in the art of blind fastenings that the fastener as thus far described resembles a well-known form of blind rivet, and it functions in much the same way. During the first part of the installation process, the tail-most zone of the body shank **21** collapses radially outwardly to form a blind head, as will be described later. To this end, the body shank **21** is provided with band-annealed weakened zone at an appropriate position along its length. In conjunction with the blind head, the body head **15** provides the first securing means.

[0011] In this example, second securing means is provided by a collar **22**, shown in **FIG. 1B**. The collar has a flat end face **23**, in which is provided with a radially enlarged counterbore **24**, which meets the end face **23** in a square-section edge **25**. The other end of the collar has a chamfer **30**.

[0012] **FIGS. 2 to 9** show the installation of this fastener to secure together two sheet-like members **26** and **27** of a workpiece. The rear member **26** has a hole **28** in which the shank **21** of the fastener body is a close fit, whilst the front member **27** has a hole of slightly larger diameter. The two members **26** and **27** are positioned in mutual contact with the hole **29** overlying the hole **28**. The body shank **21** is inserted through the holes **29** and **28** until the outside rim **31** of the body head **15** contacts the near face of the front member **27**.

The majority of the length of the shank **21** of the body protrudes from the rear member **26**. This is the position shown in **FIG. 2**.

[0013] A pulling tool, similar to the well-known blind riveting tool, is then placed over the fastener pin tail end, as shown in **FIG. 3**.

[0014] The tool has a nosetip **32** which has a shallow conical anvil face **33**. This conical anvil face has a slightly larger included angle than the face of the head **15** of the fastener body. In this example, the included angle of the anvil face is 162°, whereas the included angle of the body head is 158°.

[0015] The tool operator presses the tool towards the members so that the anvil face **33** is in contact with the body head **15** and presses it against the front member **27**. The operator then actuates the tool so that jaws (not shown) engage the gripping grooves **19** on the pin tail and exert tension on the pin, the reaction being taken up by the anvil face **33** against the body head **15**.

[0016] This exerts an increasing axial compression on the shank **21** of the fastener body, with the result that the protruding rear portion of the shank bulges outwardly to form a blind head **34**, as shown in **FIG. 4**. This deformation is promoted by the aforementioned weakened zone in the body shank. The members **26** and **27** are pushed together between the preformed body head **15** and the blind head **34**, thus closing any gap which may initially exist between the members. The reaction between the nosetip and the body head **15** causes the latter to deform slightly, to conform to the slightly shallower shape of the anvil face. (Even if the body head **15** had initially been flat instead of conical, the force exerted on the head would have caused the head to deform to conform to the anvil shape).

[0017] In the example fastener shown, which has a body shank diameter of 10 millimetres, the body head **15** is designed to deform at a force of 2 kN. The blind bulbed head is sufficiently formed to engage the rear member at an applied force of approximately 15 kN, and is fully formed at approximately 20 kN. The installation tool for this first part of the installation process is preset to exert a maximum force on the fastener which is greater than the 20 kN to fully form the blind head **34** and less than the force required to break the pin breaker groove **18**, which in this example is approximately 50 kN. Because the body head **15** is supported by the anvil face **33** during this part of the process, there is no significant deformation of it after the first 2 kN of force has been applied.

[0018] The tool operator then de-activates the tool, so that the gripping jaws release the pin tail, and removes the tool from the fastener.

[0019] The clamp force created to clamp the workpiece members **26** and **27** together may be greater than the 2 kN required to deform the body head **15**, and which is the force supported by this deformed head. However, as the installation tool disengages from the fastener, the deformed body head **15** relaxes under the clamp force, thereby reducing the clamp force to 2 kN. This is the position illustrated in **FIG. 5**. The residual clamp force of 2 kN is low enough to allow lateral adjustment of the two members **26**, **27** relative to each other, if needed, making use of the clearance of the hole **29** in the front member **27** around the body shank **21**.

[0020] After any such adjustment has been made, the second part of the installation process is started. As illustrated in **FIG. 6**, a collar **22** is placed over the protruding pin **11** and pushed towards the members **26** and **27** until the collar counterbore edge **25** contacts the head **15** of the fastener body. As is apparent from **FIG. 6**, the diameter of the collar counterbore **24** is slightly greater than the outside diameter of the body shank **21**.

[0021] A second installation tool is now applied to the protruding pin tail **11** and the collar **22**. This tool is similar to the well-known type of tool used for installing swage-type lockbolts. The tool nosetip **35** has an internally chamfered and curved face **36** which is of an appropriate size to co-operate with the chamfer **30** of the collar. The operator actuates the tool so that it engages with and grips the gripping grooves on the pin tail (not shown in **FIG. 7**) and applies increasing tension to the pin tail **11**, the reaction being taken up by reaction of the anvil face **36** on the collar **22** and thereby of the collar edge **25** on the body head **15**. This tool is preset to apply substantially greater tension than is the first tool. As the tension applied by it increases, the head **15** of the body shears annularly, since the diameter of the collar counterbore edge **25** is slightly greater than the outside diameter of the body shank **21**. The sheared-off head **15** is driven against the front face of the front sheet, where it acts as a washer between the collar face **23** and the front member **27**. The counterbore **24** of the collar is sufficiently deep to allow the top end of the body shank **21** to enter it without meeting the end of the counterbore, even if further compression of the blind head and of members **27** and **26** occurs. The axial clamp force between the collar **22** and the blind head **34** is exerted completely on the members **26** and **27**, none of it being supported by the fastener body.

[0022] As the force exerted by the tool continues to increase, the tool anvil compresses the collar radially inwardly and passes down over it, swaging the collar into the locking grooves **17** on the pin, and securing the collar to the pin. This is the position shown in **FIG. 8**.

[0023] As the force increases still further, the tension on the pin tail causes the pin to fracture at the breaker groove **18**. This is the position shown in **FIG. 9**, after the tool and broken-off pin tail have been removed from the fully installed fastener.

[0024] One possible modification of the fastener just described is illustrated in **FIGS. 10 and 11**. In this, the collar counterbore has a radiussed edge **37**. This has the result of not shearing the body head **15** from the shank **21**, but of deforming it, still connected to the shank **21**, into contact with the front face of the member **27**. This provides a slightly larger area of contact with the face, but the residual clamp load is reduced (compared with the sheared-off head version).

[0025] A second example fastener is illustrated in **FIGS. 12 to 18**, corresponding respectively to **FIGS. 2 to 9** of the first example. The fastener of this second example is generally similar to that of the first example, and only the differences will be described. In the second example, the collar is replaced by an internally threaded nut **38**. The nut **38** has a counterbore **24**, with a square leading edge **25**, like the collar in the first example. The tail end of the pin **39** is shorter and is provided with a threaded portion **41** to mate with the nut **38**. The end face of the pin is provided with a

hexagonal wrenching recess **42**. There are no gripping grooves, locking grooves or breaker groove. Two rotary tools are used in the installation process, both of which have a non-rotatable hexagonal key which engages the pin recess **42** to prevent the pin from rotating.

[0026] **FIG. 12** shows the fastener inserted through the members **26** and **27** so that the body head **15** contacts the front sheet **27**. A first rotary tool is then applied to the fastener. The tool hexagonal key **43** is sprung forwardly so that it engages in the recess **42** of the fastener pin but can retract with respect to the tool nosepiece **44**, which is internally threaded at **46** to engage the pin and which has a conical anvil face **45** similar to the anvil face **33** of the first tool in the first example. The tool is actuated so as to cause rotation of the anvil **44** with respect to the wrench pin **43**, thus securing the anvil down on to the fastener, until the anvil face **45** contacts the fastener body head **15**. This is the position shown in **FIG. 13**.

[0027] Continued operation of this tool draws the fastener pin **39** into the nosetip, causing the formation of a blind head **34** which contacts the rear member **26**, and the slight deformation of the body head to conform to the shape of the tool anvil face **45**, as shown in **FIG. 14**. This first tool is preset to reverse at the torque corresponding to this position, and it is then removed from the fastener, leaving the fastener securing the members **26** and **27** at a pre-determined low clamp value, as shown in **FIG. 15**. They can then be laterally adjusted if needed.

[0028] A nut **38** is then threaded over the threaded portion **41** of the pin. This may be done by hand or by a separate application tool, but is most conveniently done by pre-loading the nut in the matching wrenching socket **47** in the nosetip **48** of the second installation tool. The tool is actuated, to rotate the nosetip **48** with respect to the fixed key **49** of the tool, which is axially fixed and not retractable. The nut **38** has a counterbore **24** with a shank edge **25**, like the collar **22** in the first example. As the nut **38** progresses down the pin, it first contacts the head **15** of the fastener body, as shown in **FIG. 16**. Further action of the tool causes the head **15** to shear from its body, as in the first example and as shown in **FIG. 17**. It then acts as a washer between the rotating nut **38** and the front member **27**, to prevent damage to the latter. The second tool continues to apply an increasing driving torque to the fastener nut, until the preset level, corresponding to the desired high clamp level, is achieved. The tool then reverses, to withdraw from the fully installed fastener, as shown in **FIG. 18**.

[0029] The fastener of this second embodiment has the advantage that, unless bulbing of the body shank to form a blind head has been achieved during the first part of the installation process, there is insufficient projection of the fastener pin **39** for the fixed wrenching key **49** of the second tool to engage the pin wrenching recess **42**. If this occurs, the whole fastener would be rotated by the second tool, making it obvious that the first part of the installation process had not been completed properly.

[0030] It will be apparent that the fasteners described in the foregoing examples meet the requirement of manufacturing industries for an initial, low clamp, securing together of two or more members so as to allow relative lateral adjustment, followed by a final, high clamp, locking of the members together. This two-stage fastening is known as a "fit-up" facility.

[0031] If such a facility is not required, it is not necessary to limit the clamp force in the first part of the installation process. Consequently the example fasteners could then be modified by providing a thicker and stronger body head, limited only by the need to ensure that the head is sheared through prior to swaging of the collar in the case of the first example, or that the required maximum torque is reached in the case of the second example.

[0032] The invention is not restricted to the details of the foregoing examples.

1-14. (canceled)

15. A blind fastener for installation in a workpiece, said workpiece comprising a plurality of workpiece members, thereby to secure the workpiece members together, which fastener comprises a tubular body and a pin member extending therethrough and a radially extending head at one end of the body, said head being configured to contact a near face of the workpiece, wherein at least a portion of said tubular body is configured to deform and contact a far face of the workpiece during application of an initial clamp force to the workpiece, such that the workpiece members are initially coupled together but are laterally adjustable relative to each other, is configured to yield, by either breaking or deforming, thereby applying a greater clamp force to the workpiece.

16. (canceled)

17. (canceled)

18. A fastener as claimed in claim 16 in which the head of the fastener body, before installation, has an underhead recess.

19. A fastener as claimed in claim 15 including a locking member which applies the said greater level of clamp force to the head of the body and is then secured to the pin member.

20. A fastener as claimed in claim 19 in which the locking member is provided with a radially enlarged counterbore at its end which contacts the body head.

21. A fastener as claimed in claim 19 in which the body head is sheared off by the locking member when it applies the greater level of clamp force to the head of the body and before it is finally secured to the pin member.

22. A fastener as claimed in claim 21 on which the sheared off body head acts as a washer between the body shank and the locking member.

23. A fastener as claimed in claim 20 in which the depth of the counterbore in the locking member is sufficient for an end portion of the tubular body shank to enter therein after it has sheared from the head.

24. A fastener as claimed in claim 19 in which the locking member is provided by a collar which is secured to the pin member by swaging during the second part of the installation process.

25. A fastener as claimed in claim 19 in which the locking member is provided by a threaded nut.

26. A fastener as claimed in claim 19 in which the head is configured to yield by plastic deformation but does not separate from the body.

27. A fastener as claimed in claim 19 in which an end portion of the pin protrudes beyond the locking member, sufficiently to engage an installation tool for the application of the said greater clamp force only if the initial clamp force has been correctly applied.

28. A fastener as claimed in claim 20 in which the depth of the counterbore in the locking member is sufficient for an end portion of the tubular body shank to enter therein after it has sheared from the head.

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