

March 30, 1965

K. EICKMANN

3,175,474

CLOSURE DEVICE FOR HYDRAULIC CYLINDER OR THE LIKE

Filed Feb. 15, 1961

11 Sheets-Sheet 1

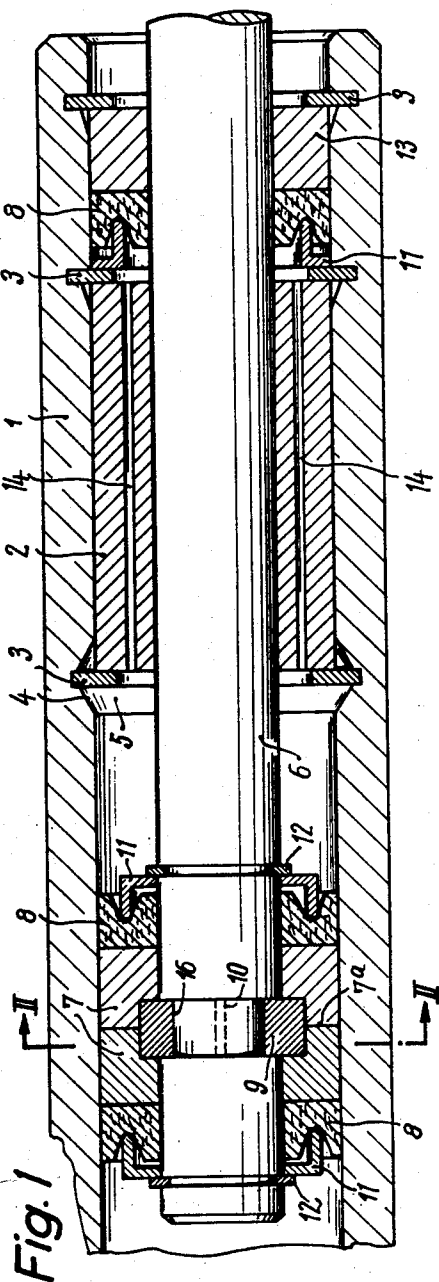
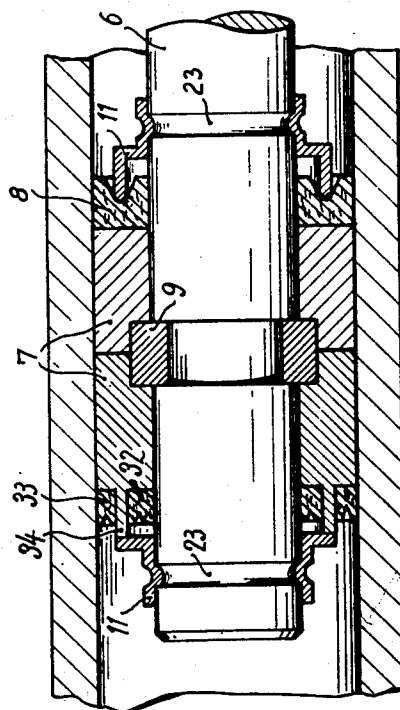
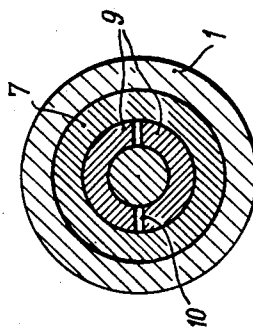


Fig. 2



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11 Sheets-Sheet 2

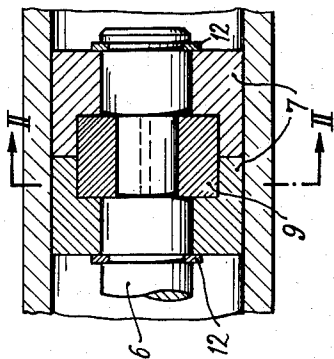


Fig. 4

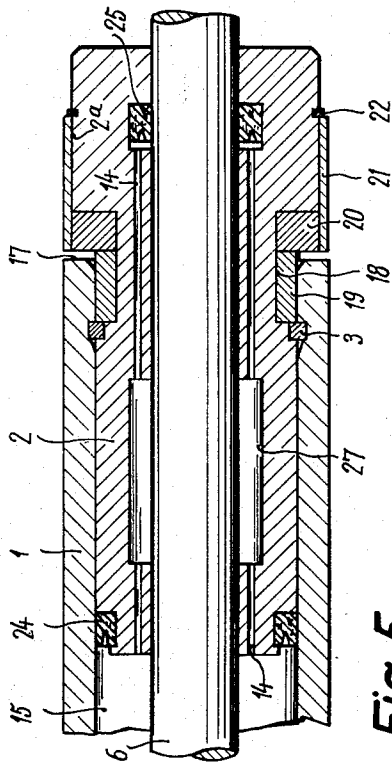


Fig. 5

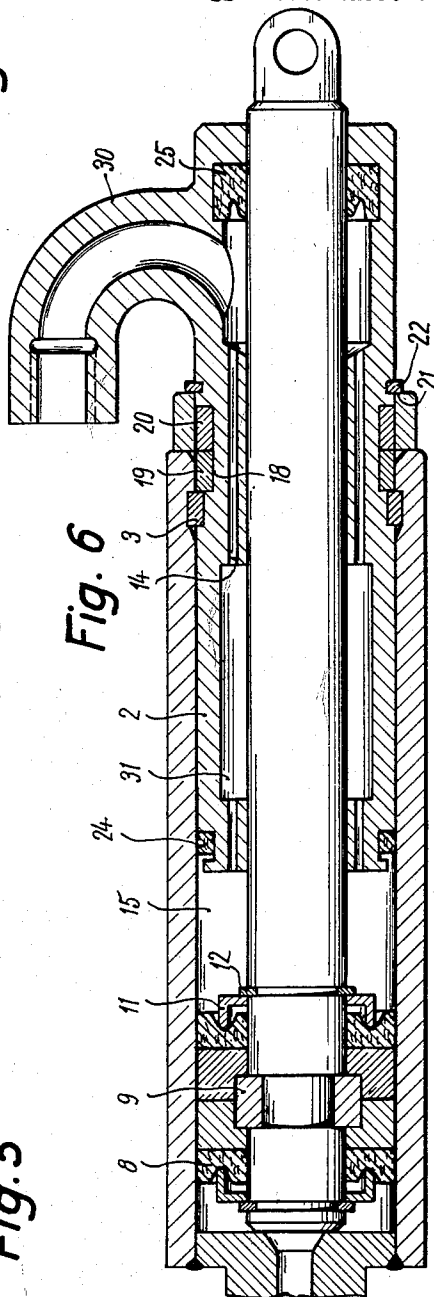


Fig. 6

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Fig. 8

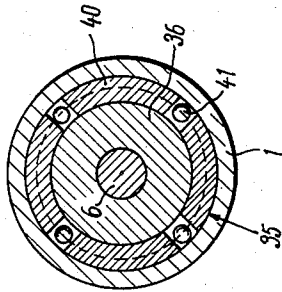


Fig. 10

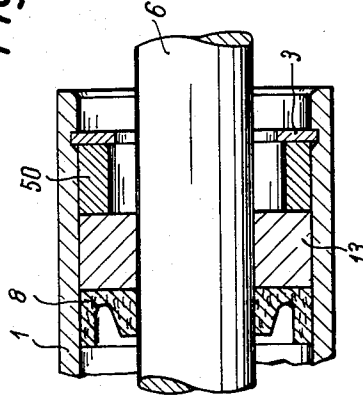
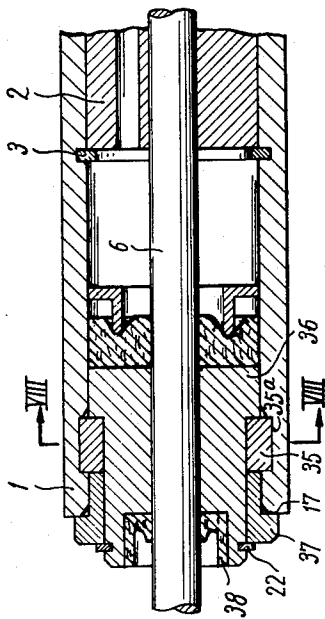
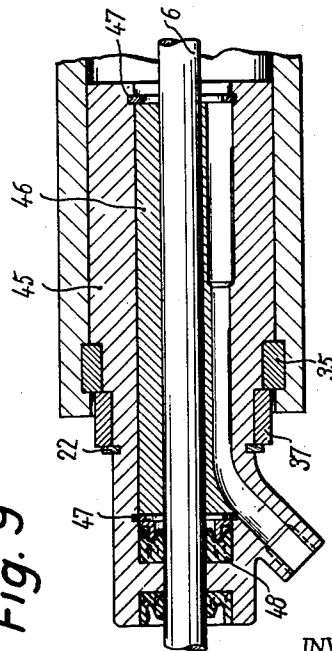


Fig. 7

Fig. 9



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11 Sheets-Sheet 4

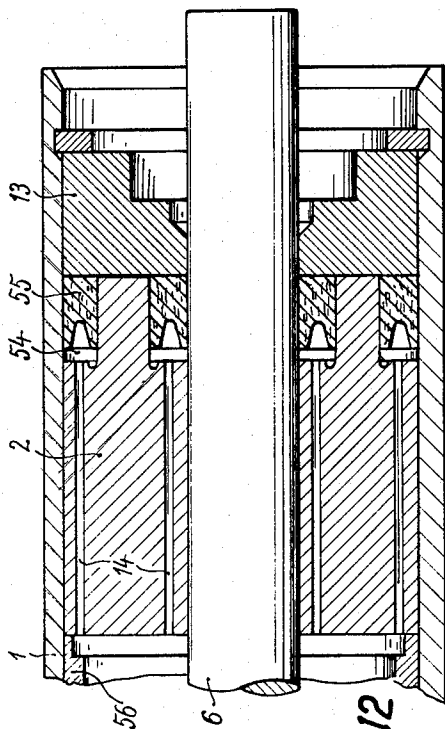


Fig. 12

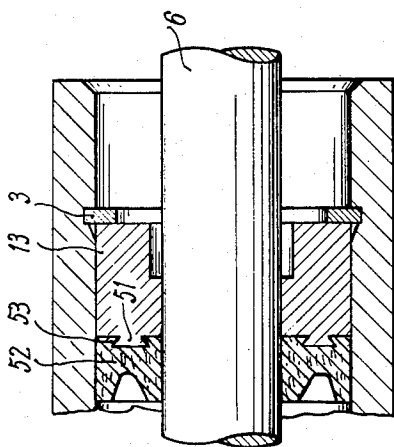


Fig. 11

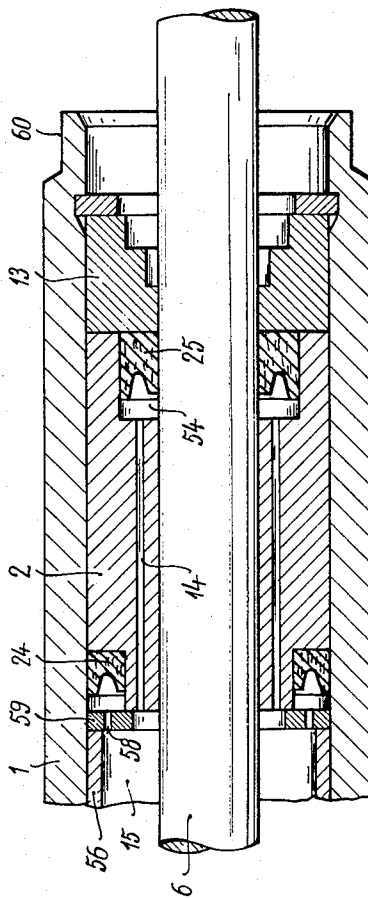


Fig. 13

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Fig. 14

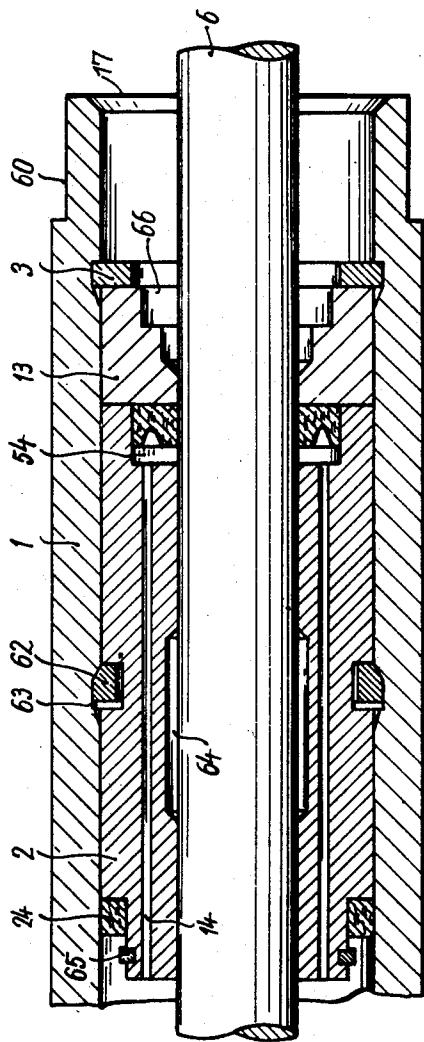


Fig. 15

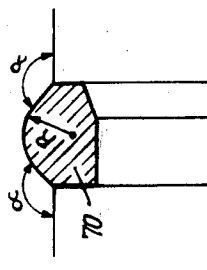
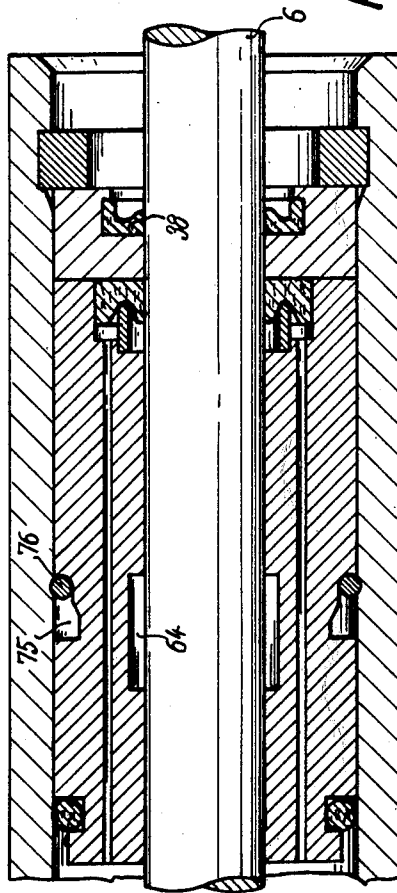


Fig. 16



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11 Sheets-Sheet 6

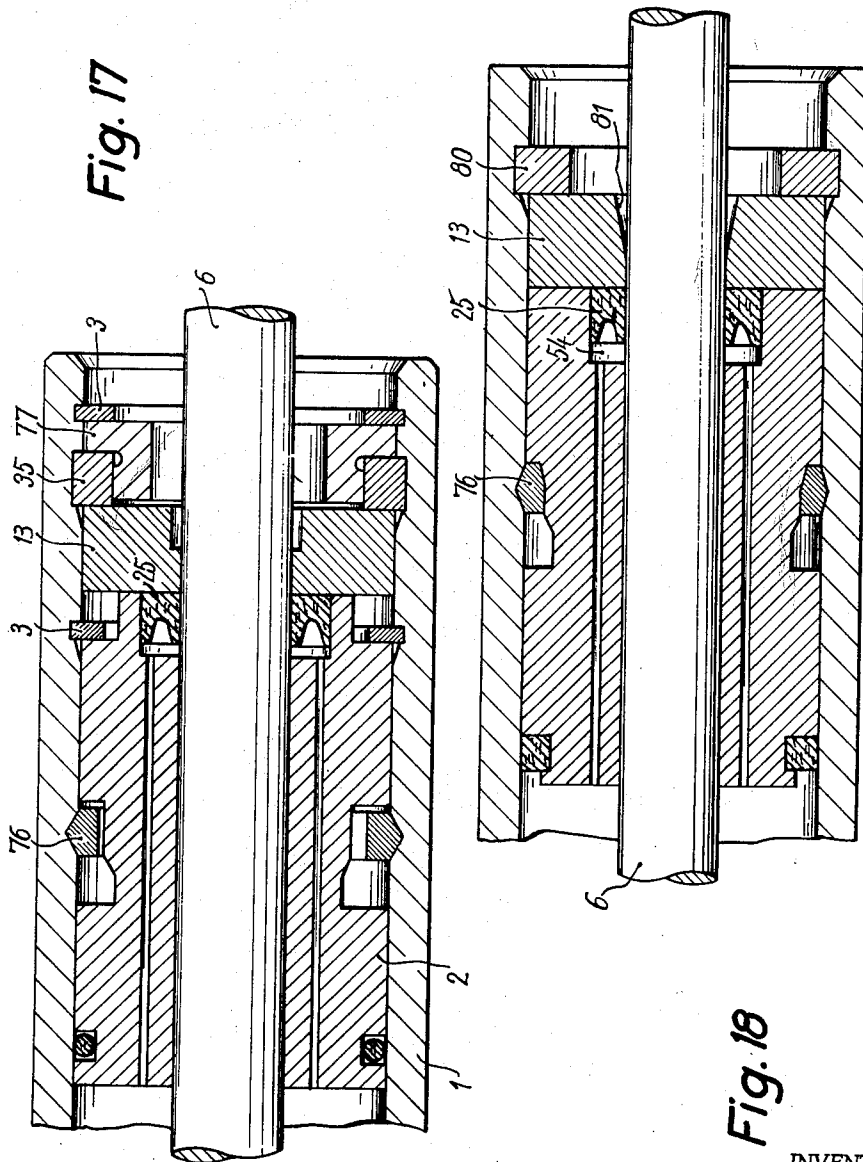


Fig. 18

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11 Sheets-Sheet 7

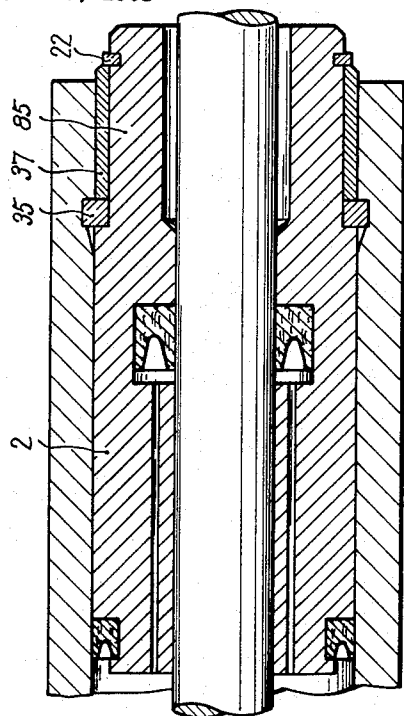


Fig. 19

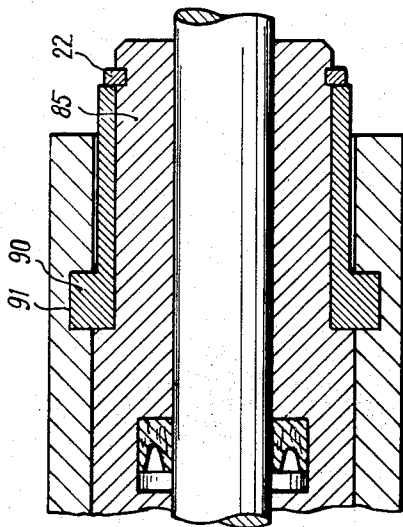


Fig. 20

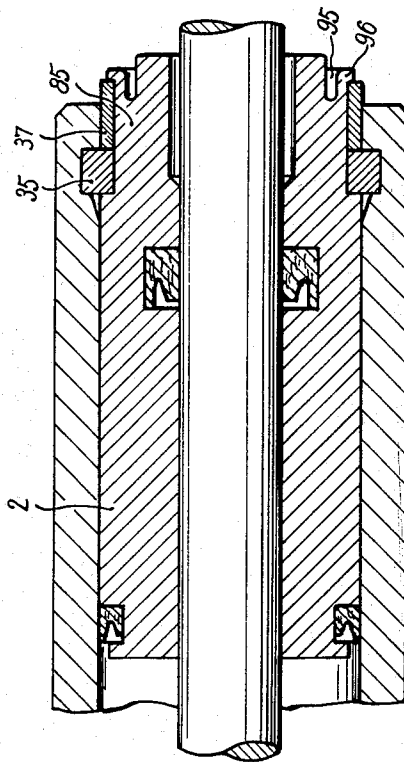


Fig. 21

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Fig. 22

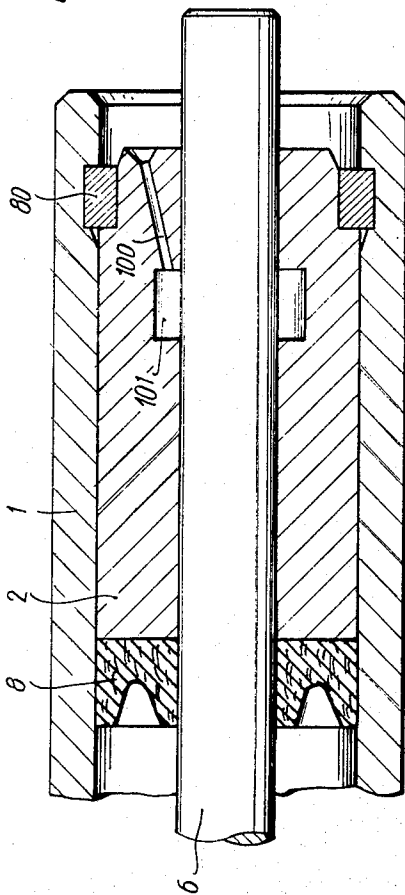
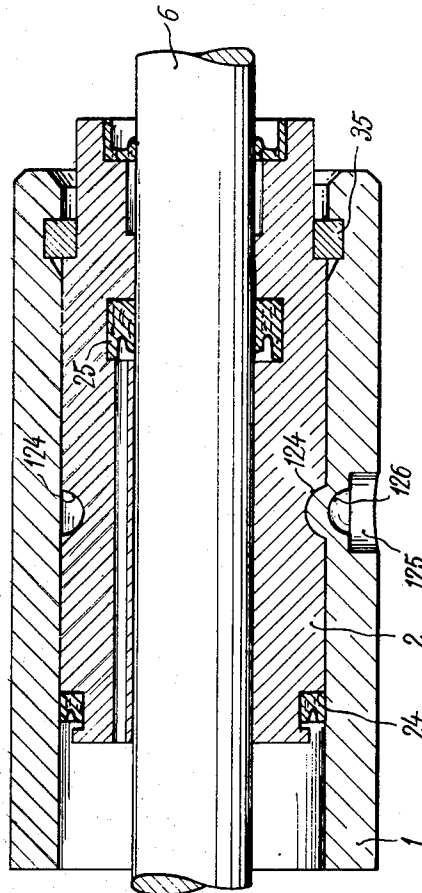


Fig. 23



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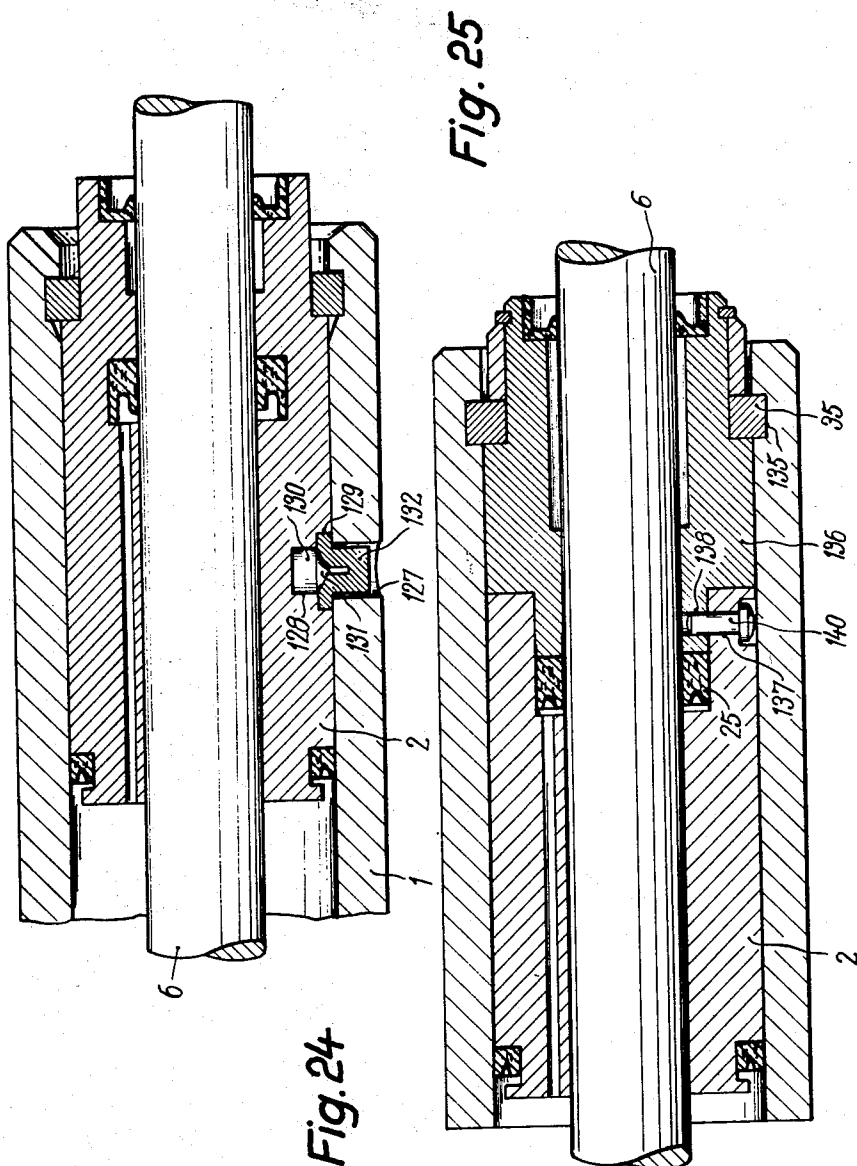
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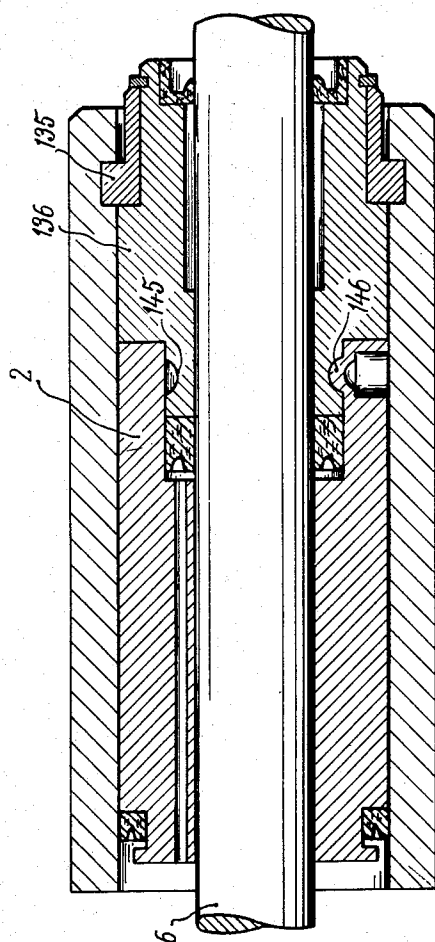


Fig. 26

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CLOSURE DEVICE FOR HYDRAULIC CYLINDER OR THE LIKE

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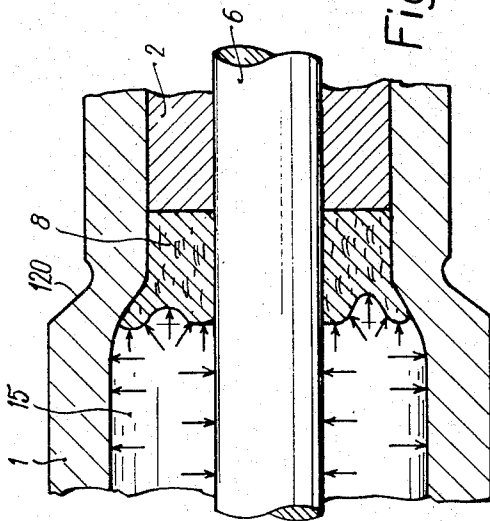
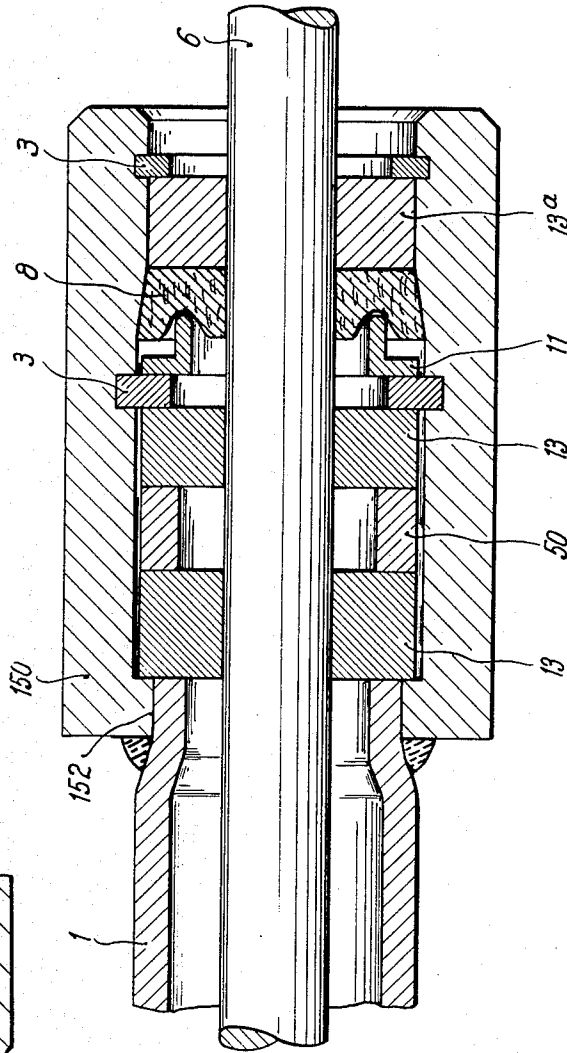


Fig. 27

Fig. 28



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3,175,474 CLOSURE DEVICE FOR HYDRAULIC CYLINDER OR THE LIKE

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Claims priority, application Germany, May 17, 1960,
B 57,876

32 Claims. (Cl. 92-168)

The present invention relates to a closure device for a hydraulic apparatus having a cylinder and a piston with a piston rod thereon slidable within the cylinder, and in which closure means are provided for closing the inside of the cylinder which is supplied with a pressure medium either at the side containing the piston rod or also at the opposite side.

Although the present invention is concerned primarily with apparatus which are to be operated under high pressure by means of hydraulic pressure media, it is to be understood that the term "hydraulic apparatus" as used herein with respect to the present invention also includes similar apparatus which may be operated with a pneumatic pressure medium. The closure device according to the invention may be applied to cylinders, the pistons of which may be acted upon either at one side or at both sides, and in which the piston rods may extend from the cylinders either only at one side or at both sides.

It is an object of the present invention to provide a closure device for a hydraulic apparatus which is capable of functioning properly also when subjected to very high hydraulic pressures.

A further object of the invention is to provide a closure device of the mentioned type which may be very easily manufactured and installed.

A further object of the invention is to provide very secure means for sealing the cylinder toward the outside, especially at the side containing the piston rod, and possibly also for sealing the piston relative to the cylinder.

An essential feature of the invention therefore consists in providing a cylinder in which at least a part thereof forms a continuous tube of a uniform inner diameter, except for certain recesses in the inner wall of this tubular part which, however, do not extend through this wall to the outside, and in further providing suitable elements, such as end walls, guide bushings for the piston rod, and the like, which are adapted to close this tubular part or are to be inserted therein, and which are fitted between the inner cylindrical surface of this part and the piston rod and are secured in this part against movement in the axial direction by means of annular elements, such as spring rings or rings which are divided into sections, which are inserted into radial grooves extending in the peripheral direction into the inner wall of the tubular part.

The term "divided ring" is used in the present application to define a ring-shaped structure interrupted by one, or more than one gap, such as a split ring or ring-shaped structure composed to separate sections.

For lower pressures, for example, up to about 50 atm., it is still possible to manufacture the closure means according to standard dimensions since minor out-of-true errors will then not seriously affect the sealing action.

This is, however, quite different if the apparatus is to be operated under high pressures of several hundred or even at about 1000 atmospheres. If at such high pressures, the different parts of the apparatus are made of different diameters, they will always tend to jam even if machined as accurately as possible, the cylinder will under the internal pressure be radially widened, and the parts will be differently worn at different parts to different

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extents, which in turn, will lead to leaks. As soon as a high pressure acts from the inside of the cylinder, the axial pressure resulting therefrom will be transmitted to the front spring ring. Experiments have shown that this spring ring may then be wrenched off in the axial direction, and that the edges of the closure ring and of the cylinder will be rounded off until finally the spring ring, the cylinder, and the closure ring will be completely deformed whereupon the parts will be jammed against each other and become inoperative.

According to the above-mentioned feature, the present invention permits the closure elements which also serve as bearing or guide members for the piston rod, as well as additional guide members which might be required to be produced with uniform outer and inner diameters by one continuous operation so that, after they have been installed into the cylinder, they will not have any out-of-true errors with respect to their common axis.

By experiments it has been ascertained that the so-called closure or end rings must be made of a length which depends upon the amount of pressure to which the cylinder is to be subjected. With high pressures, this would result in closure rings of a very great length which would be very undesirable because they would prevent a proper lubrication of the piston rod. As soon as the proportion of the axial length to the radial thickness becomes too large, the friction between the closure ring and the piston rod will become so strong that it is no longer possible to insure an adequate lubrication.

Since the bearing surface of the closure ring will be lubricated only by the microscopically thin oil film which remains in the pores of the piston rod, the closure ring should not exceed a certain axial length. If it is of a greater length, this microscopic oil film on the piston rod will not be sufficient to provide adequate lubrication and undue wear and jamming of the piston rod will result.

It is for this reason that an additional guide bushing which is provided in the cylinder primarily for the purpose of centering and guiding the piston rod becomes of importance. This bushing may be exposed to pneumatic or hydraulic pressure from either side or from both sides. For adequate lubrication the cylindrical gap between such an additional bushing and the piston rod should, if possible, be supplied with oil under pressure from both sides. In order to carry out its centering and guiding functions properly, the guide bushing should be several times, for example, three to six times, as long as the actual closure member which closes the cylinder toward the outside, and its length should generally be considerably greater than its outer diameter. If the cylinder is very long, the guide bushing may be divided in the axial direction into two parts and these parts may be spaced from each other in the axial direction by a spacing sleeve.

A further important finding of the present invention consists in the fact that, if a hydraulic cylinder consists of a cylindrical tube of a uniform inner diameter and also a uniform outer diameter throughout its length, it is not only admissible but advantageous to provide the inner wall of the cylinder with an annular groove for securing therein a spring ring for locking a guide bushing in a fixed position. It has thus surprisingly been found that, despite the grooves for the spring rings, the cylinder closure according to the invention is in practically every case more durable than the remainder of the cylinder, especially within the area adjacent to the groove.

By calculations which have been carried out in connection with extended experiments it has been possible to ascertain the relations which have to be observed for determining the proper dimensions of the grooves and

the ring elements, and these calculations have shown that, contrary to the previous opinion, the grooves for the spring rings practically do not reduce the solidity of the tube, but on the contrary, make the tube considerably more elastic against a strong internal pressure so that the cylinder will be prevented from bulging outwardly within the area of the bushing for guiding the piston rod. The provision of a groove for the insertion of a spring ring for securing the cylinder closure therefore does not require the tube to be of a greater wall thickness throughout its length, but, on the contrary, such a greater wall thickness is even undesirable. In practically every case, a cylinder subjected from the inside to a strong hydraulic or pneumatic pressure will be radially distended toward the outside and, if the pressure becomes too high, it will eventually tear apart at this part long before the highest admissible axial stress will be reached at the grooved part of the cylinder containing the spring ring.

In connection herewith it has also been found that, when a cylindrical tube tears or bursts or bulges radially because of a very high internal pressure, the part of the cylinder axially behind the gasket ring will not also become radially distended since this part is protected by the gasket. Axially outside of the gasket, the cylindrical tube therefore retains its original diameter and the annular groove containing the spring ring will remain undamaged even though axially within the area of the gasket the cylinder might already start to be distended. The elastic transition from the radially distended part of the tube to the unstressed part thereof may then occur within the area axially adjacent to the gasket ring.

This fact also facilitates the provision of a pressure inlet conduit so as to extend through the closure member. According to another feature of the invention such a conduit extends through the outer end of the guide bushing, for example, by being designed so as to avoid sharp corners and not to interfere with the free flow of the pressure medium, and this conduit is combined with the bushing so as to form an integral part thereof. For this purpose, the bushing may, for example, consist of a cast or forged part. In this manner it will be possible to avoid the thermal stresses which are bound to occur if the pressure inlet conduit is welded subsequently to the guide bushing or to the cylindrical closure member, and which would result in a distortion of the cylindrical parts so that they would no longer remain exactly circular in cross section.

The guide bushing may also be provided with an annular groove into which a portion of the wall of the cylinder may be pressed, preferably at a point where the thickness of the wall is reduced and where such a groove is protected from the pressure at the inside of the cylinder by a gasket ring which is mounted on the end of the bushing facing toward the pressure side. Similar connections are also very advisable for connecting the parts of the guide bushing to each other if the latter is made of two parts.

Constructions of the last-mentioned design are especially adapted for use as axial closures for one-way active hydraulic lifting cylinders such as, for example, upright plunger-piston cylinders.

All of the features of the different embodiments of the invention are based upon the object to save in material in the production of the cylinder closures, to reduce the amount of time and labor required for their production, to reduce the amount of space required for these closures, to permit them to be exchanged, and to insure that they will resist the highest possible pressures.

These as well as additional features and advantages of the present invention will become more clearly apparent from the following detailed description thereon, par-

ticularly when the same is read with reference to the accompanying drawings, in which—

FIGURES 1, 3, 5, 6, 7, 9 to 14, and 16 to 26, inclusive, show cross-sectional views of 22 different embodiments of the closure device according to the invention for cylinders which are subjected to very high pressures;

FIGURE 2 shows a cross section taken along line II—II of FIGURE 1;

FIGURE 4 shows a modification of the piston structure according to FIGURE 1;

FIGURE 8 shows a cross section taken along line VIII—VIII of FIGURE 7;

FIGURE 15 shows a modification of a guard ring similar to that shown in FIGURE 14; while

FIGURES 27 and 28 show two embodiments for further illustrating the invention.

Each of these drawings illustrates only one end of the cylinder. The other end may in each case be symmetrical thereto, with the possible exception that, if the closure element is used as an end or bottom closure, the piston rod will not pass therethrough. It is, however, also possible to design one end of the respective cylinder according to one of the drawings and the other end according to any of the other drawings, that is, either with or without a piston rod, or the remainder of the respective cylinder or the other end thereof may also be of a different design or even form a separate part.

FIGURE 1 illustrates a part of a cylinder in the form of a tube 1 with uniform outer and inner diameters, while FIGURE 2 shows a cross section taken along line II—II of FIGURE 1. A guide bushing 2 is fitted tightly into this cylindrical tube 1 and is secured at each end against movement in the axial direction by a spring ring 3. In order to facilitate the installation of the spring rings, the edges 4 of the annular grooves 5 in tube 1 for receiving spring rings 3 may be beveled toward the adjacent cylindrical surfaces.

Guide bushing 2 serves as the means for guiding a piston rod 6 in the axial direction. On its inner end which is acted upon by pressure, piston rod 6 carries a piston 7 which may consist of one piece or may be divided at 7a into two parts, and it is provided at both sides with gaskets 8. Piston 7 which is adapted to act in both directions is secured to piston rod 6 by a ring 9 which is divided into two parts which are separated by a slot 10, as shown in FIGURES 1 and 2, and are inserted into an annular recess 16 in the piston rod. For installing the piston, the two parts 7 thereof may, after ring 9 has been inserted into recess 16, be slipped from the opposite sides over ring 9, whereupon gaskets 8 are pressed against the end surfaces of the piston by means of angular, cup-shaped thrust washers 11 which are then secured by means of spring rings 12. At the end of the cylinder which is not subjected to pressure another gasket 8 is provided at the other side of bushing 2 and it is pressed against another thrust washer 11 by means of an end ring 13 which also guides piston rod 6 in the axial direction and serves as a locking member which is fitted tightly into cylinder 1 and is secured in the axial direction by another spring ring 3. By providing one or more axial bores 14 in bushing 2, the full pressure of the pressure medium may be transmitted to one side of gasket 8 which faces at the other side toward the atmosphere so that the lips of this gasket will be pressed in sealing engagement against the inner wall of the cylinder and against the surface of piston rod 6. These axial bores 14 also serve as lubricant passages in the event that the pressure medium consists of oil.

FIGURE 3 shows a modification of the invention in which the spring rings 12 as shown in FIGURE 1 are omitted. In place of the annular grooves in piston rod 6 for receiving these spring rings, the piston rod is provided with rounded annular grooves 23 in which thrust rings 11 which are preferably bent over twice at right angles are secured by beading. As shown at the right side

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of FIGURE 3, thrust rings 11 may either press gaskets 8 against piston 7 or, as shown at the left side, a pair of deep annular grooves may be cut into the end surface of piston 7 into which an inner and an outer gasket 32 and 33 may be fitted. In this case, thrust ring 11 is bent only once at a right angle and engages firmly against the annular projecting part 34 of the end of the piston.

A similar axial locking device may, if desired, also be provided between bushing 2 or similar fixed parts and the cylinder.

According to FIGURE 4, piston 7 is secured by means of a ring 9 and a pair of spring rings 12 without any interposed gaskets to piston rod 6.

FIGURE 5 illustrates a modification of a guide bushing 2 which is extended beyond the end 17 of cylinder 1 which is not subjected to pressure and has behind this end an enlarged portion of a diameter 2a substantially equal to the outer diameter of the cylinder. Adjacent to the end of the cylinder, bushing 2 has an annular recess 18 into which two rings 19 and 20, each consisting of several parts, are inserted next to each other so that one ring 19, lying between the inner wall of the cylinder and the bushing engages at one side against a spring ring 3, while the other ring 20, lying behind the end of the cylinder, is held in place by a cover sleeve 21 which, in turn, is secured in the axial direction by a spring ring 22. The means for sealing cylinder chamber 15 are divided into two sections. At the pressure side of bushing 2, a gasket 24 serves as a high-pressure seal between bushing 2 and cylinder 1, while bushing 2 and piston rod 6 are sealed relative to each other at the outer end of the bushing by means of a gasket 25. Axial bores 14 in bushing 2 again serve as passages for conducting the pressure medium to gasket 25 so as to spread the lips thereof, and press them against the surfaces of the bushing and piston rod in the same manner as previously described with reference to FIGURE 1. A larger annular recess 27 may be provided in bushing 2 to store up lubricant in the event that the pressure medium consists of oil.

The modification of the invention as illustrated in FIGURE 6 forms a further development of the embodiments according to FIGURES 1 and 5 and differ therefrom by the provision of an inlet conduit 30 for the pressure medium at the right side of the cylinder. In order to avoid any distortions of the bushing caused by thermal stresses when the two parts are welded together during the production, and in order to insure that the bushing will be perfectly round, it is advisable to make this conduit 30 and bushing 2 for a single piece of material. This also avoids the need of welding any conduits to the tubular cylinder and the distortions resulting from such welding, and it also avoids any flow resistances which are due to sharp edges. Several, for example, three wide sector-shaped recesses 31 in bushing 2 also insure a strong flow of pressure medium. The means for sealing cylinder chamber 15 are again divided into two sections, and spring ring 3 is again installed as described with reference to FIGURE 5. For this purpose, bushing 2 including gasket 24 is moved to such an extent into the cylinder that spring ring 3 can be inserted into its annular recess through the annular gap between recess 18 and cylinder 1, whereupon bushing 2 is again withdrawn from the cylinder until it engages with spring ring 3 to permit the ring sections 19 and 20 to be inserted. After sleeve 21 has been slipped over ring 20 and spring ring 22 has been inserted, the closing means are completely installed and ready to operate.

FIGURE 7 illustrates a modification of the divided ring. Similar to ring 19 in FIGURE 6, the divided ring 35 lies within an annular groove 35a in cylinder 1 adjacent to the end 17 of the cylinder which is not subjected to pressure. The cylinder is not closed in this case by guide bushing 2 which is located further inwardly of the cylinder between spring rings 3, but by a closing ring 36 which supports the divided ring 35, while a

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spacing sleeve 37 retains ring 34 in a fixed position and is, in turn, secured at the outer end of ring 36 by a spring ring 22. A gasket 38 may be further provided to prevent the entry of dust so that the bearing surfaces of the piston rod will not be soiled.

FIGURE 8 shows a cross section taken along line VIII—VIII in FIGURE 7 and illustrates the construction of the divided ring 35. The individual ring sectors 40 of ring 35 are separated by spacing means in the form of rollers or balls 41 and they are thus uniformly distributed. For installing the ring sectors 40, closing ring 36, for example, together with piston rod 6, is inserted into the cylinder by being moved toward the right in FIGURE 7 until its end surface is disposed behind the annular groove 35a for ring 35, so that the ring sectors may then be inserted radially from the inside into the groove. The closing ring 36 is then again withdrawn toward the left of FIGURE 7 and secured by spacing sleeve 37 and spring ring 22.

FIGURE 9 shows a cylinder closure with a built-in inlet conduit for the pressure medium for a double-acting cylinder. This embodiment differs from that according to FIGURE 6 by the use of divided rings 35 in accordance with FIGURE 8. Furthermore, the guide bushing is made of two parts, namely, of an outer bushing 45 and an inner bushing 46 concentrically thereto. A bushing of this construction has the advantage of providing a very advantageous, almost unrestricted inlet conduit for the pressure medium. The inner bushing 46 is secured within the outer bushing 45 by a pair of spring rings 47. For sealing the piston rod 6 toward the outside, a gasket 48 is inserted between bushings 45 and 46. A spacing sleeve 37 which, in turn, is held in bushing 45 by a spring ring 22 secures the divided ring 35 in a fixed position.

In certain cases it may be advisable to modify the cylinder closure according to FIGURE 1 in the manner as subsequently described and illustrated in the following drawings.

FIGURE 10 shows a closure in which a gasket 8 and a closing ring 13 are disposed within cylinder 1. Between ring 13 and spring ring 3 another ring 50 is interposed which is preferably hardened and serves for the purpose of reducing the bearing length of closing ring 13 as much as possible so as to provide the best possible lubrication of the bearing surface.

FIGURE 11 differs from FIGURE 10 in that the closing ring 13 is provided at the pressure side with a dovetailed annular projection 51 in which a gasket 52 is secured by means of a dovetailed groove 53. Closing ring 13 and spacing ring 50 are combined into one integral piece which is secured by a spring ring 3. The annular groove 57 is provided for the same purpose as the annular recess at the inside of ring 50 in FIGURE 10, namely, to reduce the length of the bearing surface of ring 13.

The further modification according to FIGURE 12 also serves for improving the sliding properties of the piston rod in the different bearings thereof. Closing ring 13 has also in this case a short bearing surface. Bushing 2 is also provided with a plurality of axial bores 14 which serve as passages to permit a flow of oil especially to the inner annular chamber 54 between bushing 2 and an inner gasket 55 and to lubricate the sliding piston rod at both bearing ends of the bushing. The out-of-true errors which were mentioned at the beginning and which are so detrimental to a high-pressure seal can also not occur with this arrangement of the closing means. This is due to the fact that the closing ring 13, the guide bushing 2 and a spacing sleeve 56 are made at the same time of one piece of material and are subsequently separated from each other or, if they are made separately, they are finished to the same outer diameter on a common mandrel of a uniform diameter so that its respective outer and inner diameters will not be out of true. This manner of production is preferably also applied to all of the other em-

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bodiments of the invention. Since in the embodiment according to FIGURE 12 the spacing sleeve 56 may extend up to the bottom of the cylinder, especially in single-acting cylinders, this embodiment only requires a single annular groove to be cut for a single spring ring.

FIGURE 13 shows an arrangement of the gaskets 24 and 25 which is principally the same as that shown in FIGURES 5 and 6. However, in order to transmit the full pressure of the pressure medium from the cylinder chamber 15 to the gasket, an intermediate ring 59 with axial bores 58 is inserted between spacing sleeve 56 and bushing 2. Furthermore, at its closure end, the wall of the cylinder is turned to a smaller diameter 60 to permit the cylinder to be clamped at this end portion by suitable means so that the inner surface of the cylinder may be made accurately true in accordance with this turned end, for example, for the purpose of cutting internal grooves into the cylinder for spring rings which should be accurately true.

This last-mentioned procedure is especially advisable if, as shown in FIGURE 14, a spring ring 62 is to be inserted into an annular groove in the inner wall of the cylinder at a position as indicated in which no pressure is exerted upon the cylinder from the inside thereof, that is, for example, at the central part of bushing 2 between the latter and cylinder 1, in order to secure the bushing in the axial direction. This annular groove 63 is preferably beveled toward the inner surface of the cylinder at the side facing toward cylinder end 17. Bushing 2 together with spring ring 62, which is made of a size and shape in accordance with groove 63, is inserted into the cylinder from this end 17 until spring ring 62 snaps into groove 63 and thereby locks bushing 2 in the axial direction toward the pressure side of the cylinder. In the opposite direction, bushing 2 is again locked by a spring ring 3 and has a closure ring 13 interposed between it and this spring ring. An annular groove 66 in closure ring 13 permits the insertion of a gasket to prevent the entry of dust. A wide annular recess 64 for collecting a lubricant and an oil-filled annular chamber 54 are again provided for insuring an adequate lubrication of the piston rod along the bearing surface of the bushing. A spring ring 65 finally prevents the gasket ring 24 at the end of the bushing facing toward the pressure side from coming loose.

The spring rings as shown in the previous drawings may also be modified in accordance with the spring ring 70, as shown in FIGURE 15 which is conically beveled at both sides and has a rounded central portion, for example, with a radius R. Such a spring ring has the advantage of being very easily installed.

FIGURE 16 shows a further modification of the invention in which again a conically beveled groove 75 is provided near the center of the guide bushing. In this case, however, a spring ring 76 of a circular cross section is inserted into groove 75 and the groove in the inner wall of the cylinder is made of a corresponding arcuate shape. The effect attained by this construction is similar to that according to FIGURE 14. Also, in this case, an oil-storage recess 64 and a gasket 38 for preventing the entry of dust are provided.

A more complicated embodiment of the cylinder closure according to FIGURES 14 and 16 is illustrated in FIGURE 17. In this case, in order to secure guide bushing 2 within cylinder 1 so as to prevent any axial relative movement thereof, a spring ring 76 which is conically beveled toward both sides is inserted into an annular recess in bushing 2, substantially centrally of its length, and in addition bushing 2 is secured at the nonpressure side by means of spring ring 3. Gasket 25 is again held, as in FIGURE 13, by a closure ring 13 which, however, is secured by a divided ring 35 which, in turn, is inserted into an annular recess in a ring 77 which is secured by a further spring ring 3. Such a construction is advisable when extremely high pressures are to be applied and when an extremely high degree of safety is to be demanded.

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Usually, however, a more simple construction will be preferred as illustrated in FIGURE 18, in which the closure ring 13 is merely secured by a strong spring ring 80. For improving the sliding properties of piston rod 6, this embodiment is likewise provided with an annular oil groove 54 in front of gasket 25 and a recess 81 in closure ring 13.

FIGURE 19 illustrates an embodiment which is somewhat similar to the embodiments shown in FIGURES 5, 6, and 9. It shows that a single reduced portion 85 of a uniform diameter on the end of bushing 2 which is not exposed to pressure suffices for securing the necessary closure means relative to each other. A divided ring 35 as well as a spacing sleeve 37 and a spring ring 22 are slipped over the reduced cylindrical end portion 85 of bushing 2. This construction is especially suitable for a mass production of the closure means and may be applied as a factory-assembled cylinder closure, especially for one-way acting hydraulic apparatus such as a plunger-piston cylinder and the like, in which event the cut portion of cylinder 1 may be turned on a lathe and be provided with screw threads or with a flange or similar means.

FIGURE 20 combines parts 35 and 37 of FIGURE 19 into one integral element in the form of a divided tubular ring 90 which is secured by spring ring 22 at a point outside of the cylinder. The installation of ring 90 is carried out in such a manner that the bushing is at first inserted with its end 85 into the cylinder up to a point beyond the annular groove 91, whereupon the divided ring 90 is inserted, the bushing is retracted to the position as shown in the drawing, and finally the spring ring 22 is applied.

FIGURE 21 shows a further modification of the constructions according to FIGURES 19 and 20. Instead of being provided with a spring ring 22, the end 85 of bushing 2 is provided with an annular groove 95 which is designed so as to permit the outer edge portion 96 of the end of the bushing to be flanged over in order to lock the securing elements 35 and 37 or 90 in a fixed position.

FIGURE 22 illustrates a cylinder 1 which may be mounted, for example, in an upright position. Gasket 8 is subjected to internal pressure and is thereby pressed against bushing 2. Naturally, it may also be dovetailed as illustrated by the gasket 52 in FIGURE 11 and be held by a dovetailed projection 51 on the bushing. The bushing, in turn, is secured by a spring ring or a divided ring 80 and it is supplied with a lubricant from the outside through a small bore 100 with a funnel-like outer opening, which bore terminates into an oil groove 101 around piston rod 6.

FIGURE 23 illustrates a further embodiment which is similar to that of FIGURE 19. Bushing 2 is again secured against axial movements by a divided ring 35. Gasket 24 seals piston rod 6 relative to bushing 2, and gasket 25 seals the bushing relative to cylinder 1. Since the outer wall of bushing 2 is sealed by gasket 24 completely from any pressure medium coming from the inside of the cylinder in the same manner as shown in FIGURE 5, the inner wall of this end of the cylinder behind gasket 24 is also completely free of any pressure from the inside of the cylinder. The part of the cylinder containing the guiding and locking elements therefore does not have to be sealed behind gasket 24 and this part of the cylinder may be provided with recesses or locking projections even after the bushing has been installed. The bushing may therefore be secured in the cylinder by providing the bushing with an annular groove 124 into which a certain part of the inner wall of the cylinder may be bent. Thus, for example, as illustrated in FIGURE 23, a recess 125 may be cut into cylinder 1 by means of an end-milling cutter, and the reduced wall portion 126 may then be pressed or punched into the annular groove 124. An axial locking ring may therefore be omitted. This construction, as also, for example, that according to FIGURE 19, may be used especially for upright apparatus, for example, for one-way

operative hydraulic lifts, plunger-piston cylinders, and the like.

FIGURE 24 shows a device similar to that according to FIGURE 23 for locking the bushing against any axial movement relative to the cylinder. In this case, the wall of the cylinder is provided with a radial bore 127 which extends substantially coaxially to a socket bore 128 in bushing 2 which is radially enlarged at 129 at its outer end. A pointed cylindrical plug 130 is fitted tightly into the inner part 128 of the socket bore. The bushing and the cylinder are then rigidly secured to each other by means of a rivet 132 which is inserted into bore 127 and pressed against the pointed end of plug 130 so that its inner end will be wedged apart and pressed into the enlarged aperture 129. The bushing and cylinder will thus be firmly secured to each other and rivet 132 will also be permanently locked in its bores. Naturally, in place of such a rivet connection, it is also possible to apply any other suitable locking means which extend through the wall of the cylinder into the bushing.

The cylinder as shown in FIGURE 25 has only a single inner annular groove 135 into which a ring 35 is inserted which may consist, for example, of two parts. In order to facilitate the production of the seat for the gasket 25 in the bushing, the bushing of this embodiment is divided so as to form a closure ring 136 and the actual bushing 2. Closure ring 136 is fitted into bushing 2 in such a manner that bores 137 and 138 in both parts will extend coaxially to each other so that by the insertion of a bolt 137 they will be rigidly secured to each other.

FIGURE 26 also shows a cylinder which is provided with only one annular groove 135, and the closure part 136 and bushing 2 are also fitted tightly into each other. The collarlike projection on closure part 136 is, however, provided with an annular groove 145 into which at a point of bushing 2 of a reduced cross section a part of the wall of the bushing is irremovably bent in a manner similarly as described with reference to FIGURE 23. This also results in a very simple and efficient construction of a cylinder closure.

FIGURE 27, which merely serves for a further illustration of the invention, shows the manner in which the required closure elements, such as spring rings 3, gasket 8, thrust ring 11, closure rings 13, spacing ring 50, etc., may be assembly in a cylindrical closure member 150 so as to form a unit which may then be connected to a cylinder 1 and a piston rod 6 within the cylinder. The reinforced wall portion 152 at the point of connection between cylinder 1 and closure member 150 resists the tendency of high internal pressures to expand the cylinder. The parts of the tubular wall outside of the area of the guiding elements of the piston rod, for example, ring 13a, that is, the parts which are located at the side of gasket 8 facing toward the pressure side of the cylinder, may be expanded to some extent without danger and without affecting the secure closure of the cylinder.

FIGURE 28, which also merely serves to illustrate the applicability of the closure according to the invention, finally shows diagrammatically and overemphasized that an indentation 120 in cylinder 1 within the area adjacent to a gasket 8 may result in a certain plastic deformation of the cylinder at the parts preceding the indentation, and that this indentation may thus increase the resistance of the cylinder against being excessively expanded, whereas within the area of the cylinder containing the bushing 2, the cylinder will be relieved of all pressure so that the bushing will at all times remain accurately coaxial with the cylinder and thus also with the piston rod. Any expansion of the cylinder under extreme internal pressures will therefore occur only within the area of the compression chamber 15 of the cylinder which does not contain any guiding elements for the piston rod.

All of the embodiments of the invention as previously described and as illustrated in the drawings may be ap-

plied either for vertical or horizontal cylinders. Although the invention has been described with reference to hydraulic or pneumatic cylinders, it may also be applied for other purposes, for example, as bottle closures or the like.

Although my invention has been illustrated and described with reference to the preferred embodiments thereof, I wish to have it understood that it is in no way limited to the details of such embodiments, but is capable of numerous modifications within the scope of the appended claims.

Having thus fully disclosed my invention, what I claim is:

1. A closure device comprising a body formed with a bore having an inner cylindrical surface; a closure member including a fitting part having an outer cylindrical surface having the same diameter as said inner surface and being in contact with the same, said body and closure member being formed with at least two grooves, at least one of said grooves extending from said inner surface into said body and the other of said grooves extending into said closure member, said closure member including means having a pair of faces transverse to said outer surface and bounding said groove; and a plurality of divided rings, each divided ring located in one of said grooves and abutting both said transverse faces.

2. The closure device of claim 1 wherein said divided rings have planar end faces abutting said transverse faces.

3. The closure device of claim 1 wherein said closure member includes two parts located in said bore adjacent each other in the axial direction of said surfaces.

4. The closure device of claim 1 wherein said body is a hydraulic cylinder, and including a sealing means inserted into a groove adjacent the innermost end of said closure member and sealing said body and said closure member.

5. A closure device in a body, comprising a bore in said body, a closure member having a fitting part with an outer cylindrical surface, said outer cylindrical surface fitting in said bore of said body, said body having at least one groove extending from said bore into said body, a radially divided ring located on said groove and extending therefrom radially inwards beyond the cylindrical periphery of said bore; said closure member having an extension with an outer face with a diameter narrower than the diameter of the fitting part of said closure member, a shoulder between said fitting part and said narrowed outward extension, and a radial inwards extending groove; said shoulder abutting against an end of the inwards extending part of said divided ring; a ring means extending into said radially inwards extending groove of said extension of said closure member; and a distance means provided between said ring means and the inwards extending part of said divided ring so that the same abuts two transverse faces.

6. A closure device in a cylinder for a hydraulic apparatus, comprising a tubular member having at least one tubular end, said tubular member having an inner cylindrical surface of uniform diameter extending substantially to said one open end and a closure member for closing said open end of said tubular member; said closure member having a fitting part with an outer cylindrical surface having the same diameter as said inner cylindrical surface, said inner and outer cylindrical surfaces abutting each other in said tubular member having at least one groove; a divided ring inserted into said groove and extending therefrom radially inwards beyond said inner cylindrical surface; said closure member having an extension with an outer face with a diameter smaller than the diameter of the fitting part of said closure member, a shoulder between said fitting part and said extension and having a radially inwards extending groove; said shoulder abutting against the inwards extending part of said divided ring; a ring means extending into said radial inwards extending groove of said extension of said closure member, and a distance means provided between said ring means

and the inwards extending part or parts of said divided ring so that the same abuts two transverse faces.

7. A closure device in a cylinder for a hydraulic apparatus, comprising a tubular member having at least one tubular end, said tubular member having an inner cylindrical surface of uniform diameter extending substantially to said one open end and a closure member for closing said open end of said tubular member; said closure member having a fitting part with an outer cylindrical surface having the same diameter as said inner cylindrical surface, said inner and outer cylindrical surfaces abutting each other in said tubular member having at least one groove; a divided ring inserted into said groove and extending therefrom radially inwards beyond said inner cylindrical surface; said closure member having an extension with an outer face with a diameter smaller than the diameter of the fitting part of said closure member, a shoulder between said fitting part and said extension and having a radially inwards extending groove; said shoulder abutting against the inwards extending part of said divided ring; a ring means extending into said radial inwards extending groove of said extension of said closure member, and a ring member disposed between said ring means and the inwards extending part of said divided rings so that the same abuts two transverse faces.

8. The closure device of claim 1 wherein a plunger or piston rod extends through said closure member and is sealed and guided therein.

9. The closure device of claim 6 wherein said distance means abuts with one of its ends against the other end of the inwards extending part of said divided ring thereof and with its other end against said ring means.

10. The closure device of claim 7 wherein said ring member has an inner face fitting around the said outer diameter of said extension of said closure member.

11. The closure device of claim 7 wherein said ring member is a radially divided ring.

12. The closure device of claim 7 wherein said ring member comprises a plurality of ring member sections.

13. The closure device of claim 12 wherein said ring member sections are fitted between said inner cylindrical surface of said tubular member and said extension of said closure member.

14. The closure device of claim 6 wherein said divided ring has a cylindrical inner face and said cylindrical inner face is borne on a part of said outer face of said narrowed outward extension of said closure member.

15. The closure device of claim 14 wherein said divided ring comprises at least two ring sections.

16. The closure device of claim 6 wherein said closure member extends beyond one end of said tubular member.

17. The closure device of claim 6, said closure member being formed with a port and a passage extending from said port to one axial end of said closure member through said closure member.

18. The closure device of claim 3 wherein a plunger or piston rod extends through said closure member and is sealed and guided therein.

19. The closure device of claim 18 wherein said closure includes a guide bushing and a tubular element surrounding said guide bushing.

20. The closure device of claim 1 including a sealing means disposed adjacent the innermost end of said closure member between said body and said closure member.

21. The closure device of claim 6 wherein a plurality of said distance means are provided and including a ring surrounding said distance means or a part thereof.

22. The closure device of claim 18 including a sealing means provided in said closure member around the outer face of said piston rod or plunger.

23. The closure device of claim 1 wherein one ring of said divided rings has at least one tapered outer face; and wherein one of said grooves has at least one tapered outer face, and wherein at least one of said grooves has at least one tapered outer face.

24. The closure device of claim 23 wherein said divided ring has an inner face and said inner face is borne by a corresponding seat formed in said closure member.

25. The closure device of claim 23 wherein said groove which extends into said closure member has a larger portion adjacent said one divided ring.

26. The closure device of claim 25 wherein at least one divided ring is resiliently compressible and expandable to have different diameters.

27. The closure device of claim 3 wherein an axial recess is formed in one end of one part of said closure member, and a sealing ring located in said recess, said recess being closed by the other part of said closure member.

28. The closure device of claim 1 wherein one ring of said divided rings has an inner face, and an end ring having a seat, said inner face abutting said seat of said end ring; and a retaining ring retaining said end ring.

29. The closure device of claim 3 wherein one part of said closure member is located and retained between a pair of divided rings.

30. A closure device comprising a body formed with a bore having an inner surface; a closure member in said bore and having an outer surface in contact with said inner surface, said body and said closure member having adjacent transverse faces; divided ring means having transverse surfaces abutting said transverse faces to lock said closure member against longitudinal movement, said divided ring means one condition in which the outer diameter thereof is smaller than the diameter of said inner surface and adapted to be assembled in said condition, and having another condition in which the outer diameter thereof is greater than the diameter of said inner surface in which other condition said divided ring means abuts said transverse face of said body; blocking means located within said divided ring means in said other condition to block movement to said one condition; and means locking said blocking means in said bore against longitudinal movement.

31. A closure device comprising a body formed with a bore having an inner surface; a closure member in said bore and having an outer surface in contact with said inner surface, said body and said closure member having adjacent transverse faces; divided ring means having transverse surfaces abutting said transverse faces to lock said closure member against longitudinal movement, said divided ring means having one condition in which the outer diameter thereof is smaller than the diameter of said inner surface and adapted to be assembled in said condition, and having another condition in which the outer diameter thereof is greater than the diameter of said inner surface in which other condition said divided ring means abuts said transverse face of said body; blocking ring means located within said divided ring means in said other condition to block movement to said one condition; and locking ring means locking said blocking ring means in said bore against longitudinal movement.

32. A closure device comprising a cylinder body formed with a bore having an inner surface; a closure member in said bore and having an outer surface in contact with said inner surface, said body and said closure member having adjacent transverse faces, said closure member having passages connecting the ends thereof and a central bore; a piston rod guided in said bore; a deformable sealing member surrounding said piston at one end of said closure member; pressure fluid on the other side of said closure member so that pressure fluid passing through said passages deforms said sealing member to press the same into sealing engagement with said piston rod; divided ring means having transverse surfaces abutting said transverse faces to lock said closure member against longitudinal movement, said divided ring means having one condition in which the outer diameter thereof is smaller than the diameter of said inner surface and adapted to be assembled in said condition, and having another condition in which the outer diameter thereof is greater than the diameter

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of said inner surface in which other condition said divided ring means abuts said transverse face of said body; blocking means located within said divided ring means in said other condition to block movement to said one condition; and means locking said blocking means in said bore against longitudinal movement. 5

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