Jan. 24, 1967 A. RATCLIFFE 3,299,990

CONSTANT LOAD EXTENSION DEVICE

Filed June 18, 1965 2 Sheets-Sheet 1

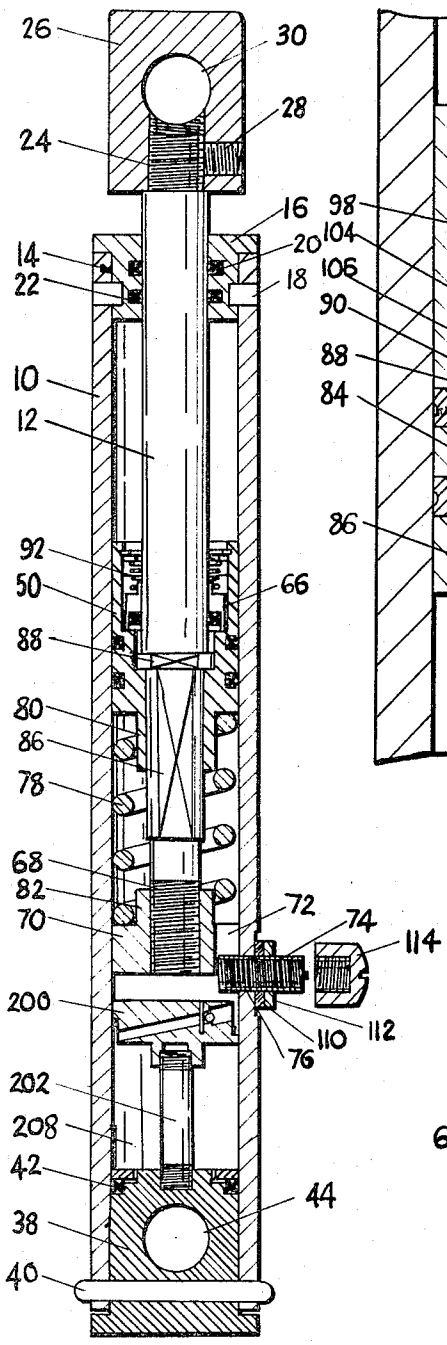


FIG. 1.

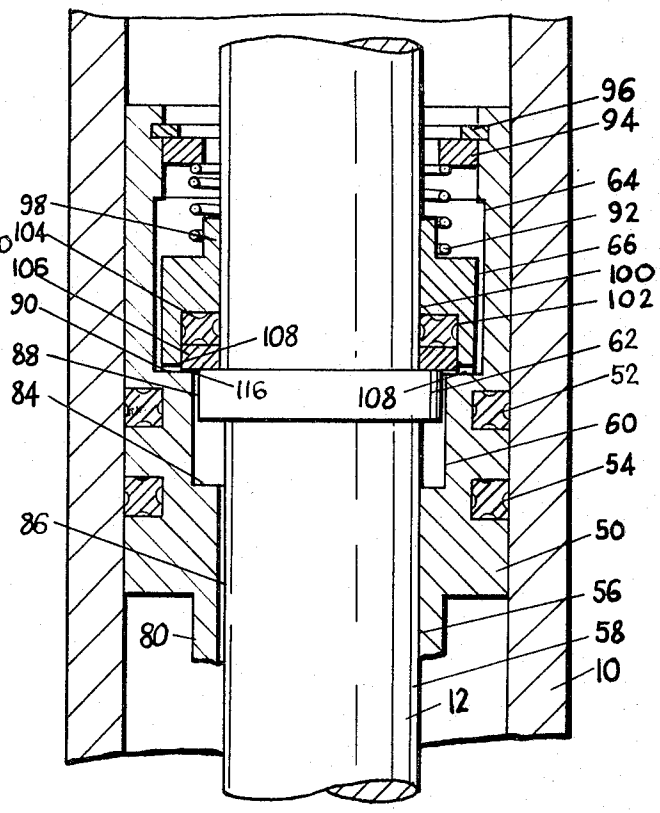


FIG. 2.

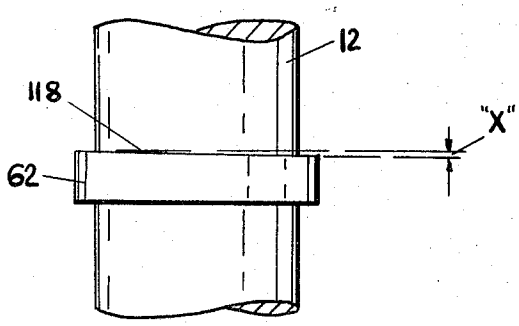


FIG. 3.

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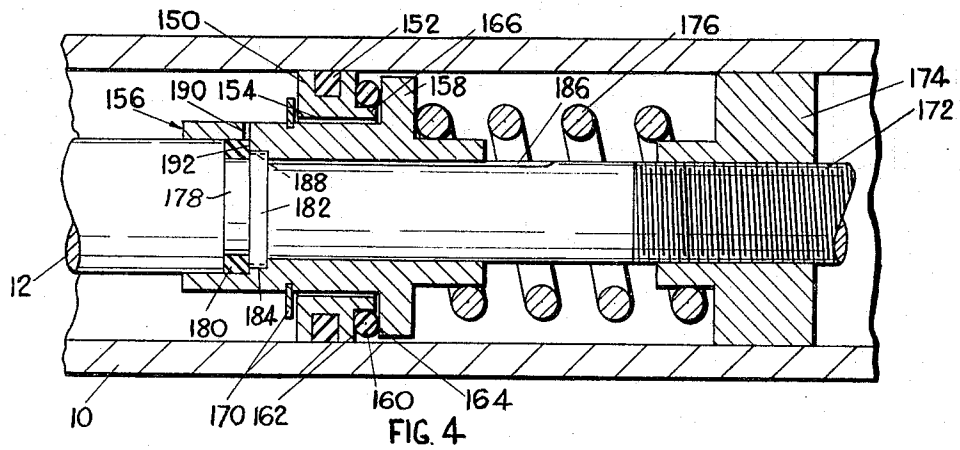


FIG. 4

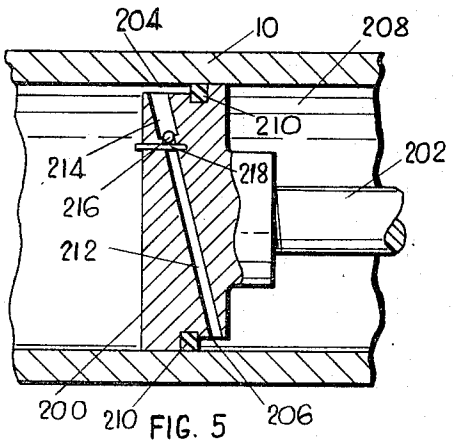


FIG. 5

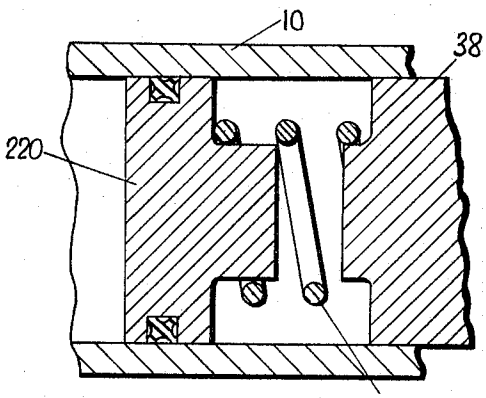


FIG. 6

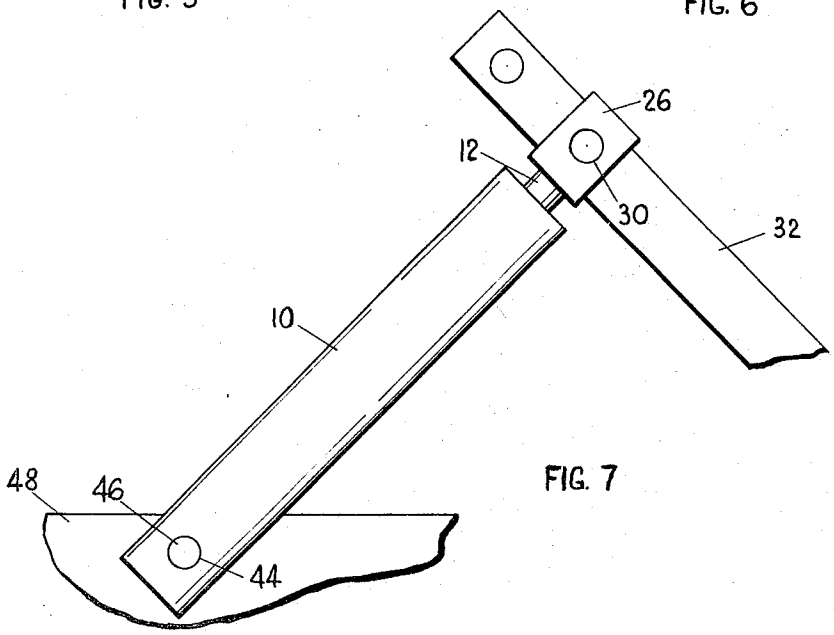


FIG. 7

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3,299,990

CONSTANT LOAD EXTENSION DEVICE

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Claims priority, application Great Britain, June 19, 1964, 25,365/64
11 Claims. (Cl. 188—67)

The ordinary helical tension spring cannot be used where extension of the loading device is required but the load must remain constant, because the load applied by a tension spring increases with extension.

The object of this invention is to provide a substantially constant load extension device, and while the invention may have many applications it has been devised as part of a loading system for bobbins on textile carding machines. There are two characteristics of such a loading system which present problems in the design of a constant load device. One is that the rate of movement of the bobbin axis is very slow. The movement arises out of the build-up of the yarn package on the bobbin, and therefore the bobbin axis may only move a few inches over a period of an hour. The other problem is that the bobbin pegs are frequently distorted which results in uneven motion of the pegs, and hence applies continuous reciprocating motion to any loading device.

As applied to a loading system for the bobbins on textile carding machines (or, more precisely, to the bobbin winding stations of such carding machines) the object of the invention is to provide substantially constant loading of a bobbin throughout the build-up of the yarn package on that bobbin, despite the movement of the bobbin due to the yarn build-up and despite also any eccentricity of the bobbin pegs.

It will be appreciated however that there are many other industrial applications of a substantially constant load extension device.

According to this invention a substantially constant load extension device comprises a cylinder, a rod projecting through one end of the cylinder and through a free piston within the cylinder, each of the rod and the cylinder being adapted for connection to one of two members between which load is to be applied, resilient means between the piston and an abutment on the rod whereby movement of the rod out of the cylinder is opposed by the resilient means and by fluid pressure acting on the opposite side of the piston to the abutment, there being a valve permitting limited flow of fluid from one side of the piston to the other to allow the piston to yield under load applied via the rod, the valve being adapted to be opened by relative movement between the rod and the piston.

By this construction an arrangement is achieved whereby the extension of the device by movement of the rod relatively to the cylinder is opposed by the compression spring, but after the pre-determined movement (which may be very small), the valve is opened and the piston moves to release the load on the spring. The apparatus can be arranged to permit limited oscillation of the spring without opening of the valve, and so that the spring is only slightly compressed by the rod movement (above its original compression) before the valve opens so that any variation in the load on the rod due to spring compression is minute.

Preferably in addition to the valve, there is a restricted passage from one side of the piston to the other to ensure that the piston only yields slowly. It is also preferred to provide loading means arranged within the cylinder to ensure that fluid pressure is maintained on the gland side of the piston during the inward movement of the piston. This ensures that pressure is available to oppose outward

movement of the rod wherever the rod stops on its inward movement. Preferably the loading means comprises a restricted passage through which fluid can flow into an auxiliary chamber beyond the inner extremity of the rod. Alternatively it may comprise a spring loaded auxiliary piston in the cylinder on the shoulder side of the free piston, the spring loading of the auxiliary piston being greater than the loading of the valve, whereby the valve is opened during retraction of the rod until the pressure on both sides of the free piston is such that the valve closes under its own spring loading.

The invention will be better understood from the following description of specific embodiments of the invention which are described by way of examples only, with reference to the accompanying drawings, in which:

FIGURE 1 is a longitudinal section through a load extension device, in the contracted position,

FIGURE 2 is a detail cross-section of part of the device shown in FIGURE 1, drawn to a larger scale to show a valve arrangement,

FIGURE 3 is a detail view of part of a rod,

FIGURE 4 is a view similar to FIGURE 2, but showing an alternative valve arrangement,

FIGURE 5 is a detail sectional view of part of the device shown in FIGURE 1, drawn to a larger scale,

FIGURE 6 is a detail view similar to FIGURE 5, but showing an alternative arrangement, and

FIGURE 7 is an external view of the device shown in operation on a bobbin winding station of a textile machine.

Basically, the extension device comprises a cylinder **10** and a rod **12** extending within the cylinder and projecting out at one end, through a gland **14**. The gland itself is made up of an end fitting **16** which is pressed into the end of the cylinder **10** and secured by means of pegs **18** or by welding, and two rubber (or synthetic rubber) sealing rings **20** and **22** which provide a substantially fluid tight joint with the rod **12**, while permitting axial and rotary movement of the rod.

The projecting end of the rod **12** is screwed at **24** and a rectangular boss **26** is screwed on to this end of the rod and locked by a grub screw **28**. A hole **30** is formed in the boss **26** to provide an attachment point for one of the two members between which the device is to apply load. If the device is applied to a bobbin winding station of a textile machine as shown in FIGURE 7, the boss **26** is fitted on to a pivoted arm **32** which is used to apply load to a bobbin. The arm **32** is pivoted at **34**, and moves in an anti-clockwise direction (thus extending the loading device as the bobbin package increases in size).

The other end of the cylinder **10** is closed by an end cap **38** which is held fixed in the cylinder by a peg **40**, and which completely seals that end of the cylinder. The seal is completed by a rubber (or synthetic rubber) sealing ring **42**. A hole **44** is formed diametrically through the cylinder **10** and the cap **38**, to provide an attachment point for the other of the two members between which the device acts. As seen in FIGURE 7, for example, the hole **44** locates the end of the cylinder **10** on an anchor peg **46** on a fixed part **48** of the frame of the machine.

Within the cylinder **10**, a free piston **50** is mounted for axial sliding movement, this piston being provided with rubber or synthetic rubber sealing rings **52** and **54** in its periphery for fluid tight sealing engagement with the internal wall of the cylinder (see also FIGURE 2). This piston **50** has a small diameter bore **56** through which a portion **58** of the rod **12** is a sliding fit; an intermediate diameter bore **60** which provides a lost-motion space (as will be further described) and within which there is a collar **62** formed on the shaft, and an outer large diameter bore **64** which provides accommodation for a valve hous-

ing 66. The piston 50 with its associated valves provides a controlled dashpot arrangement as will be described.

The inner end of the rod 12 is screwed at 68 to receive an internally screwed nut 70 which is free to slide within the cylinder 10, but which need not form a seal with the cylinder. A keyway 72 is formed in the outside of the nut 70, and the inner end of a filler plug 74 which is screwed into a hole 76 in the cylinder 10 projects into the keyway 72 as shown in FIGURE 1, when the rod 12 is in its contracted position. The inner projection of the plug 74 therefore acts as a key to prevent relative rotation between the nut 70 and the cylinder 10 in this position of the nut. A compression spring 78 extends between the nut 70 and the inner end of the piston 50, this spring being located at its ends on bosses 80 and 82 formed respectively on the piston and nut. If it is required to adjust the spring pressure, it is only necessary to push the rod 12 to its inner extremity so that its keyway engages with the plug 74, and then to rotate the rod 12 about its own longitudinal axis. This will cause relative axial movement between the nut 70 and the rod (due to their screw-threaded connection) and, according to the direction of this movement, will increase or decrease the spring pressure.

The effect of the spring 78 is to hold the piston 50 away from the nut 70, and in the free position, which is shown in FIGURE 1, the collar 62 engages against a shoulder 84 formed in the piston 50. Flats 86 and 88 are formed respectively on the portion 58 and the collar 62 of the rod 12, so that there are free fluid passages through the bores 56 and 60 of the piston 50 past the portions of the rod in those bores.

The valve housing 66 is not a close fit within the bore 64 of the piston 50, but its inner end is normally pressed against a shoulder 90 formed in the piston by a compression spring 92 which engages between the outer end of the valve housing 66 and an annular thrust member 94 which is held in position towards the outer end of the piston 50 by a circlip 96. The compression spring 92 is located on a boss 98 formed on the outer end of the housing 66. The housing 66 is bored at 100 to slide on the rod 12, but at its enter end there is an enlarged bore 102 within which are fitted a rubber or like deformable and resilient loading ring 104 and a metal or other rigid sealing ring 106. The loading ring 104 performs a dual function. Firstly, it seals on the rod 12 and so prevents fluid flow through the bore 100, and secondly, it presses the rigid ring 106 into fluid sealing engagement with the shoulder 90. One or more very small radial grooves or recesses are formed in the annular inner end of the valve housing 66 so that there is a restricted fluid passageway across the face of the inner end of the housing even when that face is pressed against the shoulder 90.

A sealing washer 110 and locknut 112 are provided for the filler plug 74 and there is also a filler plug cap 114 (shown detached in FIGURE 1) screwed internally to fit the screwed external portion of the plug 74.

The device described so far will work satisfactorily for some applications and therefore represents a simple embodiment of the invention. For this reason, its operation will now be described in detail before passing on to a description of refinements and alternatives.

When the device is originally fitted between two members one of which will move away from the other during some machine operation, but between which a substantially constant load is to be applied, its attachment bores 30 and 44 are engaged with suitable projections on the two members. Such an assembly is illustrated in FIGURE 7. The filler cap 114 is removed, and fluid (such as hydraulic oil) is forced under pressure through the filler plug 74 into the cylinder 10 with the rod 12 in its contracted position. It will be appreciated that in this position the rod 12 has its maximum displacement within the cylinder. During the filling operation, the fluid pressure acting on the ring 106 will press the valve housing 66 away from the shoulder 90 in the piston 50 (against the action of the spring 92 which will be somewhat compressed) and the fluid can then flow easily through the piston 50, so that the entire space within the cylinder is filled with fluid. After bleeding to remove any air in the cylinder, the filler cap 114 can be replaced, and the device is ready for operation.

As the bobbin peg rotates, any eccentricity in that peg causes the rod 12 to be oscillated axially, but this is permitted by the lost-motion space formed by the bore 60, which allows the collar 62 on the rod 12 to move endwise without striking the ring 106. Consequently, the ring 106 will maintain a seal against the shoulder 90, and there will be no flow of fluid through the piston 50, which must therefore remain stationary. Any slight movement of the rod out of the cylinder to accommodate such eccentricity of the peg will in fact reduce the pressure on the inside of the piston 50 (by removing some displacement) but this will create only a small pressure differential across the piston 50 and in any case such pressure differential will tend to hold the valve housing 66 pressed against the shoulder 90.

As the arm 32 moves away from the anchor point 44, the rod 12 will be pulled slowly out of the cylinder. This movement may be very slow indeed, and in the case of a carding machine it may be of the order of two or three inches per hour. This gradual extension of the device is also opposed by the spring 78 but any increase in the applied tension due to compression of the spring will be minute, because the maximum possible compression is equal to the permitted lost-motion of the collar 62 within the bore 60. Once the collar 62 strikes the ring 106 it compresses the ring 104, and opens a narrow gap (shown at 116 in FIGURE 2) between the face of the ring 106 and the shoulder 90. This in effect opens a non-return valve provided by rings 104 and 106, and permits fluid to flow from the gland side of the piston 50 to the inside of that piston. This flow is brought about due to pressure differential because (a) there is minimum displacement of the rod on the inside of the piston at this moment, and (b) the collar 62 is pressing the piston 50 outwards via the ring 106, ring 104, valve housing 66, spring 92 and member 94. Of course the permitted fluid flow is restricted by the size of the grooves 108 and the width of the gap 116, so that there is in effect a dashpot action. Nevertheless, the flow of fluid permits the piston 50 to move slightly outwards until the ring 106 again closes the gap 116. In consequence, the rod 12 moves slightly outwards by the same distance.

This action is repeated many times during the extension of the device, and at each opening of the valve, there is a small increment of outward movement of the rod. This permits the gradual extension of the device whilst maintaining the load applied between the arm 32 and the anchor point 46 substantially constant. If the rod is continually oscillating due to eccentricity of the peg, then the valve will only be opened at the outward extremity of the oscillations, but it will have exactly the same effect.

When the device is released from its load by removing a bobbin from engagement with the arm 32, then the rod can be pushed back by hand or by application of any light load, into the contracted position. During this movement, the pressure differential across the piston 50 will be such as to compress the spring 92 and move the housing 66 away from the shoulder 90, so permitting relatively free flow of fluid from the inside to the outside of the piston, and allowing the piston to move inwardly. The collar 62 of course, engages with the shoulder 84 and drags the piston inwardly. It will be observed that the spring loaded housing 66 acts as a release valve. Also during this inward motion there may be a slight suction effect produced on the outside of the piston and this coupled with the displacing effect of the rod helps to keep the valve member away from the shoulder 90 long enough to virtually equalise pressures on each side of the piston.

When the rod **12** is contracted, the device is ready for re-use.

A small refinement is illustrated in FIGURE 3. It will be appreciated that the opening of the valve **106** must be slight to achieve very small increments of outward movement of the rod. In order to reduce the opening movement of the valve still further, the collar **62** may have its outer face **118** inclined at a small angle to the plane normal to the longitudinal axis of the rod. This inclination has been exaggerated in FIGURE 3, but in practice the high point of the face may be some .005 inch displaced from the low point. This is the distance X shown in FIGURE 3. Obviously, with this engagement, the high point will open the valve first, and the opening may be so small that the low point does not engage with the ring **106**. It has been found that with this arrangement, a very slight pressure additional to that at which the device is set to operate, will cause it to extend. Consequently, it is possible to extend it by hand if desired even though the device is set to operate automatically at high loads.

An alternative piston and valve arrangement is shown in FIGURE 4. It should be understood that in other details the device is constructed as shown in FIGURE 1, and the same reference numerals are used for the cylinder **10** and the rod **12**. In this construction however, the piston **50** is replaced by a piston **150**. It will be noted that the piston **150** is quite short, and that it has a rubber or synthetic rubber sealing ring **152** in its periphery to seal against the inside of the wall of the cylinder **10**. Like the piston **50**, the piston **150** is free to slide axially within the cylinder.

A comparatively large bore **154** is formed in the piston **150**, to accept a valve housing **156**, but it will be noted that the latter is not a close fit within the bore **154** and that fluid can flow through this bore. There is a collar **158** on the valve housing and a rubber or like deformable and resilient sealing ring **160** of circular cross-section is trapped between the inside face **162** of the piston **150** and the outside face **164** of the collar **158**. The piston has an extension **166** on which the ring **160** is supported, but in the normal position (as shown in FIGURE 4) there is a gap between the end of this extension **166** and the collar **158**. Movement of the housing **156** inwardly relatively to the piston is restricted by a circlip **170**.

The rod **12** is screwed at its inner end as shown at **172** to receive a nut **174** which functions exactly like the nut **70**, and there is a compression spring **176** which acts between the nut **174** and the housing **156**. It will be seen that this spring **176** will have the effect of holding the housing **156** as far away from the nut **174** as possible.

An annular groove **178** is formed in the rod **12** (within the housing **156**) and a rubber or synthetic rubber sealing ring **180** is fitted into this groove. The inside wall of this groove is formed by the outer wall of a collar **182** integral with the rod **12**, and this collar is housed in a bore **184** of the housing **156**. This particular design is intended to operate in conditions where the problem of eccentricity does not arise. If this problem has to be met, then the bore **184** would have to be long enough to provide lost motion for the collar **182**.

A recess or groove **186** is formed in the rod **12** and there are grooves **188** in the periphery of the collar **182**. In addition, one or more small bore holes **190** are formed radially through the housing **156**, into the space occupied by the sealing ring **180**. This ring **180** provides the valve member of this arrangement, and it normally prevents fluid flow through the piston by sealing (a) the bottom of the hole(s) **190**, (b) between the rod **12** and the inside of the bore of the housing **156** and (c) against a shoulder **192** on the housing **156**.

The action of the device on the outward movement of the rod is very similar to that described with reference to FIGURES 1 and 2, except that there is no oscillation of

the rod. As the rod begins to attempt to move outwardly, it moves the sealing ring **180**, and opens a passageway via the hole(s) **190**, a small gap between the ring **180** and the face **192**, the grooves **188**, the gap created between the inner face of the collar and the shoulder in the housing **156**, and the recess **186**. This passageway permits flow of fluid from one side of the piston **150** to the other to permit the small increment of movement of the rod **12** outwardly. As soon as there is any movement of the piston **150**, the housing **156** also moves, and this again closes the non-return valve provided by the ring **180**.

On the inward stroke of the rod, the fluid pressure differential holds the piston **150** on the circlip **170**, and the release valve is opened, because the ring **160** is not nipped and the fluid can flow past it. The collar **182** may have its outer face modified in accordance with FIGURE 3 if required.

To compesate for oil losses, it has proved advantageous to provide extra loading means to ensure that slight pressure is maintained on the gland side of the piston when the piston is moved inwardly. (It has already been mentioned that there may be a tendency to produce reduced pressure conditions on the gland side of the piston during the inward movement.) One such loading device is shown in FIGURES 1 and 5. The cylinder **10** is extended beyond the nut **70**, and a loading member **200** is fixed in this extension on a stud **202** fixed in the cap **38**. Recesses **204** and **206** are formed at diametrically opposed positions, the recess **204** being in communication with the interior of the cylinder between the nut **70** and the member **200**, and the recess **206** being in communication with an auxiliary chamber **208** on the inside of the member **200**. A sealing ring **210** may be fitted in an inclined fashion as shown in FIGURE 5, but it may be possible to rely upon a metal-to-metal seal as complete sealing is not essential.

An inclined small bore **212** is formed between the recesses **204** and **206**, the upper end having an enlarged bore **214**. A ball **216** rests within the bore **212** on a peg **218** and provides a restriction which will allow only a very small flow of fluid past the ball.

When the device is filled with fluid under pressure, some fluid passes the ball **216** and fills the auxiliary chamber **208**. If there is any loss of fluid due to leakage, some fluid will be drawn out through the bore **212** to make good this loss on the return motion of the rod **12**.

As an alternative to the loading member **200**, there may be an auxiliary piston **220** (see FIGURE 6) loaded by a spring **222**. When the unit is filled with fluid, the spring **222** will yield to provide a larger fluid chamber. Whenever the rod is returned the spring **222** is strong enough to maintain sufficient pressure in the fluid to keep the release valve open until pressure has equalised on both sides of the piston **50**.

I claim:

1. A substantially constant load extension device for use between two relatively movable parts of a machine comprising a cylinder, a rod extending within said cylinder and projecting out of said cylinder at one end thereof, gland means at said one end of said cylinder, said gland means permitting axial movement of said rod relatively to said cylinder, each of said rod and said cylinder being adapted for attachment to parts of a machine, a free piston within said cylinder and surrounding said rod, said piston making substantially fluid-tight sealing engagement with said cylinder, but having freedom for axial movement within said cylinder and relative to said rod, an abutment on said rod, resilient means mounted between said abutment and said piston said resilient means opposing movement of said rod out of said cylinder, means providing a fluid passage from one side of said piston to the other and valve means within said passage, said valve means being controlled on its opening movement by relative movement between said rod and said piston, whereby said piston can yield towards said one end of said cylinder

when said passage is opened, said valve means comprising an annular rigid ring, and a resilient ring engaging one face of said rigid ring, a shoulder on said piston engaging part of the opposite face of said rigid ring to that engaged by said resilient ring, and a shoulder on said rod also engaging said opposite face of said rigid ring and loading means within said cylinder, said loading means ensuring maintenance of fluid pressure on said one end of said piston on movement of said rod inwardly of said cylinder.

2. A substantially constant load extension device as claimed in claim 1, wherein said loading means comprises a member dividing said cylinder on the opposite side of said piston to said gland means, to provide an auxiliary chamber, and means defining a restricted passage through said dividing member.

3. A substantially constant load extension device as claimed in claim 1, wherein said loading means comprises a spring loaded auxiliary piston at the opposite end of said cylinder to said gland.

4. A substantially constant load extension device for use between two relatively movable parts of a machine comprising a cylinder, a rod extending within said cylinder and projecting out of said cylinder at one end thereof, gland means at said one end of said cylinder, said gland means permitting axial movement of said rod relatively to said cylinder, each of said rod and said cylinder being adapted for attachment to parts of a machine, a free piston within said cylinder and surrounding said rod, said piston making substantially fluid-tight sealing engagement with said cylinder and having freedom for axial movement within said cylinder and relative to said rod, an abutment on said rod, resilient means mounted between said abutment and said piston, said resilient means opposing movement of said rod out of said cylinder, means providing a fluid passage from one side of said piston to the other, a resiliently loaded non-return valve within said passage, said non-return valve being controlled on its opening movement by relative movement between said rod and said piston when said rod moves towards said one end of said cylinder, said non-return valve comprising an annular rigid ring, and a resilient ring engaging one face of said rigid ring, a shoulder on said piston engaging part of the opposite face of said rigid ring to that engaged by said resilient ring, and a shoulder on said rod engaging said opposite face of said rigid ring, and a release valve operable to permit fluid flow from one side of said piston to the other, said release valve having means controlled on its opening movement by relative movement between said rod and said piston when said rod is moving away from said one end of said cylinder,

whereby said piston can yield to move in either direction when one of said non-return valve and said release valve is opened.

5. A substantially constant load extension device as claimed in claim 4, wherein said shoulder on said rod is inclined relatively to a plane normal to the longitudinal axis of said rod, whereby one point on said shoulder engages with said opposite face of said rigid ring before other points.

6. A substantially constant load extension device as claimed in claim 4, in which an abutment member is adjustable on said rod within said cylinder, said resilient means comprising a compression spring between said adjustable abutment and said piston.

7. A substantially constant load extension device as claimed in claim 4, in which said rod is capable of limited movement relative to said piston before opening said non-return valve.

8. A substantially constant load extension device as claimed in claim 4, wherein said resilient means comprises a compression spring.

9. A substantially constant load extension device as claimed in claim 6, wherein said abutment member comprises a nut having screwed engagement with said rod, there being locking means preventing rotation of said nut relative to said cylinder.

10. A substantially constant load extension device as claimed in claim 4, wherein said release valve comprises a valve housing and resilient means urging said valve housing into engagement with a face on said piston.

11. A substantially constant load extension device as claimed in claim 4, wherein said release valve comprises opposed faces on each of said piston and a collar on said rod, and a deformable resilient ring disposed between said opposed faces.

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