June 3, 1969 N. DÖRNER ET AL 3,447,645

COLUMN OF ADJUSTABLE LENGTH

Filed Sept. 19, 1966 Sheet 1 of 2

Fig.1

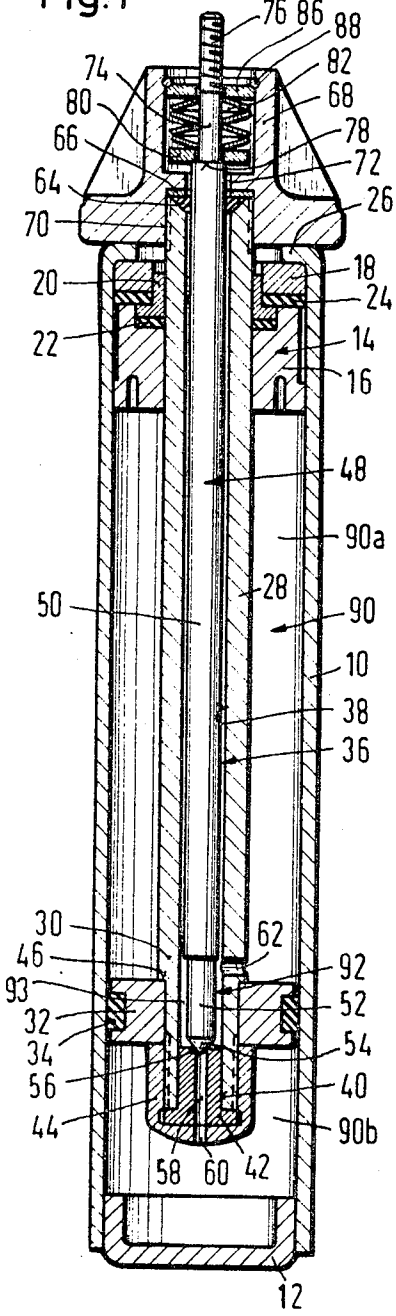
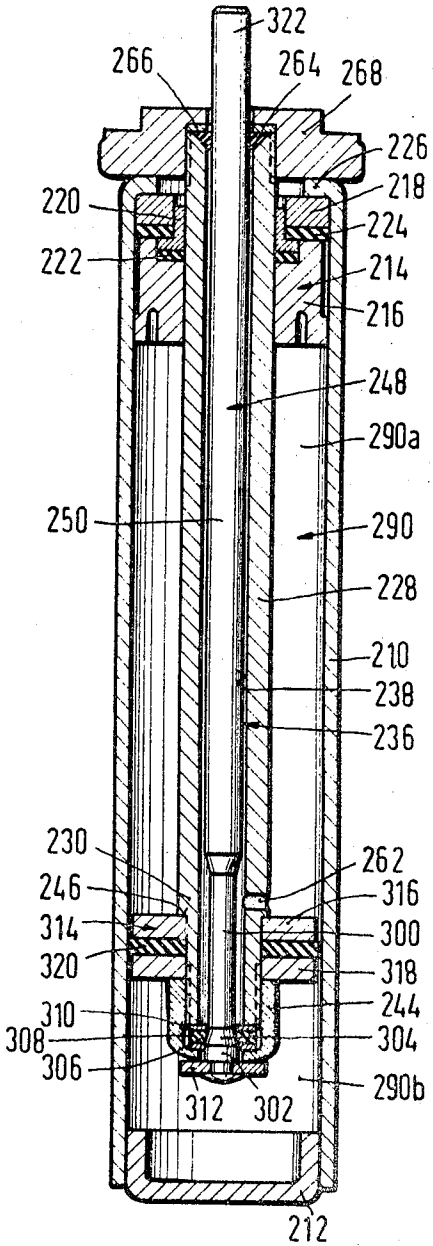


Fig.2



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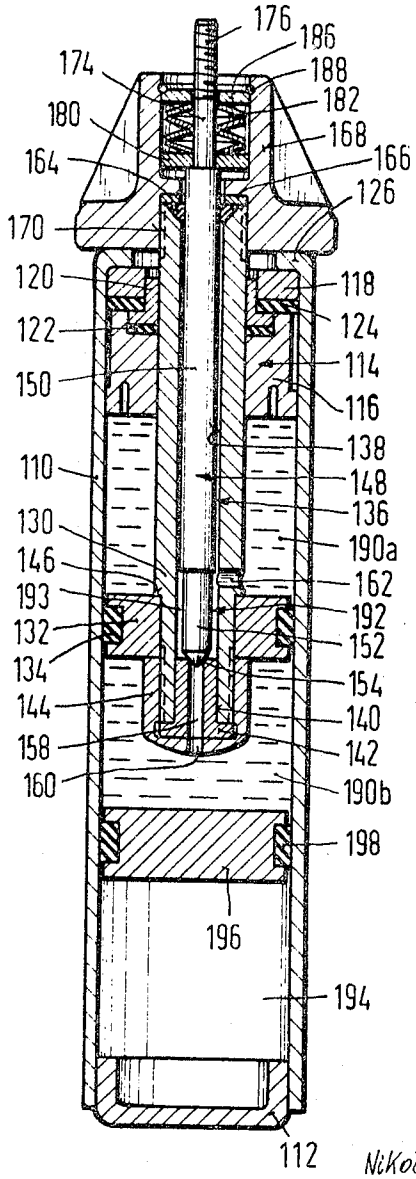
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Fig. 3



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COLUMN OF ADJUSTABLE LENGTH

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U.S. Cl. 188—96
6 Claims

ABSTRACT OF THE DISCLOSURE

A column of adjustable length for use as a furniture leg including a cylinder and a piston whose rod projects axially upward from the cylinder. The cylinder portion under the piston is divided by a floating piston. A duct extending through the piston and a portion of the piston rod to a radial bore in the latter is controlled by a valve whose actuating rod extends out of the cylinder through the piston rod. A liquid fills the compartments on either side of the piston, and a compressed gas is contained under the floating piston.

This invention relates to structural supporting elements whose length may be adjusted continuously, and which may be secured against length change in the adjusted position, and particularly to columns of adjustable length which may be used, for example, as legs in tables of adjustable height and in similar pieces of furniture.

It is known to provide such columns with a cylinder member and with a piston member axially movable in the cylinder member and dividing the cylinder cavity into two compartments. When the available space of the cavity is filled with a fluid, relative movement of the piston and cylinder members is normally limited by the compressibility of the fluid, and the piston member may be moved in the cylinder cavity beyond these limits only when a by-pass connecting to the two compartments is opened. When a table top is connected to the piston member by a piston rod extending outward of the cylinder cavity, and the cylinder member is supported on a floor or otherwise, the height of the table top may be adjusted when the by-pass is open, and is substantially fixed when the by-pass is closed.

The object of the invention is the provision of an adjustable column of the type described above which is particularly simple and rugged so that it is capable of long useful service even under severe operating conditions.

Other objects and many of the attendant advantages of this invention will become apparent to those skilled in the art as the invention becomes better understood by reference to the following detailed description of preferred embodiments when considered in connection with the accompanying drawings in which:

FIG. 1 shows a column of the invention in elevational section on its axis, the column being contracted to its condition of minimum length; and

FIGS. 2 and 3 illustrate modifications of the column of FIG. 1 in corresponding views.

Referring to the drawing in detail, and initially to FIG. 1, there is seen an upright cylinder **10** whose bottom is sealed by an imperforate fixedly inserted, cup-shaped closure member **12**. The top of the cylinder cavity **90** is bounded by a closure assembly **14** mainly consisting of an annular plug **16** which is prevented from axial movement outward of the cylinder by an internal flange **26** on the latter, a retaining ring **18** abuttingly engaging the flange, and an annular gasket **24** axially interposed between the plug **16** and the ring **18**. The plug **16** sealingly engages the inner wall of the cylinder **10** and has a axial aperture in which a guide bushing **20** is sealed to the plug **16** by a gasket **22**.

A tubular piston rod **28** is axially guided in the aperture of the plug **16** by the bushing **20** and is sealed to the plug by the gasket **22**. The lower or inner end portion **30** of the rod **28** has a shoulder **46** against which a radial face of a piston **32** is held by an internally threaded cap **44** mounted on the threaded terminal part of the piston rod portion **30**. The piston **32**, which is equipped with a circumferential sealing ring **34**, axially divides the cylinder cavity **90** into first and second compartments **90***b* and **90***a* near the closure member **12** and the closure assembly **14** respectively. The cap **44** also retains an apertured plug **42** in the downwardly directed orifice **40** of the axial bore **36** in the piston rod **28**. The axial aperture **58** of the plug **42** is aligned with an opening **60** in the cap **44**. Threads **70** on the upper end portion of the piston rod **28** which projects from the cylinder **10** secure a connector **68** to the piston rod. The connector is normally attached to a table top or the like while the closure member **12** may stand on the floor.

The top face **56** of the plug **42** provides a recessed conical seat about the aperture **58** for a correspondingly conical valve member **54** mounted on a valve stem **52**. The valve stem is cylindrical and of smaller diameter than the duct portion **92** of the bore **36** in which it is arranged so as to leave an unobstructed passage **93** of annular cross section in the duct **92**, the passage being bounded in a radially outward direction by the cylindrical inner wall **38** of the piston rod **28** in the bore **36**. When the valve member **54** is lifted from its seat **56**, a by-pass connection is opened between the compartments **90***a*, **90***b* through a radial bore or conduit **62** extending in the piston rod **28** between the passage **93** and the radially aligned portion of the compartment **90***a*, the passage **93**, the aperture **58**, and the opening **60**.

The valve member **54** is normally pressed against the seat **56** by a stepped, cylindrical valve actuating rod **48**, coaxially fastened to the stem **52**, and having a main portion **50** of greater diameter than that of the stem **52**. The rod portion **50** is sealed to the piston rod by an annular seal **64** held in position at the top end of the piston rod **28** by a retaining washer **66** interposed between the piston rod and the connector **68**. The outermost portion **74** of the valve actuating rod **48** is of reduced cross section so as to define a shoulder **78** of the rod **48** which carries a washer **80**. Another washer **86** is retained in an axial bore **72** of the connector **68** by a spring clip **88**. The washers **80**, **86** provide abutments for cup springs **82** which normally press the valve actuating rod **48** inward of the cylinder **10**. A non-illustrated knob attached to the valve actuating rod **48** by threads **76** permits the valve member **54** to be lifted from the valve seat **56** against the restraint of the cup springs **82**.

The compartments **90***a*, **90***b* and the ducts and passages which connect the compartments when the valve member **54** is lifted from its seat **56** are filled with compressed air or another gas, such as nitrogen, under a pressure normally higher than atmospheric pressure and selected for the load to be supported by the column, and for the permissible sag of the column under load. The sag is inversely related to the compressibility of the fluid in the cylinder cavity, and may be reduced to an insignificant value by filling the cylinder cavity with a suitable liquid. The filling nipple, normally sealed, which permits the cylinder cavity **90** to be filled or replenished with fluid in an obvious manner is not shown in the drawing.

If it is desired to adjust the column to a length greater than that shown, the valve actuating rod **48** is pulled upward by the knob (not shown) on the threaded top portion **74**, and the connector **68** and cylinder **10** are shifted axially relative to each other as desired. The adjusted position is secured by releasing the rod **48**, except for the predictable sag due to the resilience of the fluid in the cylinder **10**.

The column of the invention illustrated in FIG. 2 is closely similar in many features to that shown in FIG. 1, and reference numerals differing from those of FIG. 1 by the addition of 200 designate structural and functional equivalents of the corresponding features in FIG. 1.

The cavity **290** of the cylinder **210** is axially bounded by closures **212, 214**, the latter including a plug **216**, a retaining ring **218**, a guide bushing **220**, and annular gaskets **222, 224** retained by a flange **226**. A tubular piston rod **228** has an axial bore **236** and an internal cylindrical wall **238** in the bore. The inner or lower end portion **230** of the rod **228** carries a piston **314** which consists of two circular metal discs **316, 318** and an axially interposed rubber disc **320** which seals the piston to the cylinder **210**. The piston **314** is held against a shoulder **246** of the piston rod **228** by a cap **244** which abuts against the lower radial face of the piston.

A by-pass which connects the two compartments **290*a*, 290*b*** of the cylinder cavity **290** above and below the piston **314** includes a radial bore or conduit **262** in the piston rod portion **230** and is controlled by a valve arrangement operated by an elongated actuating rod **248** movable in the bore **236** of the piston rod **228**, and sealed to the piston rod by a resilient ring **264** held in position by a retaining washer **266** clamped between the upper end of the piston rod and a connector **268**. The portion **250** of the cylindrical valve actuating rod **248** in the cylinder **210** has the same diameter as the outer portion **322** which upwardly projects from the cylinder.

The column shown in FIG. 2 differs from that described with reference to FIG. 1 mainly by details of the valve arrangement. The actuating rod **248** carries a coaxial, cylindrical valve stem **300** integral with a valve member **302** which extends outward through an opening of the cap **244**. A disc-shaped abutment **312** of relatively rigid metallic material is mounted on the valve member **302** in the cavity compartment **290*b*** and normally engages an external face of the cap **244**, as is seen in FIG. 2. An upwardly tapering conical face **304** of the valve member **302** conformingly engages a valve seat **306** in the central opening of a flat sealing ring **308** which is held in position between the bottom orifice of the piston rod **228** and the cap **244** by an annular backing plate **310**.

The weight of a table top or other supported structure attached to the connector **268** causes increased fluid pressure in the compartment **290*b*** to hold the valve member **302** in its seat **306**. Damage to the resilient seat is prevented by engagement of the much more rigid abutment disc **312** with the equally rigid cap **244**. If it is desired to vary the length of the column, the outer actuating rod portion **322** is depressed until fluid may flow between the compartments **290*a*, 290*b*** as needed. The valve may then be closed by upwardly pulling the rod portion **322**, but the valve normally closes automatically when an applied load initially causes liquid to flow upward from the compartment **290*b*** into the compartment **290*a*** under the pressure applied by the piston **314**.

FIG. 3 shows a further modification of the column of FIG. 1 which is preferred when the compartments **190*a*, 190*b*** above and below the piston **132** are filled with liquid. Except for dimensional relationships, and the features to be discussed in more detail hereinafter, the column illustrated in FIG. 3 is identical in structure and function with that discussed above with reference to FIG. 1, and corresponding elements have been provided with the same reference numerals preceded by the FIGURE 1. They do not require further description.

The compartment **190*b*** between the piston **132** and the bottom closure **112** is axially partitioned by a floating piston **196**. The part **194** of the compartment near the bottom closure **112** is filled with compressed air and is hermetically sealed from the remainder of the compartment **190*b*** by a circumferential sealing ring **198** on the floating piston or partition **196**. The compartment **190*a***, the duct **192** in the piston rod **148**, and the part of the compartment **190*b*** remote from the bottom closure **112** are filled with a liquid, for example, hydraulic brake fluid of the common automotive type. The compressed gas in the compartment part or chamber **194** expands and contracts when the piston rod **130** moves outward and inward of the cylinder **110** during length adjustment, thus permitting the use of a liquid of very low vapor pressure in all other portions of the cylinder cavity which is not practical in the devices shown in FIGS. 1 and 2.

The apparatus illustrated in FIG. 3 is operated as described above with reference to FIG. 1.

What is claimed is:

1. A column of adjustable effective length comprising, in combination:

(a) a cylinder member having an axis and defining an axially extending cavity therein;

(b) first closure means including an imperforate closure member fixedly fastened to said cylinder member in sealing engagement and axially closing one end of said cavity;

(c) second closure means axially spaced from said first closure means in sealing engagement with said cylinder member and axially bounding the other end of said cavity, said second closure means being formed with an axial aperture therethrough;

(d) a piston member in axially movable sealing engagement with said cylinder member in said cavity, said piston member separating first and second compartments of said cavity respectively adjacent the corresponding closure means;

(e) a piston rod member having an inner portion fastened to said piston member and an outer portion sealingly passing through said aperture outward of said cavity,

(1) said inner portion of said piston rod member defining an axial duct therein, a first axial portion of said duct having an orifice communicating with said first compartment, and a second axial portion of said duct being radially aligned with said second compartment,

(2) said piston rod member being formed with a radial conduit connecting said duct with said second compartment;

(f) valve means for opening and closing said duct, said valve means including a valve seat, a valve member axially movable toward and away from a position of sealing engagement with said valve seat, a valve stem member axially movable in said piston rod member and fastened to said valve member, and actuating means at least partly outside said cavity for axially moving said stem member;

(g) partition means defining a chamber, said partition means including a partition member separting said chamber from one of said compartments;

(h) a liquid substantially filling said compartments and said duct;

(i) a gas under a pressure higher than atmospheric pressure filling said chamber,

(1) said partition member being movable inward and outward of said chamber and of said one compartment under the pressures of said liquid and of said gas,

(2) said inner portion of said piston rod member being formed with a shoulder, said piston member having two radially extending axially spaced opposite faces, one of the faces abuttingly engaging said shoulder, and said piston rode mem-

ber having a free terminal portion projecting from said piston member into said first compartment;

(j) a cap member threadedly fastened to said terminal portion and abuttingly engaging the other one of said faces; and

(k) apertured plug means positively retained in said orifice by said cap member, the cap member being formed with an opening aligned with the aperture of said plug means, a portion of said plug means constituting said valve seat.

2. A column as set forth in claim 1, wherein said valve member is offset from said valve seat toward said second closure means when said valve means open said duct, the valve means further including yieldably resilient means interprosed between said piston rod member and said actuating member for urging said valve member against said valve seat.

3. A column as set forth in claim 1, further comprising connecting means on said outer portion of the piston rod member for securing the piston rod member to structure to be supported by the column.

4. A column as set forth in claim 1, wherein said partition member is axially movable in said cavity in sealing engagement with said cylinder member, and said chamber is a portion of said cavity interposed between said partition member and said first closure means.

5. A column as set forth in claim 1, wherein said valve seat is annular about said orifice, and said valve stem

member axially extends in said duct, leaving an unobstructed passage of annular cross section in said duct, said passage connecting said conduit with said orifice.

6. A column as set forth in claim 5, wherein said actuating means include an axially elongated actuating member means slidable in said piston rod member, and sealed to the same, an inner portion of said actuating member having a cross section greater than the cross section of said stem member and being fixedly fastened to the same, and an outer portion of said actuating member outwardly projecting from said piston rod member.

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U.S. Cl. X.R.

188—67; 248—354