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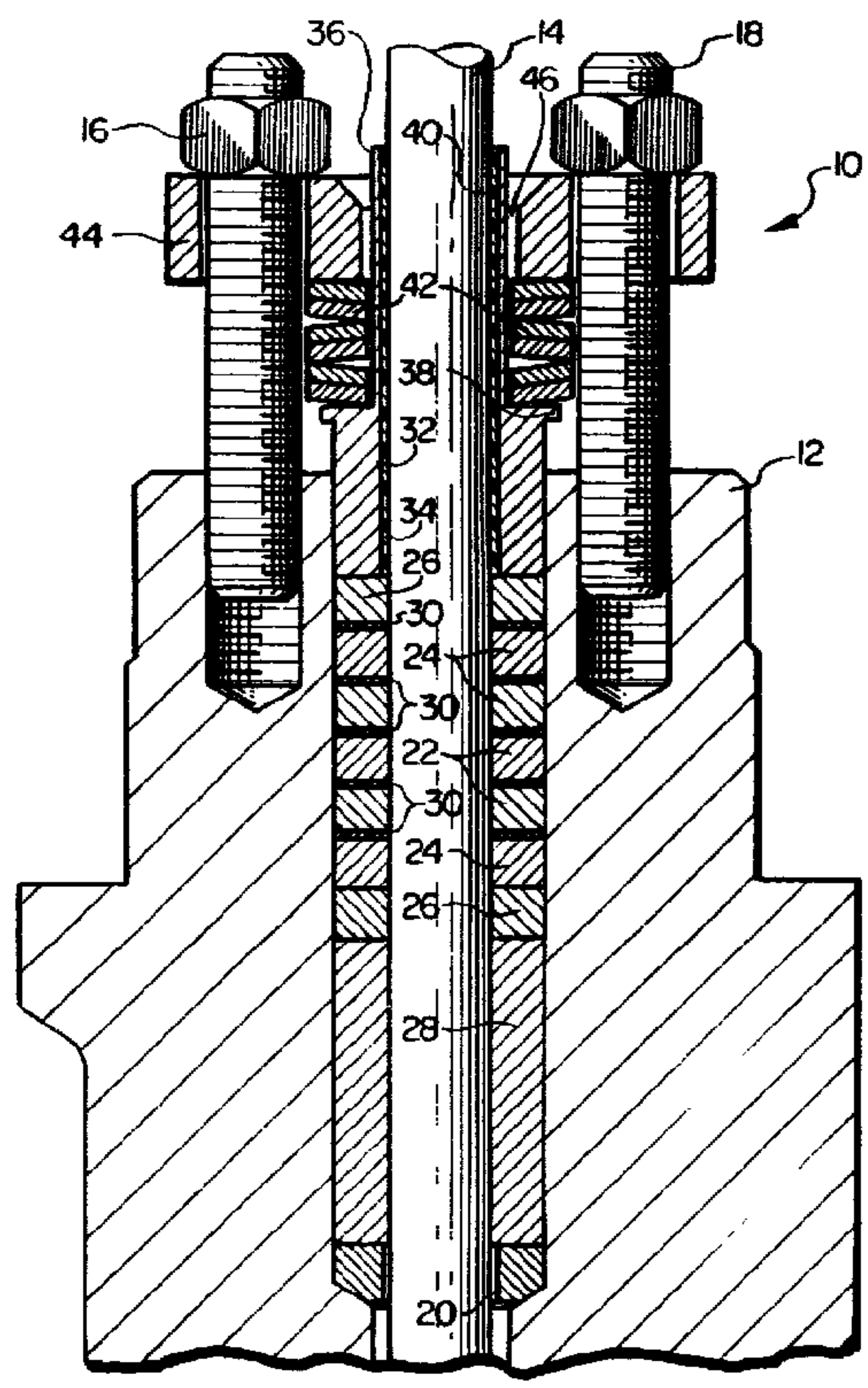

(57) Abrégé/Abstract:
A fluid valve graphite packing assembly with graphite packing rings and thin PTFE disc rings surrounding an operating valve member. Softer graphite packing rings on the interior are bounded by progressively harder graphite packing rings. A PTFE disc ring is inserted between the graphite packing rings. The packing is subjected to sufficient packing stress to cause the PTFE disc rings to extrude onto the operating valve member. A laminated packing ring formed of alternating sheets of flexible graphite and PTFE which is die cut to provide a crown shaped cross-section aiding in enabling PTFE extrusion to enhance valve operating member lubrication and sealing.

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IMPROVED GRAPHITE PACKING

Abstract of the Disclosure

A fluid valve graphite packing assembly with graphite packing rings and thin PTFE disc rings surrounding an operating valve member. Softer graphite packing rings on the interior are bounded by progressively harder graphite packing rings. A PTFE disc ring is inserted between the graphite packing rings. The packing is subjected to sufficient packing stress to cause the PTFE disc rings to extrude onto the operating valve member. A laminated packing ring formed of alternating sheets of flexible graphite and PTFE which is die cut to provide a crown shaped cross-section aiding in enabling PTFE extrusion to enhance valve operating member lubrication and sealing.

IMPROVED GRAPHITE PACKING

This invention relates to valve structures used in controlling the flow of fluids, and in particular to an improved packing particularly useful in meeting very stringent fluid leakage restrictions and in environments where the prevention of catastrophic leakage of the valve structure is desired.

Background Of The Invention

Packing materials are widely used to prevent fluid leakage around an operating member in a housing with fluid, such as a rotary shaft or a sliding stem in fluid control valves or in a reciprocating pump shaft. Normally such packing is formed of a resilient member and is placed under a static load by being bolted into position within a packing box around the operating member. In other instances the packing is subjected to spring loading in what is known as a live loaded packing configuration. Live loaded packing is particularly useful in attempting to prevent leakage of undesired fluids into the environment. Also, at operating temperature conditions of around 450°F (232°C) (i.e., operating temperature in the packing area) it is desired to use commonly available graphite packing rather than packing material formed of polytetrafluorethylene (PTFE) because PTFE packing tends to extrude at such elevated temperatures which could lead to packing failure and fluid leakage.

As an example, certain applications of a fluid control valve require not only that the valve meet stringent leakage requirements but that it also meet a stringent fire retarding test to prevent catastrophic packing failure. Fluid control valves in pipelines at refineries, and in other chemical processing applications are desired to have substantially zero leakage (i.e., less than 500 ppm) of fluid around the top of the valve, and to meet fire retarding tests as an equipment safety factor.

In such applications, graphite packing alone is not suitable. Attempts to increase the loading on the graphite packing provides a slight reduction in leakage but leads to extrusion of the graphite along the sliding stem or rotary shaft operating member, thereby causing increased friction and undue limitations in the useful valve life or valve stem/shaft travel. To reduce the leakage, it is desired to use PTFE packing material which can provide a better seal than graphite material. However, the use of PTFE packing at elevated packing temperatures is normally not recommended, and particularly where the valve must meet fire retarding tests, as in refinery applications, the extrusion and potential breakdown and vaporization of PTFE packing under high temperature fire conditions would lead to catastrophic packing failure and undesired hazardous fluid leakage.

Summary Of The Invention

In accordance with the principles of the present invention, there is provided an improved packing for sealing an operating member in a housing with fluid, such as in a sliding stem valve, rotary shaft valve, or reciprocating pump shaft. Thin, PTFE discs are inserted between the graphite packing rings of the packing system. The graphite packing is maintained at a stress level that is high enough to readily cause the PTFE discs to extrude inward against the operating member so that the PTFE material will lubricate the operating member in movements through the packing. The improved packing in accordance with the present invention significantly reduces leakage so as to meet the most stringent presently known leakage requirements of less than 500 ppm leakage concentration. In addition, the controlled, deliberate extrusion of the PTFE discs lubricates the operating member and leads to increased valve life.

In a constructed embodiment of the invention, a sliding stem valve incorporates live loading in the form of Belleville springs mounted around the shaft. The packing comprises four separate types of packing members maintained in the packing box and around the sliding stem.

The first and inner most packing members comprise a pair of die formed ribbon flexible graphite rings of a conventional type. On either side of the flexible graphite rings there is provided the second packing member comprising a graphite composite packing end ring which is slightly harder than the flexible graphite ring material. Such composite end rings are disclosed in U.S. Patent No. 4,826,181, assigned to Union Carbide Corporation of Danbury, Connecticut.

The third packing member in the packing system comprises carbon bushing end rings adjacent the composite packing end ring on either side of the packing system. The fourth packing member comprises a plurality of PTFE discs with a respective PTFE disc located between certain of the aforementioned packing member rings in the packing box. Accordingly, the improved graphite packing system of the present invention includes relatively softer packing material rings encapsulated by somewhat harder packing material rings, which in turn is encapsulated by still harder packing material rings and with thin PTFE discs located between certain of the packing material rings.

As an example, a sliding stem valve embodiment of the invention included two ribbon graphite seal rings; a graphite composite packing end ring on one side and two composite end rings on the other side; a short carbon bushing on opposite sides and a long carbon bushing on one side; and seven PTFE discs each about 0.015 inch (0.381 mm) in thickness and a respective PTFE disc placed between each of the aforementioned packing members on a 1/2 inch (12.7 mm) diameter sliding stem shaft. The packing was subjected to a live loaded packing stress of 6,000 psi (41369 kPa) and 56,000 cycles of operation at ambient temperature over thirteen days of deriving test data (elapsed time for the test was twenty-five days). In this leak rate test, no bubbles of leaking fluid were observed during three minute observations during the first three test data days and an insignificant amount of bubbles were observed during the next four test data days.

In a preferred embodiment of the invention only five PTFE discs were used with the same graphite packing rings and carbon bushings and sliding stem diameter as the above described embodiment. A respective PTFE disc was inserted between each of the graphite packing rings and between the upper most ring and the short carbon bushing at the packing top. The packing was subjected to a live loaded packing stress of 5,000 psi (34474 kPa). Over 430,000 cycles of operation were run at temperatures between 400-450°F (204-232°C) with weekend shutdowns and resulting thermal cycles during ninety-two test data days. The elapsed time for the test was one hundred fifty-five days. No bubbles of leaking fluid were observed during three minute observations during the first seventy-two test data days.

In a constructed rotary shaft valve embodiment of the invention, live loading was provided in the form of Belleville springs mounted around the rotating shaft. The packing comprises a laminated ring sandwiched between a pair of anti-extrusion containment rings.

The laminated ring includes a flexible graphite sheet material laminated with PTFE sheet material and die cutting the lamination to form a laminated ring having a crown shape cross-section. It has been found that the crown shape cross-section enables the axial load from the packing follower to flatten the laminated ring so as to provide a radial force on the shaft and the packing box bore sufficient to desirably, controllably extrude some PTFE material onto the shaft and bore thereby lubricating the valve and leading to increased valve life. This effective transfer of the axial gland load to radially sealing force is accomplished by making the width of the packing cross-section greater than the cross-section of the packing box.

On either side of the composite laminated ring there is provided an anti-extrusion containment ring comprising a carbon bushing end ring. Preferably, these end rings are formed as zero clearance anti-extrusion rings having a slight interference fit with the shaft and split. Alternatively, the anti-extrusion end rings may be formed of PEEK material, and in addition a pair of graphite composite packing end rings may be used on each side of the laminated packing ring with the carbon bushing or PEEK end rings completing each end of the packing system.

As an example, a constructed rotary shaft valve embodiment of the invention included a laminated ring formed with six sheets of flexible graphite sheet material sandwiching a sheet of PTFE material between each flexible graphite sheet, and a zero-clearance carbon bushing on opposite sides of the laminated ring, all mounted on a 1.0 inch (25.4 mm) diameter rotating shaft. The laminated ring was formed of 0.030 inch

(0.762 mm) thick flexible graphite sheet material alternating with 0.005 inch (0.127 mm) thick PTFE sheet material. The laminations were die cut so that at the base of the die the bottommost graphite ring was formed with a crown having a radius of about 0.16 inch (4.06 mm) and with the crown radius being reduced substantially towards the top of the die so that the topmost layer of flexible graphite ring was substantially flat or contained a very significantly reduced crown radius compared to the bottom layer. The composite ring measured 0.236 inch (5.99 mm) in thickness with an inside diameter of 1.0 inch (25.4 mm) and an outside diameter of 1.375 inch (34.9 mm).

To allow the wider packing material to be easily installed the die cut packing rings are formed with a crown shape so that the arc length of the packing cross section is approximately 0.015 inch (0.381 mm) longer than the width of the packing box cross section. The crown shape allows this ring to drop easily into the packing box. When the axial gland load is applied the crown shape is flattened, forcing the packing material to apply the radially sealing force against the stem and wall of the packing box.

The constructed valve with this improved packing was subjected to a test pressure of 1230 psi (8481 kPa) and 25,000 cycles of operation and four thermal cycles from ambient temperature to 450°F (232°C) over five days of deriving test data (elapsed time for the test was seven days). In this leak rate test, no bubbles of leaking fluid were observed during five minute observations during the five test data days.

The constructed valve next was subjected to a test pressure of 1100 psi (7585 kPa) and about an additional 20,000 cycles of operation and four thermal cycles from ambient temperature to 600°F (316°C) over four days of deriving test data (elapsed time for the test was seven days). In this leak rate test, virtually no bubbles of leaking fluid were observed during five minute observations during the four test data days.

The same laminated ring design may be used without the crown shape by controlling the fit of the ring with the shaft and packing box bore. However, the axial loading required to achieve the same radial force to desirably extrude PTFE material may be greater. Also, rather than forming a laminated ring, individual rings formed of flexible graphite sheet material and PTFE sheet material can be utilized. However, for assembly convenience, the laminated ring configuration is desired to enable ready emplacement of the integral laminated ring structure rather than attempting to positionably assemble several very thin, individual rings of flexible graphite and PTFE sheet material in alternating layers on the shaft and in the packing box. In addition, the die formed packing rings could have a wave spring shape. This would allow the packing material to apply the radially sealing force against the stem and wall of the packing box when the axial load is applied to flatten out the packing ring. Thus, the present invention provides a packing system which can meet stringent fluid leakage requirements and fire retardation requirements which are found necessary in many environmental applications.

Brief Description Of Drawings

The features of this invention which are believed to be novel are set forth with particularity in the appended claims. The invention may be best understood by reference to the following description taken in conjunction with the accompanying drawings in which like reference numerals identify like elements in the several figures and in which:

Figure 1 is a fragmented cross-sectional view illustrating a preferred embodiment of the improved packing of the present invention in a sliding stem valve;

Figure 2 is an exploded view of the improved packing of Figure 1;

Figure 3 is a fragmented cross-sectional view illustrating a preferred embodiment of the improved packing of the present invention in a rotating shaft valve; and

Figure 4 is an exploded view of the improved packing of Figure 3.

Detailed Description

As indicated previously, the principles of this invention are applicable to sliding stem or rotating shaft valves, as well as reciprocating pump shaft units. Figures 1 and 2 illustrate a sliding stem valve incorporating the invention, and Figures 3 and 4 illustrate a rotating shaft valve incorporating the invention.

Referring to the drawings, there is illustrated a fluid valve 10 of the sliding stem valve type having a valve body with a valve bonnet 12 through which extends an operating valve member illustrated as sliding stem 14. Packing nuts 16 are threadably mounted on packing studs 18 so as to adjust the loading on the packing within the bonnet and around the valve stem.

Within a packing box formed of a packing bore 20 in valve bonnet 12, there is provided improved graphite packing with PTFE discs as will be described in more detail hereinafter. The improved packing includes a pair of flexible graphite rings 22 which are conventional packing rings of die formed ribbon flexible graphite. The flexible graphite rings 22 are relatively soft material each of which readily acts to seal the valve stem.

On each opposite side of the flexible graphite rings 22, there is provided a graphite composite packing end ring 24. As illustrated in the drawings, two composite end rings 24 are located at one end or top end of the packing whereas only one composite end ring 24 is located at the bottom or other end of the packing. Each of the graphite composite packing end rings 24 are commonly available items from Argo Packing Company of Oakmont, Pennsylvania and are manufactured in accordance with the aforementioned Union Carbide Corporation patent, U.S. Patent No. 4,826,181.

Composite rings 24 are formed of somewhat harder material than flexible graphite rings 22 so as to act as anti-extrusion members to help prevent transfer of the somewhat softer flexible graphite material on stem 14. Since the composite rings 24 are slightly harder than flexible graphite rings 22, rings 24 tend to wipe the sliding stem valve 14 during operation thereof so as to aid in the prevention of transfer of flexible graphite material to the stem.

A conventional carbon bushing 26 is located at each opposite end of the packing. Since carbon bushings 26 are somewhat harder than composite end rings 24, they act as anti-extrusion rings and also aid in maintaining valve stem 14 centered in the packing box to prevent deformation and destruction of the softer packing material in composite rings 24 and flexible graphite rings 22. A somewhat larger carbon bushing spacer ring 28 is mounted at one end of the packing indicated at the bottom end illustrated in the drawings adjacent packing box end ring 29 so as to take up the rest of the space within the packing box and to provide support for the sliding stem 14.

A plurality of PTFE discs each about 0.015 inch (0.381 mm) are provided. In the preferred embodiment of the invention five PTFE discs are used. As illustrated, a respective PTFE disc 30 is inserted between each of the packing rings 22 and between graphite composite packing rings 24 and bushing 26 at the top of the packing system. The PTFE discs are intended to partially extrude inward against the stem 14 so that the PTFE material will lubricate the sliding of the stem through the packing. Thus the PTFE discs serve as a lubricant in the packing system as well as a sealing member to aid the graphite packing rings in their sealing function.

A live load packing system is provided so that the packing members are maintained at a stress level that is high enough to readily cause the PTFE discs to extrude. The live load packing includes a packing follower 32 having a follower base 34 at one end, a follower guide sleeve 36 at the other end, and a follower flange 38 therebetween. Follower 32 includes a liner 40 formed of carbon filled PTFE or other suitable material which may be bonded to the inside surface of the packing follower.

A series of Belleville disc springs 42 is slidably mounted on follower guide sleeve 36 with one end of the disc springs in contact with flange 38.

Packing flange 44 has suitable apertures through which the packing studs may be passed and includes a central aperture 46 to allow passage of valve stem 14. One end of Belleville disc springs 42 lies in contact with packing flange 44.

After assembly of the valve components as shown in the drawings, the packing nuts 16 on studs 18 surrounding valve stem 14 are tightened so that packing flange 44 transmits the packing stud and nut load to the Belleville disc springs 42. The Belleville springs 42 in turn become compressed with continued tightening of nuts 16 as shown in Figure 1 so as to maintain a spring load on packing rings 22, 24, 26, 28 and 30 through packing follower 32. If desired, an O-ring (not shown) may be used on follower guide sleeve 36 to maintain the Belleville disc springs in position prior to assembly on stem 14.

The embodiments of the invention shown in the drawings and as described herein provided a significant reduction in fluid leakage as is referred to previously in the described leak rate tests. Thus, in accordance with the principles of the present invention, the improved packing system of illustrated valve 10 reduces fluid leakage to virtually zero so that the valve of this invention can meet the most stringent fluid leakage requirements presently in existence.

The use of PTFE discs 30 provide the desired significant sealing and lubricating qualities of PTFE material and yet because the discs are of a small volume percentage with respect to the total packing volume, catastrophic failures under high temperature fire conditions is avoided. The present invention therefore provides the desired use of PTFE material in an improved packing without incurring the usual detrimental effects of PTFE material at higher operating temperatures. It is understood that in accordance with standard valve practice, zinc discs can be utilized in the packing as sacrificial material to minimize stem corrosion.

Reference may now be made to the drawings of Figures 3 and 4 wherein there is illustrated a fluid valve 50 of the rotating shaft valve type containing valve components similar to those shown with respect to the sliding stem valve of Figures 1 and 2. In particular, the valve body includes a valve bonnet 52 through which rotates an operating valve member illustrated as rotating shaft 54.

Within a packing box formed of a packing bore in valve bonnet 52, there is provided improved graphite packing which includes a laminated ring 56. Reference may be made to Figure 4 wherein the components of the ring 56 can be seen more clearly as comprising flexible graphite rings 58 of sheet material laminated with PTFE rings 60 of PTFE sheet material. As illustrated in the exploded view of Figure 4, six sheets of flexible graphite material are laminated with five sheets of PTFE material with each respective PTFE ring 60 sandwiched between two flexible graphite rings 58.

Laminated ring 56 is preferably formed in a die forming operation wherein the alternating flexible graphite and PTFE sheets are suitably bonded with heat and pressure in a standard laminating operation and die formed in order to die cut ring 56 in the illustrated crown shaped cross-section. As can be seen from Figure 4, lowermost flexible graphite ring 58 is formed with a cross-sectional crown radius 62. The crown radius decreases in the upper layers of the ring so that the top most layer is substantially flat or has a very slight crown radius compared to the lowermost ring crown radius. It is preferred to form ring 56 with the crown shaped cross-section so as to enable axial loading of the packing to flatten the packing ring and allow it to exert a radial force on shaft 54 and on the packing box bore.

Each of the PTFE thin disc rings 60 are formed of 0.005 inch (0.127 mm) thick PTFE sheet material. Each of the flexible graphite rings 58 are formed of 0.030 inch (0.762 mm) thick flexible graphite sheet material. The PTFE disc rings are intended to controllably, partially extrude inward against shaft 54 so that the PTFE material will lubricate the shaft as it rotates through the packing. Thus the PTFE disc rings serve as a lubricant in the packing system as well as a sealing member to aid the flexible graphite rings in their sealing function.

On each side of laminated ring 56 there is provided a carbon bushing 64 which act as anti-extrusion rings and also aid in maintaining rotary shaft 54 centered in the packing box. Carbon rings 64 are of the zero clearance anti-extrusion type referred to in co-pending application serial no. 07/596,225, assigned to the same assignee as herein. In particular, carbon bushings 64 are split and formed with an inner diameter slightly less than the diameter of rotating shaft 54 and an outer diameter slightly less than the packing bore. Bushings 64 are split with a single fracture 66 which enables the bushings to be inserted onto the operating member with a zero clearance or interference fit while still permitting axial movement on the operating member and thereby transmitting gland loading to the packing.

As in the sliding stem valve embodiment, in rotating shaft valve 50, a live load packing system is provided so that the packing members are maintained at a stress level that is high enough to readily cause the PTFE disc rings to controllably extrude. The live load packing includes a packing follower 68 which includes a liner formed of carbon filled PTFE which may be bonded to the inside surface of the packing follower. A series of Belleville disc springs 70 is slidably mounted on the follower guide sleeve with one end of the disc springs in contact with a packing follower flange as noted in Figure 3. Packing flange 72 has suitable apertures through which the packing studs, such as packing stud 74, may be passed. Packing flange 72 further includes a central aperture to allow passage of rotating shaft 54. One end of the Belleville disc springs lies in contact with packing flange 72.

After assembly of the valve components as shown in Figures 3 and 4, packing nuts 76 are tightened on studs 74 so that packing flange 72 transmits the packing stud and nut load to the Belleville disc springs 70. The Belleville springs in turn become compressed with continued tightening of the nuts so as to maintain a spring load on packing rings 56 and 64 through packing follower 68. O-ring 78 is provided on the follower guide sleeve so as to maintain the Belleville disc springs in position prior to assembly on shaft 54. A conventional metal packing box ring 80 is mounted within the packing bore to form the bottom of the packing box.

As alternative embodiments, PEEK rings can be used in place of the carbon rings 64. Also, graphite composite end rings such as rings 24 described previously may be used between the laminated ring 56 and the upper and lower rings 64. The same laminated ring 56 configuration could also be used without the crown shape cross-section by controlling the fit of ring 56 with shaft 54 and with the packing box bore. However, in order to achieve the same radial force sufficient to desirably partially extrude the PTFE material inwardly against the shaft and outwardly against the packing bore, the axial load required from the packing follower in order to achieve this desired result may be greater than is required with the crown shaped cross-section configuration of ring 56. Also, bushings 26 shown in Figure 1 may be formed with a high compressive strength linear aromatic polymer such as polyetheretherketone (PEEK).

The foregoing detailed description has been given for clearness of understanding only, and no unnecessary limitations should be understood therefrom, as modifications will be obvious to those skilled in the art.

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

1. In a fluid valve, a packing system for reliably sealing a sliding stem operatively moving through the packing system in said fluid valve comprising:

a packing box within said valve;

packing follower mounting means for slidably supporting said sliding stem in said packing box;

a packing assembly including a plurality of packing rings mounted around said sliding stem in said packing box for providing a fluid seal around the sliding stem to restrict fluid leakage from said packing box;

live loading means for applying a spring loading on said packing assembly to maintain said fluid seal;

said plurality of packing rings including at least one flexible graphite ring (a), at least one graphite composite packing end ring (b) on each opposite end of said packing assembly and adjacent said flexible graphite ring along said sliding stem, at least one carbon bushing ring (c) on each opposite end of said packing assembly and adjacent said graphite composite packing end ring along said sliding stem, and a respective PTFE disc ring (d) formed of PTFE packing material and mounted between at least each of said adjacent (a) and (b) rings in said packing assembly; and

said live loading means maintaining a sufficient spring loading on said packing assembly to enable said PTFE discs to partially extrude PTFE packing material on said sliding stem and to lubricate said sliding stem in slidable movements through said sliding stem packing assembly.

2. A packing system according to claim 1, wherein said packing assembly includes a pair of said flexible graphite rings with a PTFE disc ring therebetween and, a pair of said graphite composite packing end rings on one end of said flexible graphite rings with a PTFE disc ring therebetween.

3. A packing system according to claim 2, wherein said packing assembly further includes a PTFE disc ring between said graphite composite packing end ring and said adjacent carbon bushing ring at one end of said packing assembly.

4. A packing system according to claim 3, wherein said packing assembly further includes a carbon bushing spacer at one packing assembly end and adjacent one of said carbon bushing rings.

5. A packing system according to claim 1, wherein said live loading means is provided by Belleville disc springs.

6. A packing system for reliably sealing an operating member in a housing containing fluid comprising:

a packing assembly including a plurality of packing rings providing a fluid seal surrounding the operating member for preventing fluid from leaking from said housing around said operating member;

spring means for applying a spring loading on said packing assembly to maintain said fluid seal;

said plurality of packing rings including from an inner portion of said packing assembly outwardly toward each opposite end of said packing assembly along said operating member,

a. at least one flexible graphite ring;

b. at least one graphite composite packing end ring adjacent said flexible graphite ring;

c. at least one carbon bushing ring adjacent said graphite composite packing end ring; and

d. a PTFE disc ring formed of PTFE packing material and mounted between each of said adjacent rings a. and b. in said packing assembly;

said spring means maintaining a sufficient spring loading on said packing assembly to enable said PTFE discs to partially extrude PTFE packing material on said operating member and to lubricate said operating member in movements through said packing assembly.

7. A packing system according to claim 6, wherein said spring means is provided by Belleville disc springs.

8. A packing system according to claim 6, wherein said plurality of packing rings includes a pair of said flexible graphite rings with a PTFE disc ring therebetween, and a pair of said graphite composite packing end rings with a PTFE disc ring therebetween.

9. A packing system according to claim 8, wherein said plurality of packing rings includes a PTFE disc ring between said graphite composite packing end ring and said adjacent carbon bushing ring at one end of said packing assembly.

10. A packing system according to claim 9, wherein said packing assembly includes a carbon bushing spacer at one packing assembly end and adjacent one of said carbon bushing rings.

11. A packing system for reliably sealing an operating member in a housing containing fluid comprising:

a packing assembly including a plurality of packing rings providing a fluid seal surrounding the operating member for preventing fluid from leaking from said housing around said operating member;

spring means for applying a spring loading on said packing assembly to maintain said fluid seal;

said plurality packing rings including from an inner portion of said packing assembly outwardly toward each opposite end of said packing assembly along said operating member,

a. at least one flexible graphite ring;

b. at least one anti-extrusion bushing ring adjacent said flexible graphite ring; and

c. a PTFE disc ring formed of PTFE packing material and mounted between each of said flexible graphite rings in said packing assembly;

said spring means maintaining a sufficient spring loading on said packing assembly to enable said PTFE discs to partially extrude PTFE packing material on said operating member and to lubricate said operating member in movements through said packing assembly.

12. A packing system according to claim 11, wherein said anti-extrusion bushing ring is formed of carbon.

13. A packing system according to claim 12, wherein said flexible graphite ring and said PTFE disc ring is formed of a flexible graphite sheet material laminated with PTFE sheet material to provide a laminated ring.

14. A packing system according to claim 13, wherein said laminated ring includes a crown shaped cross section.

15. In a fluid valve, a packing system for reliably sealing a rotating shaft operatively moving through the packing system in said fluid valve comprising:

a packing box within said valve;

packing follower mounting means for rotatably supporting said rotating shaft in said packing box;

a packing assembly including a plurality of packing rings mounted around said rotating shaft in said packing box for providing a fluid seal around the rotating shaft to restrict fluid leakage from said packing box;

live loading means for applying a spring loading on said packing assembly to maintain said fluid seal;

said plurality of packing rings including at least two flexible graphite rings along said rotating shaft, at least one anti-extrusion ring on each opposite end of said packing assembly and adjacent said flexible graphite ring along said rotating shaft, and a respective PTFE disc ring formed of PTFE packing material and mounted between each of said flexible graphite rings in said packing assembly; and

said live loading means maintaining a sufficient spring loading on said packing assembly to enable said PTFE discs to partially extrude PTFE packing material on said rotating shaft and to lubricate said rotating shaft in rotational movements through said rotating shaft packing assembly.

16. A packing system according to claim 15, wherein said anti-extrusion bushing ring is formed of carbon.

17. A packing system according to claim 15, wherein said flexible graphite ring and said PTFE disc ring is formed of a flexible graphite sheet material laminated with PTFE sheet material to provide a laminated ring.

18. A packing system according to claim 17, wherein said laminated ring includes a crown shaped cross section.

19. A packing ring for sealing fluids around an operating member and for lubricating the operating member during movement through said packing ring comprising:

a stacked plurality of laminated sheets of flexible graphite sheet material and PTFE sheet material formed into a laminated ring; and

each of said laminated sheets including a sheet of flexible graphite sheet material, a sheet of PTFE sheet material, and means for bonding the sheet of flexible graphite sheet material and the sheet of PTFE sheet material into a single laminated sheet.

20. A packing ring according to claim 19, wherein said stacked plurality of laminated sheets includes a crown shaped cross section.

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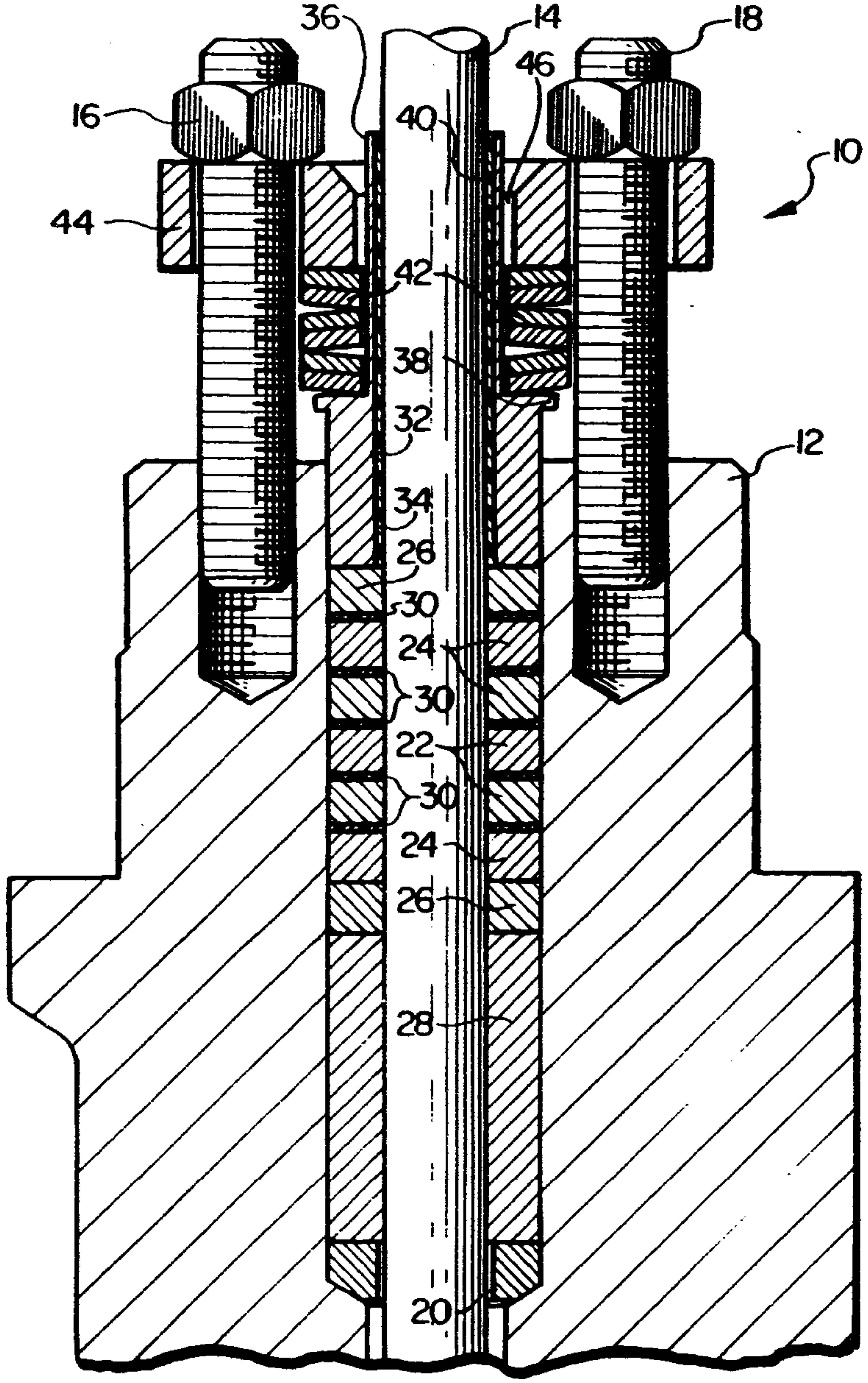

FIG. 1

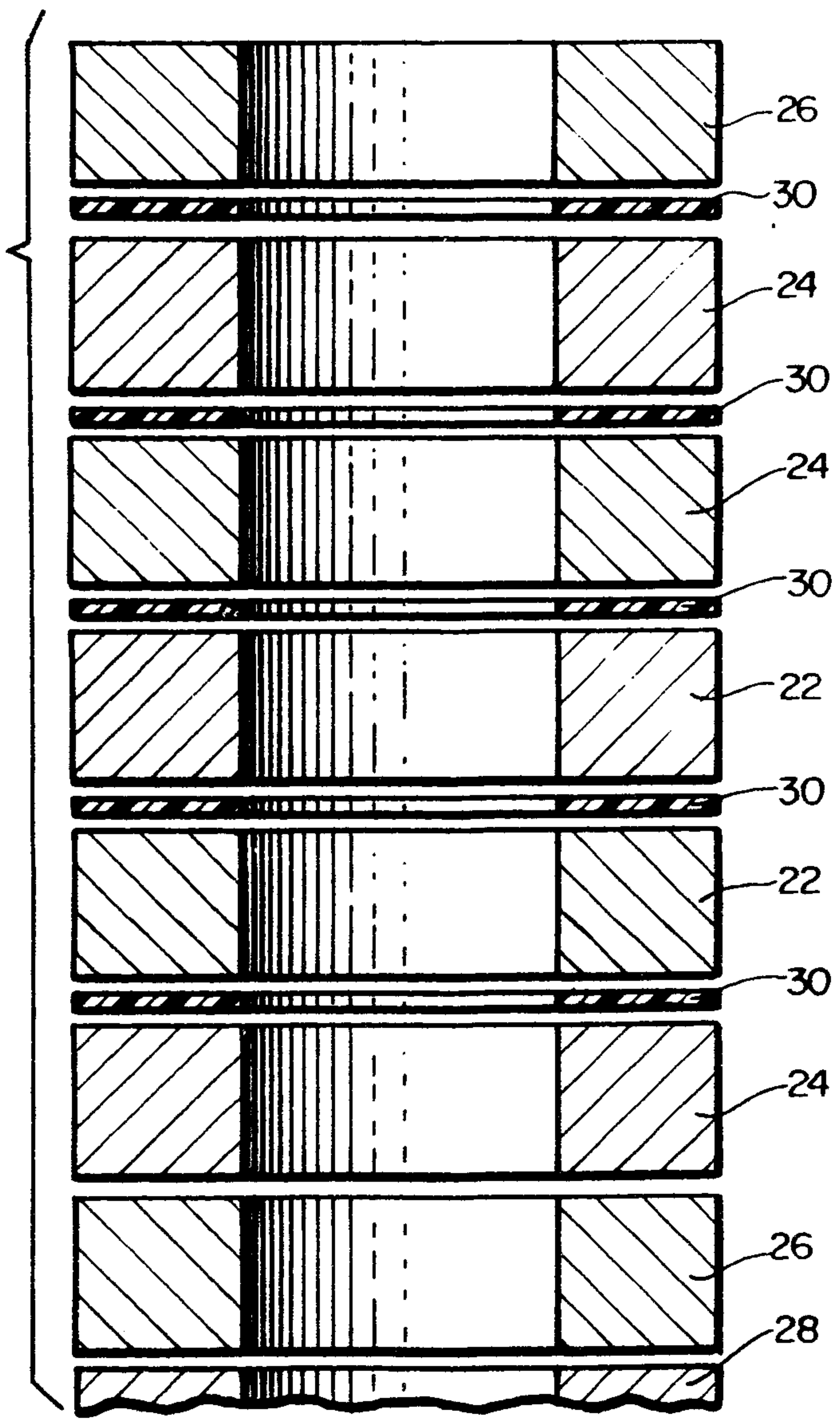

FIG. 2

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FIG. 3

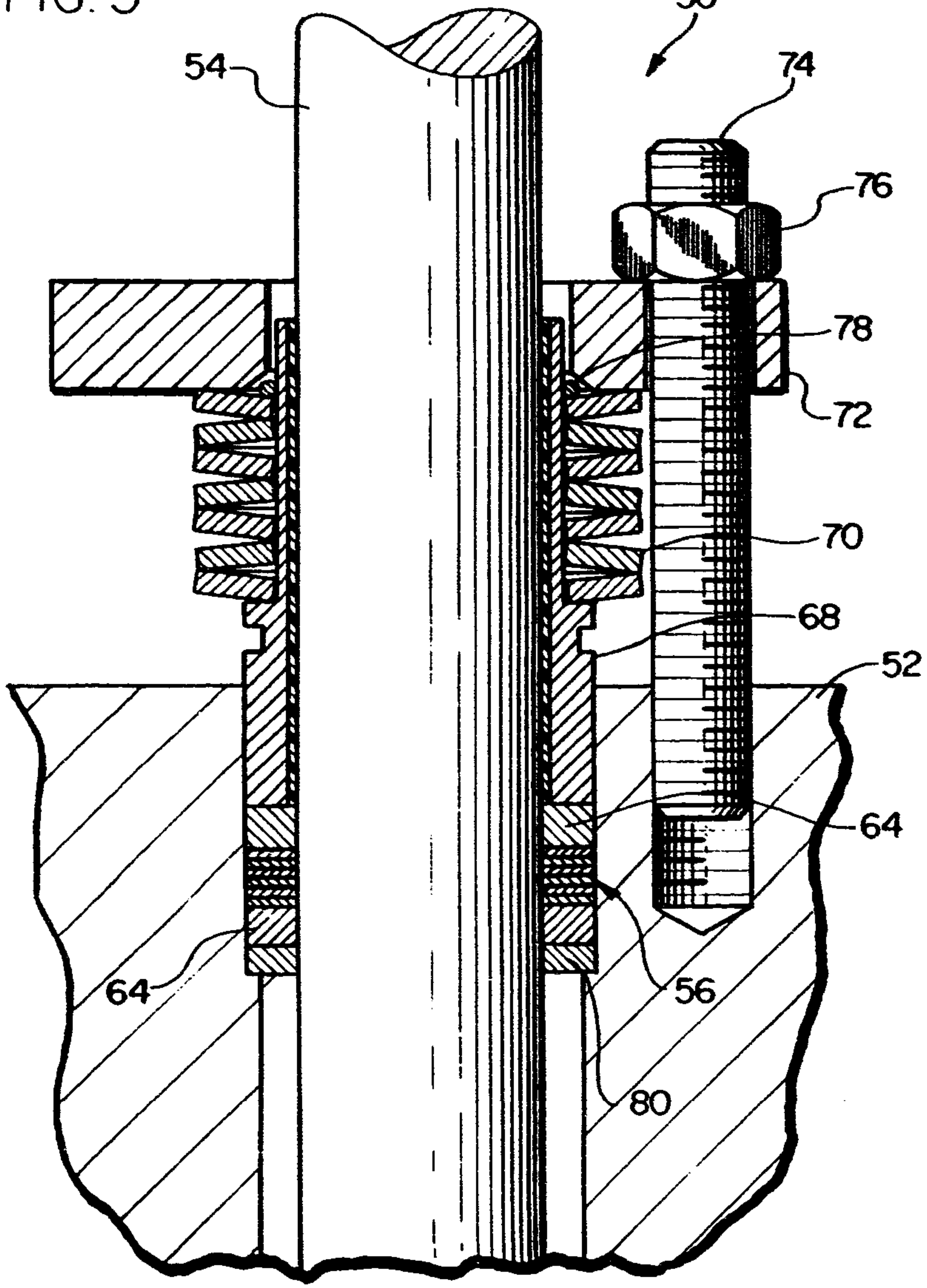
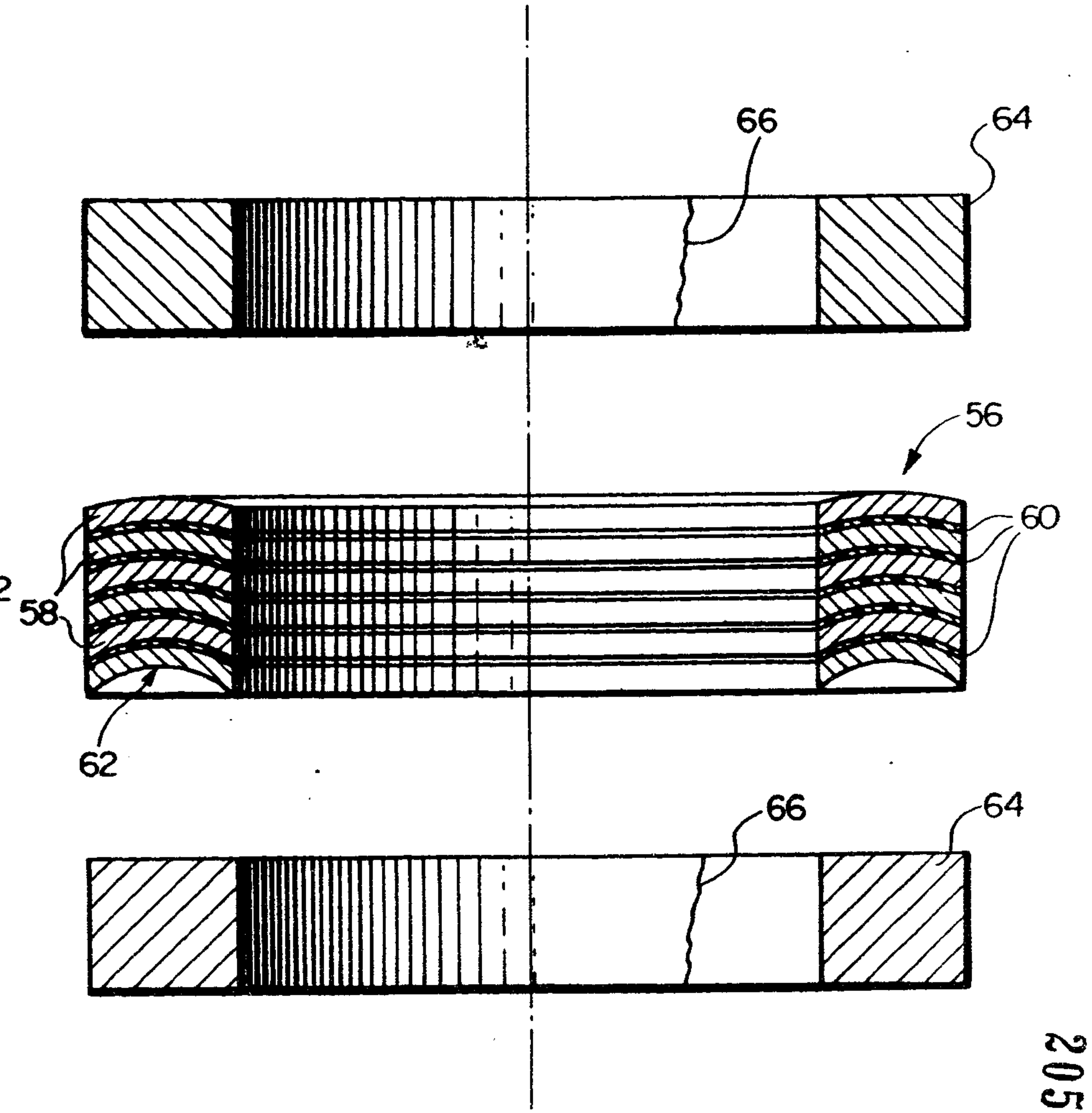
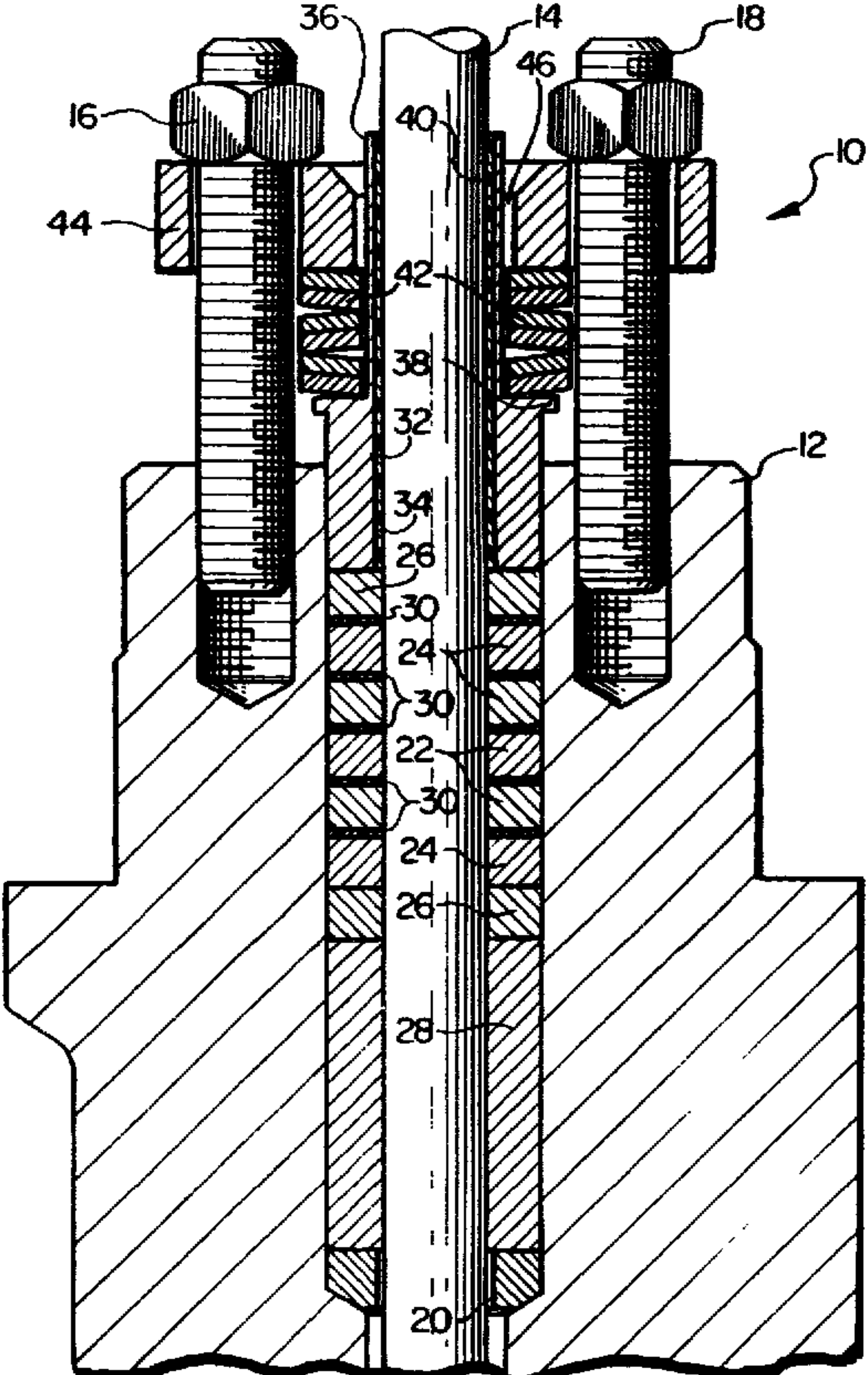


FIG. 4





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