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(12) (19) (CA) **Brevet-Patent**

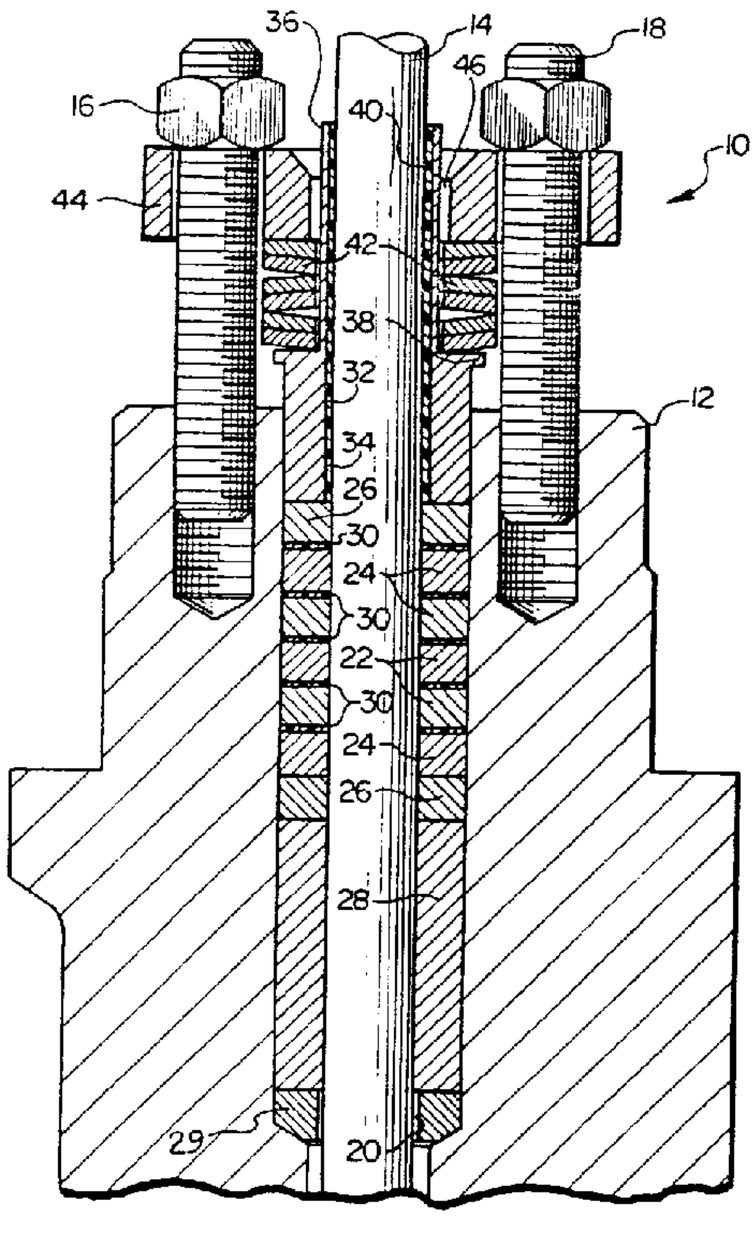
(11) (21) (C) **2,058,265**
(22) 1991/12/20
(43) 1992/06/22
(45) 2000/10/31

(72) Brestel, Ronald Ray, US
(72) Funk, Ronnald James, US
(72) Scheffert, William Charles, US
(73) Fisher Controls International, Inc., US

(51) Int.Cl.[5] F16K 41/00
(30) 1990/12/21 (07/632,097) US

(54) **GARNITURE DE GRAPHITE DOTEE DE DISQUES DE POLYTETRAFLUOROETHYLENE**

(54) **GRAPHITE PACKING WITH PTFE DISCS**



(57) 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.

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"IMPROVED GRAPHITE PACKING WITH PTFE DISCS"

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.

"IMPROVED GRAPHITE PACKING WITH PTFE DISCS"

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 500°F (260°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 sliding stem 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 thereby causing increased friction and undue limitations in the useful valve life or valve stem 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 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 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, an 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 50,000 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 thirteen 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) and the testing of this preferred embodiment is still continuing. At the present time over 157,000 cycles of operation have been run at temperatures between 400-450°F (204-232°C) with weekend shutdowns and resulting thermal cycles during thirty-six test data days. The elapsed time for the test so far is fifty days. No bubbles of leaking fluid have been observed during three minute observations during the thirty-six test data days.

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:

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; and

Figure 2 is an exploded view of the improved packing in the preferred embodiment.

Detailed Description

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 under high pressure - packing stress conditions.

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, 24 and between packing ring 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 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.

Furthermore, valve 10 meets required fire retarding tests which require that if there is a fire there must not be any sudden catastrophic failure of the packing, and the valve and the packing must maintain pressure integrity. 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.

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 assembly 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.

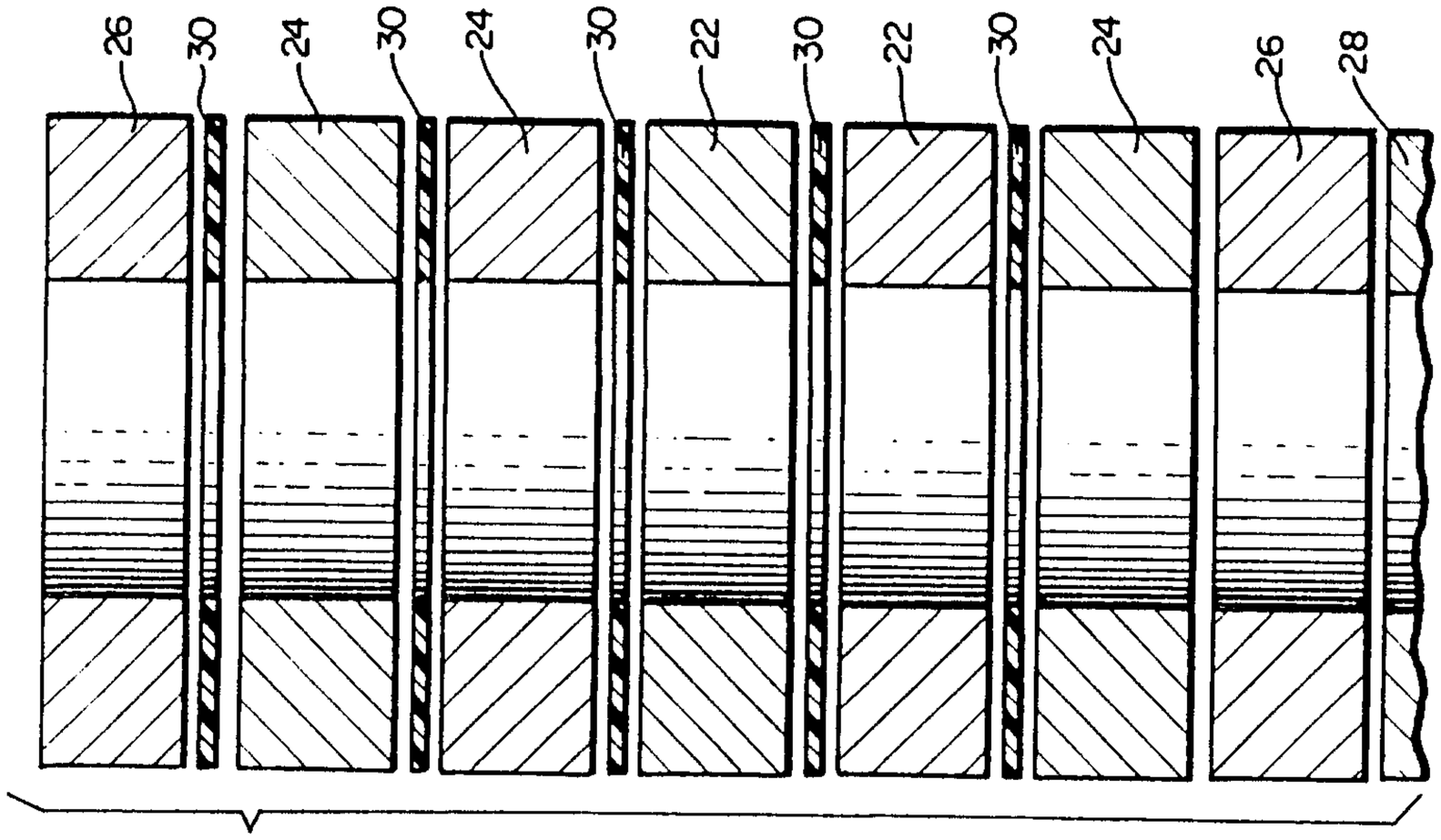
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FIG. 2

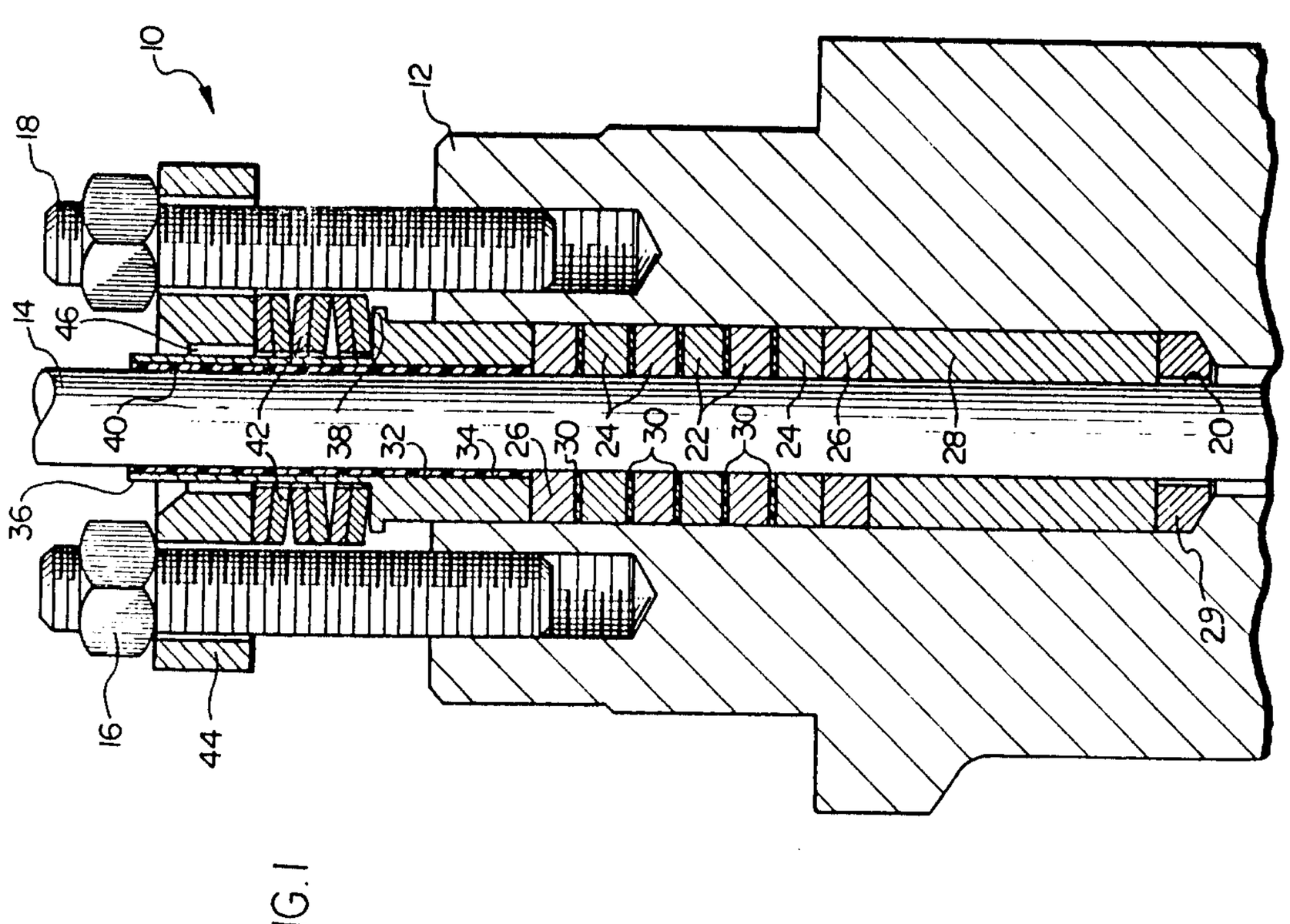
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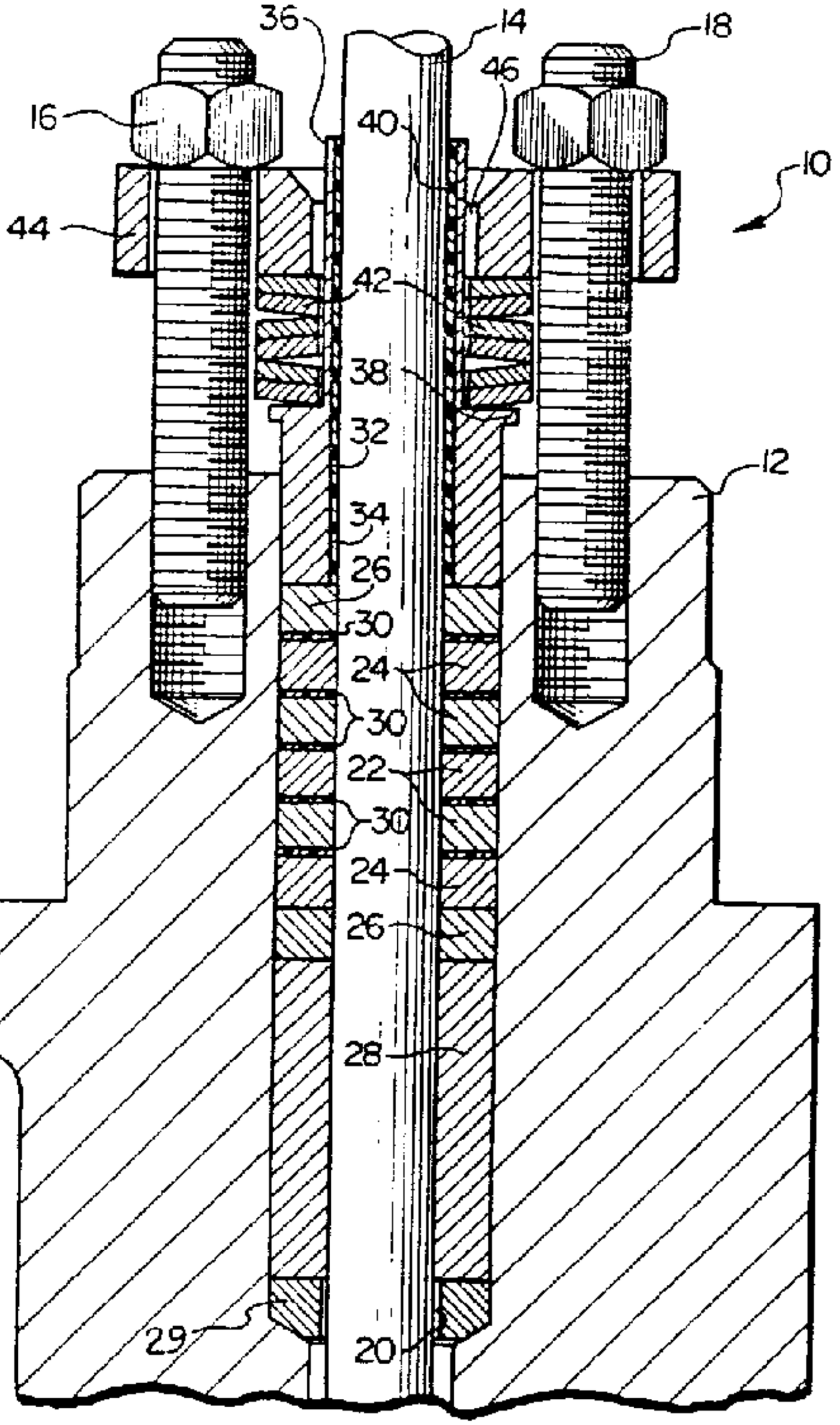
FIG. 1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