Aug. 23, 1960 H. A. GUYER 2,949,625

DOOR CLOSER

Filed Feb. 21, 1956 5 Sheets-Sheet 1

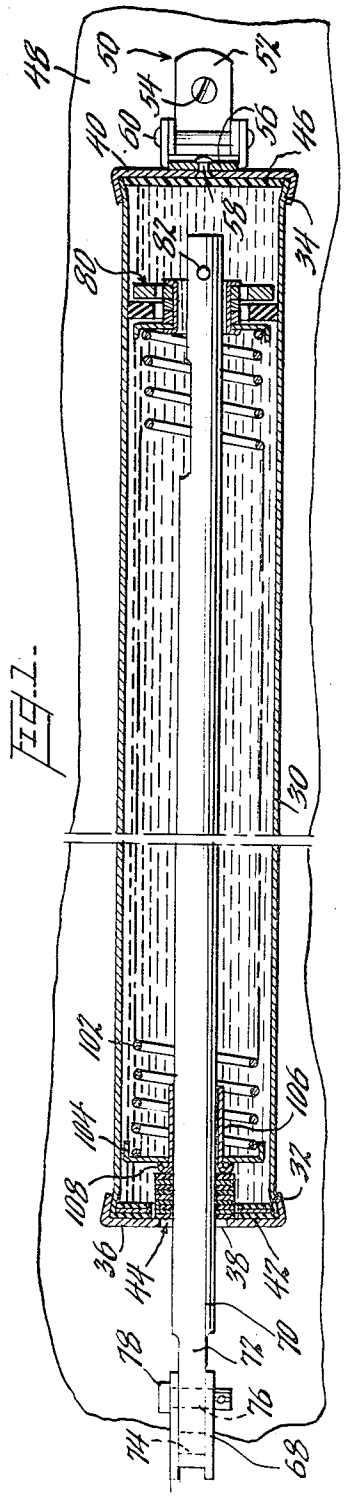


FIG. 1.

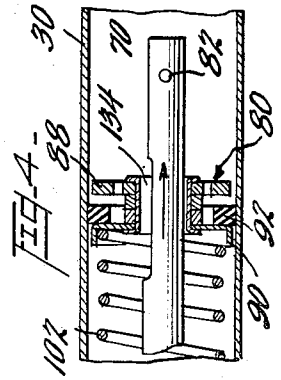


FIG. 4.

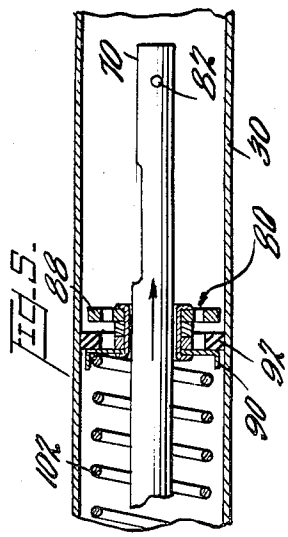


FIG. 5.

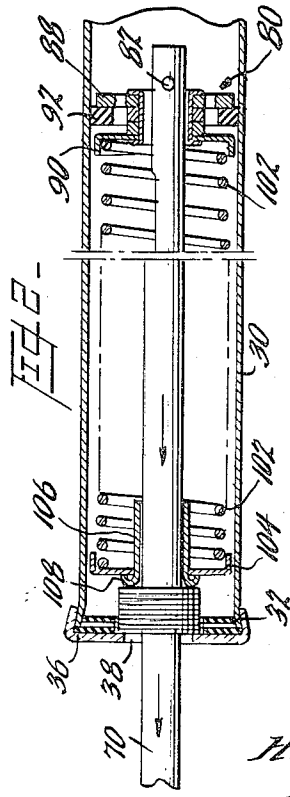


FIG. 2.

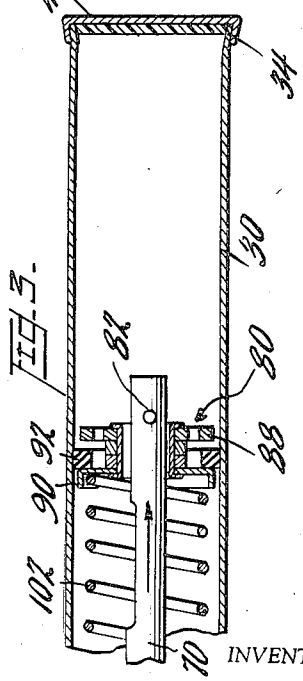


FIG. 3.

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FIG. 6.

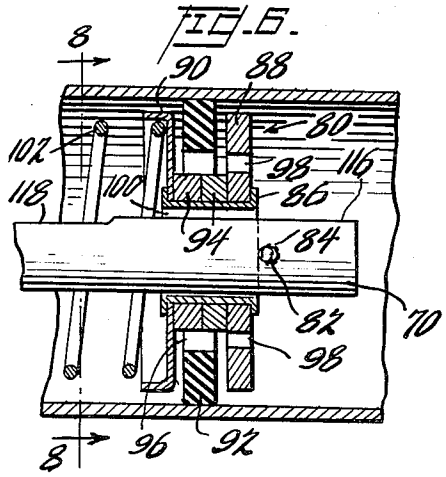


FIG. 7.

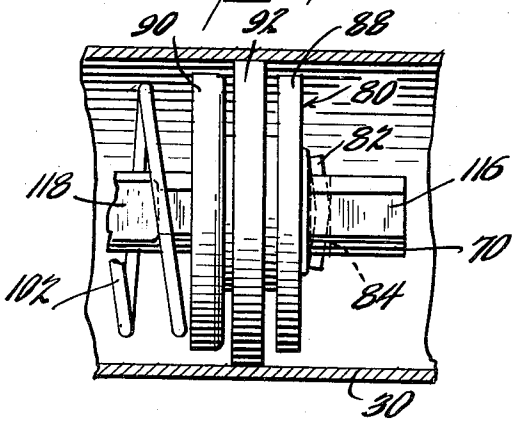


FIG. 8.

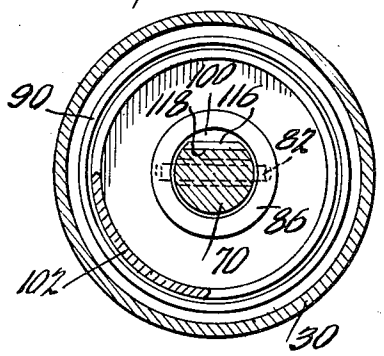


FIG. 9.

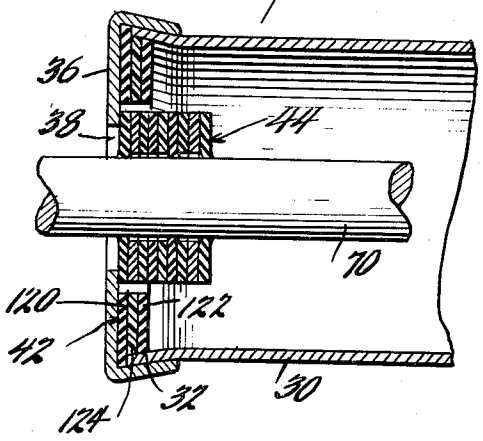


FIG. 10

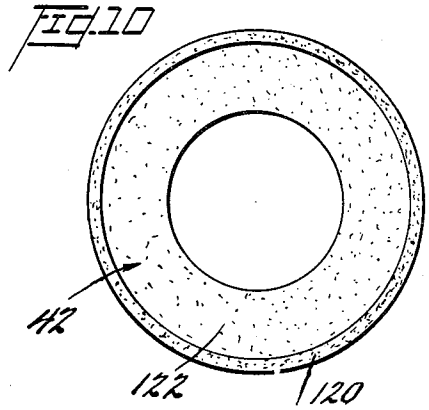
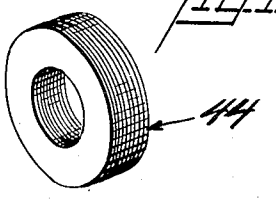


FIG. 11.



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FIG. 12.

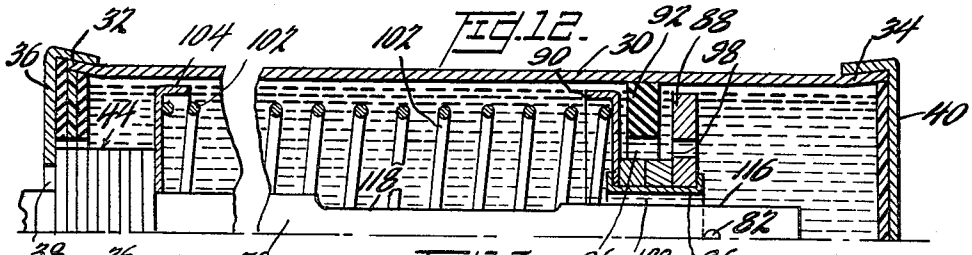


FIG. 13.

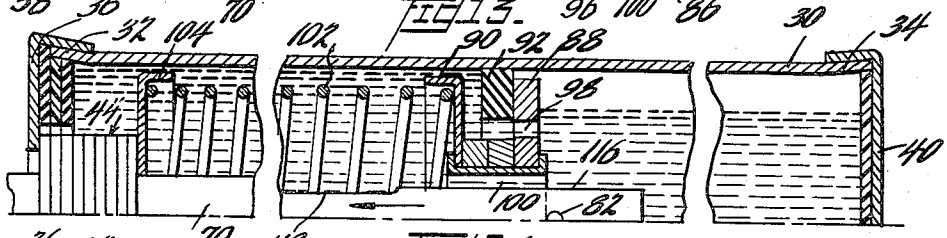


FIG. 14.

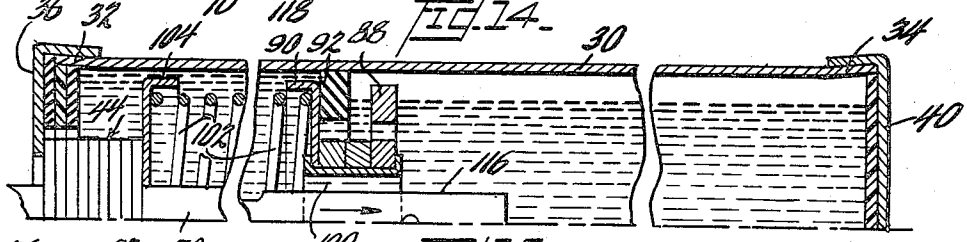


FIG. 15.

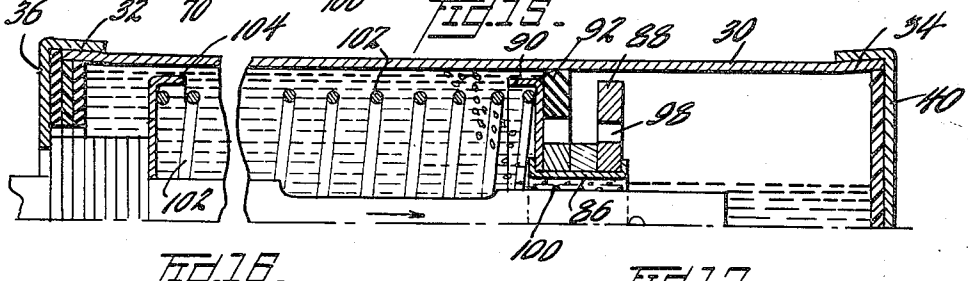


FIG. 16.

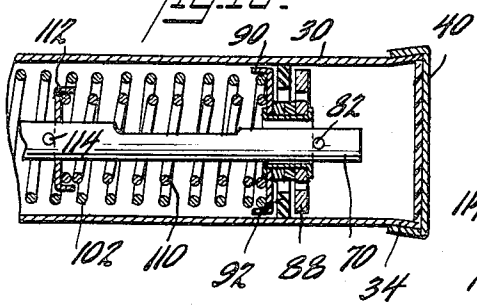
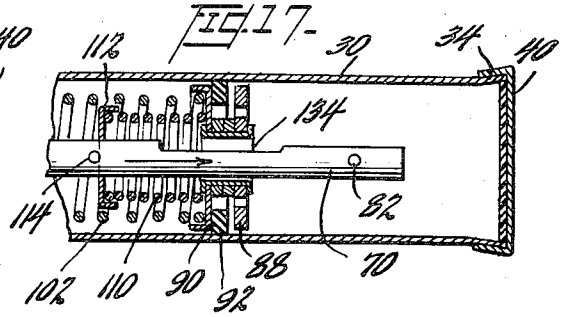


FIG. 17.



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DOOR CLOSER

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FIG. 18.

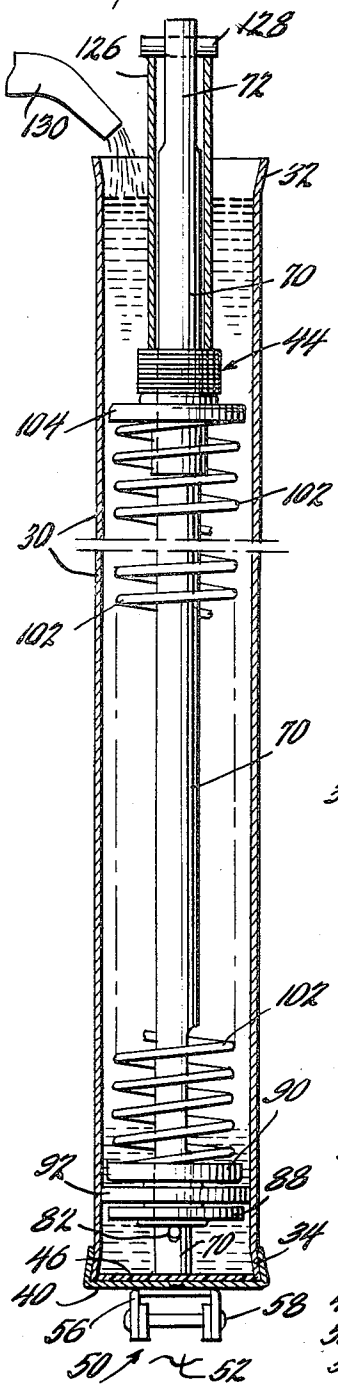


FIG. 19.

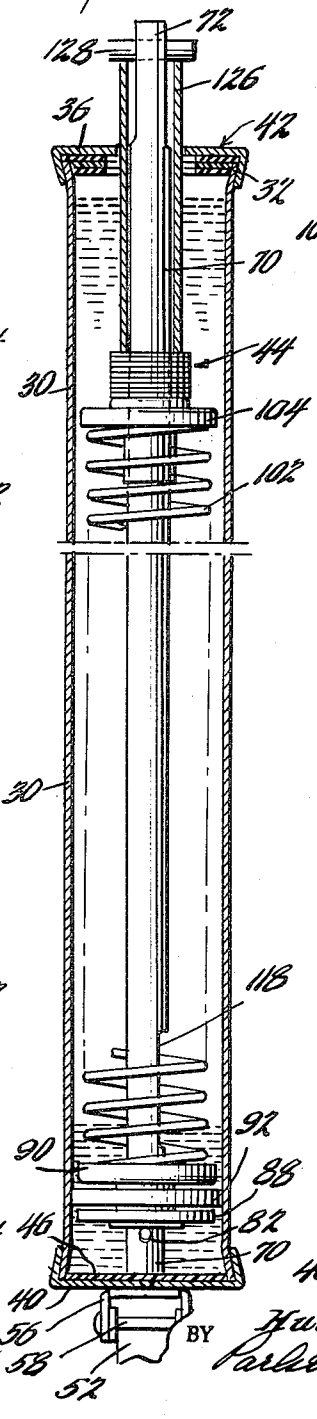
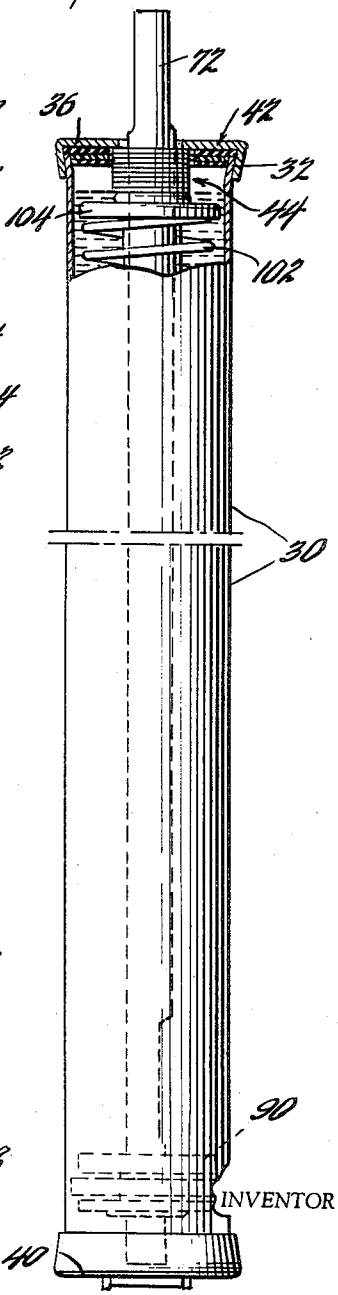


FIG. 20.



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FIG. 21.

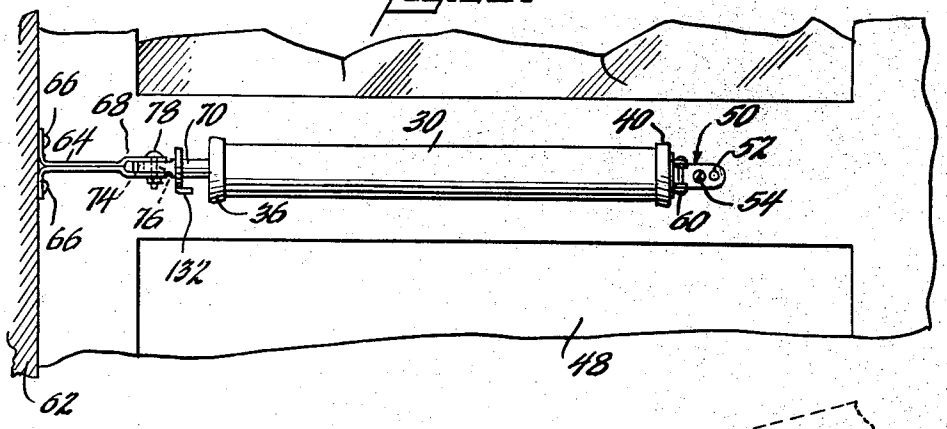


FIG. 22.

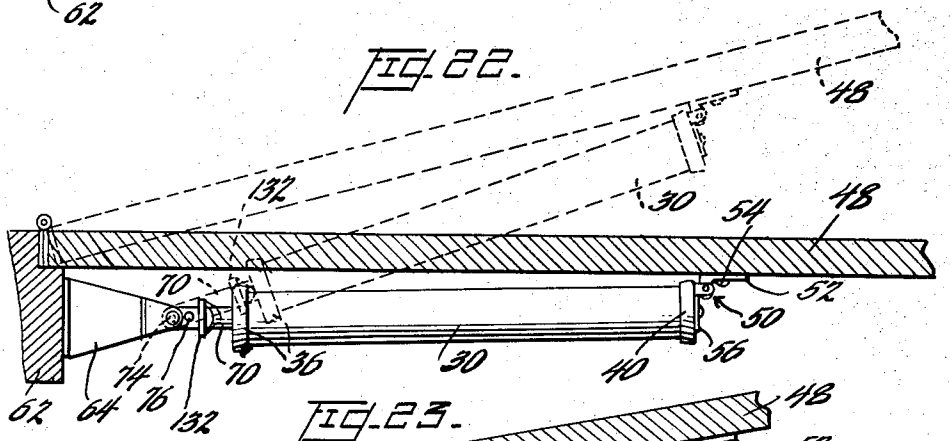


FIG. 23.

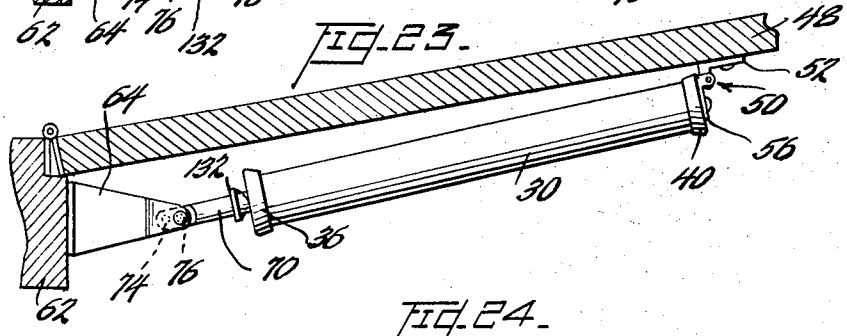
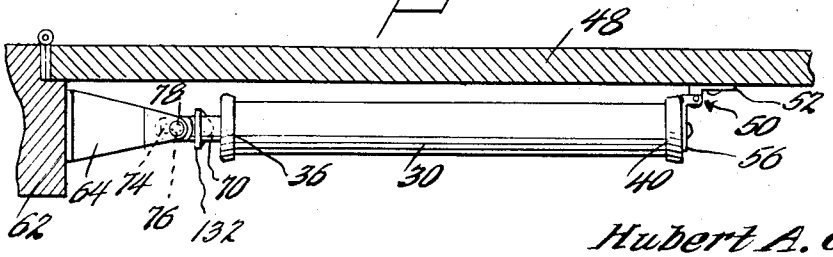


FIG. 24.



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United States Patent Office 2,949,625 Patented Aug. 23, 1960

2,949,625

DOOR CLOSER

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Filed Feb. 21, 1956, Ser. No. 566,901

11 Claims. (Cl. 16—52)

The present invention relates generally to the field of hydraulics and is more particularly directed to certain new and useful improvements in automatic door closers of the hydro-mechanical type.

Although automatic door closers of various types have been well known in the art for many years, in general their use has tended to be limited to various commercial applications where the elements of initial cost and maintenance could be better justified than in the case of domestic or residential dwellings. However, in recent years there has developed a definite trend toward the widespread installation of storm doors in residential dwellings and, in parallel with this trend, there has also developed a definite need for an automatic door closer properly suited to the requirements of such installations.

As is well known to those skilled in the art, the use of automatic door closers of the hydraulic or hydro-mechanical type has, in the past, involved a number of other difficulties in addition to the relatively high initial cost and maintenance expense as a result of which hydraulic devices of this type have found restricted applicability even in commercial installations. One of the principal difficulties encountered in the past has been that of leakage of the hydraulic fluid. Another problem that has been encountered is the liability of such devices to breakage through improper handling. It has also been found generally necessary in such devices to employ some form of external adjusting means which is subject to tampering and leakage and, altogether, the disadvantages of such mechanisms have largely tended to outweigh the advantages thereof in the minds of most purchasers.

With the advent of the tremendous demand for a relatively simple and inexpensive automatic door closer which has accompanied the increased use of residential storm doors, the art has turned away from hydraulic or hydro-mechanical devices in favor of the less expensive pneumatic mechanisms of this character. Even so, however, such pneumatic mechanisms still generally require the use of some form of external adjusting device and, although ordinarily somewhat less expensive than the hydro-mechanical devices, are generally less efficient in operation.

Accordingly, it is a principal object of the present invention to provide an automatic door closer of the hydro-mechanical type which is entirely self contained without any external adjusting means and which may be readily and inexpensively manufactured to meet the installation and use requirements in residential dwellings.

Another object of the invention is to provide an automatic hydro-mechanical door closer of the type described employing novel closure and packing elements so arranged as to substantially eliminate the leakage of hydraulic fluid generally found in such devices.

A further object of the invention is to provide an automatic door closer of the type described utilizing a piston and cylinder arrangement in which the piston assembly is capable of movement independent of its associated piston rod particularly during the power or door closing function.

An additional object of the invention is to provide a door closer of the type described including a self contained and automatically acting bypass arrangement to permit a forced rapid closing of the door without breakage of the closer.

Yet another object of the invention is to provide a door closer of the type described in which, by suitable manipulation, the door may be held open for a short time delay after which the automatic closing action will be resumed.

A still further object of the invention is to provide a novel method and apparatus for assembling and refilling a hydraulic door closer of the type described.

Another object of the invention is to provide a novel stop pin arrangement for use in a door closer of the type described.

Another object of the invention is to provide a hydro-mechanical door closer employing a novel orifice arrangement in such manner as to effect a relatively rapid and unobstructed movement of the door near the end of the closing cycle.

Yet another object of the invention is to provide a novel structure and method of mounting an automatic door closer in operating position in such manner as to maintain a residual door closing force of uniform predetermined amount.

The foregoing together with other and further objects and advantages of the invention will become more readily apparent to one skilled in the art from a consideration of the following detailed description taken in conjunction with the accompanying figures of drawing in which:

Figure 1 is a longitudinal cross-sectional view through a preferred form of door closer in accordance with the present invention, showing the same in mounted position upon a door with the various parts in the positions which they would normally occupy at rest or with the door closed;

Figure 2 is a fragmentary, longitudinal, cross-sectional view similar to Figure 1 but illustrating the position which certain of the parts occupy during a door opening movement;

Figure 3 is a fragmentary view similar to Figure 1 but showing the relative positions of certain of the parts during a normal door closing movement;

Figure 4 is a fragmentary view similar to Figure 1 but illustrating the relative positions of certain of the parts during a door closing movement in which a forced closing action has caused automatic operation of the bypass or safety feature of the device;

Figure 5 is a fragmentary view similar to Figure 1 but showing the relative positions of certain of the parts when, during a door closing operation, the door has been deliberately moved in such manner as to provide for holding the door open temporarily and for resumption of automatic door closing after a predetermined time delay;

Figure 6 is a longitudinal cross-sectional view through the floating piston assembly in accordance with the present invention but to a somewhat larger scale than shown in Figures 1 through 5;

Figure 7 is a top plan view of the piston assembly as shown in Figure 6 but with the cylinder shown in cross-section;

Figure 8 is a transverse cross-sectional view taken substantially along the line 8—8 in Figure 6;

Figure 9 is a fragmentary, longitudinal, cross-sectional view, to a somewhat enlarged scale, illustrating the end closure and gland packing at the rod end of the cylinder of Figure 1;

Figure 10 is an end elevational view of the closure seal as shown in Figure 9, with the actual spacing of the parts being somewhat exaggerated to better illustrate the sealing lip construction;

Figure 11 is a perspective view illustrating the gland seals of Figure 9;

Figures 12, 13, 14 and 15 are fragmentary, longitudinal, cross-sectional views, to a somewhat enlarged scale, illustrating the upper half only of the piston and cylinder arrangement of Figure 1 and showing, in sequence, the relationship between the gas-liquid level at opposite sides of the floating piston assembly as the device goes through an operating cycle, as a result of which a relatively rapid and unobstructed closing force is applied to the door near the end of the closing movement;

Figure 16 is a longitudinal cross-sectional view of the right hand end of a piston and cylinder arrangement as shown in Figure 1 but illustrating a modified form of the invention;

Figure 17 is a longitudinal cross-sectional view of the modified form of the device as shown in Figure 16 but illustrating the relative positions of the parts during an emergency or bypass operation;

Figures 18, 19 and 20 are longitudinal views in partial cross-section of the improved door closer as illustrated in Figure 1 but illustrating, in sequence, the relative positions of the parts during the original assembly or re-filling operation; and

Figures 21 through 24 are largely schematic views illustrating, in sequence, the method of mounting the door closer upon a door, Figure 21 being generally in front elevation, and Figures 22, 23 and 24 being top plan views of the assembled device.

Referring now in somewhat greater detail to the various figures of the drawing and in particular to Figure 1 thereof, the improved door closer in accordance with the present invention is seen to comprise a generally elongated, hollow cylinder **30** having its outer ends flared outwardly as indicated by reference numerals **32** and **34**. The rod end of the cylinder **30**, or the left end as viewed in Figure 1, is provided with a suitable closure in the form of a cap **36** having a central aperture **38** therein while the right end of the cylinder **30** is closed by means of a solid cap **40**, it being noted in both instances that the peripheral edges of the caps **36** and **40** are crimped or otherwise suitably formed around the opposite flared cylinder ends **32—34** in such manner as to be firmly held in place thereon. The rod end of the cylinder **30** includes a packing assembly which will hereinafter be more fully described and which is seen to comprise a composite annular washer **42** which lies partially within and partially around the flared cylinder end **32** and a wiper assembly designated generally by reference numeral **44** comprising a plurality of composite annular washers, in the present case three in number, the outermost of which lies within the aperture in the washer **42**, with an appreciable clearance, and abuts against the inner face of the closure or cap **36** around the aperture **38** therein. The right end of the cylinder **30** is provided with a disc shaped gasket seal **46** which is held in place partially within and partially around the flared end **34** by means of the cap **40**.

As shown in Figure 1, and perhaps even more clearly in Figures 21 through 24, the cylinder **30** is adapted to be secured to a door **48** by means of a hinged bracket of any suitable design designated generally by reference numeral **50**. The bracket **50** is seen to comprise an arm **52** which may be fastened to the door **48** in any convenient manner as by means of a screw **54** and an arm **56** suitably secured to the cap **40** in any convenient manner as by means of a rivet **58** and pivotally connected to the arm **52** as by means of a pivot pin **60**.

At its opposite end, the door closer is adapted to be connected to the frame or door jamb **62** by means of a fitting which comprises a bracket **64** suitably fastened to the door jamb in any convenient manner as by means of screws **66** and provided with a clevis or yoke **68** within which is pivotally mounted the flattened end of a piston rod **70** which projects from the left hand end of the cylinder **30** through the aperture **38** in the cap **36** and the wiper assembly **44**. The flattened end of the piston rod **70** is designated by reference numeral **72** and is provided with a pair of spaced apertures **74—76** for a reason which will hereinafter be more fully explained. As shown in Figure 1, the flattened end **72** of the piston rod **70** is held within the clevis or yoke **68** of the bracket **64** by means of a pivot pin **78** which passes through the single pair of apertures provided in the opposite faces of the clevis **68** and through the inner aperture **76** in the flattened rod end **72**.

As perhaps best illustrated in Figures 1, 6 and 7, the inner end of the piston rod **70** which lies within the cylinder **30** is provided with a floating piston assembly designated generally by reference numeral **80**. The piston assembly **80** is freely slidable axially along the piston rod **70** within the cylinder **30** between limit positions which may be defined as the left hand closure cap **36** and a stop pin **82** at the right hand end of the piston rod **70**. As shown in Figure 7, the stop pin **82** is inserted into an aperture **84** which extends transversely through the piston rod **70** and which is of a diameter somewhat larger than the diameter of the pin **82**. However, the pin **82** is initially bent transversely in such manner that it must be forced into the aperture **84** and, when in the position as illustrated in Figure 7, will be firmly held in place by resilient locking engagement within the aperture in a substantially centered position therein.

Referring particularly to Figure 6, the floating piston assembly **80** comprises a thimble **86** having an internal diameter slightly larger than the outside diameter of the piston rod **70** and provided with outwardly turned flanges at its opposite ends. Mounted in fixed position on the thimble **86** are two axially spaced discs **88** and **90** lying at the opposite ends of the thimble adjacent the flanges on the latter and both having outside diameters appreciably smaller than the internal diameter of the hollow cylinder **30** within which they lie. Between the fixed discs **88** and **90** there is provided a center disc **92** which is preferably formed of a suitable resilient material such as rubber and which is movable axially of the thimble **86** between the fixed discs **88** and **90**. The center disc **92** is generally in the form of a washer having its inside diameter appreciably larger than the outside diameter of the thimble **86** and having its outside diameter in slidable sealing engagement with the inner wall of the hollow cylinder **30**.

Still referring to Figure 6, it will be noted that the internal diameter of the movable center disc **92** is sufficiently larger than the outside diameter of the thimble **86** and the spacers **94** thereon to provide a relatively large aperture or orifice **96** therebetween. The fixed disc **88** at the right hand side of the floating piston assembly **80** is provided with a plurality of apertures or orifices **98** so arranged as to lie in substantial registry with the annual space between the inside diameter of the center disc and the outside diameter of the spacers **94** on the thimble constituting the orifice **96**. It may also be observed at this point that when the center disc **92** occupies any position spaced from the left hand fixed disc **90**, there is provided a relatively unimpeded path of fluid flow from the left hand end of the cylinder around the periphery of the fixed disc **90** and through the orifices **96** and **98** into the right hand portion of the cylinder **30**. On the other hand, when the center disc **92** occupies its extreme left hand position in abutting engagement with the fixed disc **90**, the orifice **96** will be closed against the face of the disc **90** so that the only path of fluid flow from one side of the piston assembly **80** to the other will be through the orifice, designated by reference numeral **100**, which is constituted by the annular

space between the inside diameter of the thimble **86** and the outside diameter of the piston rod **70**.

The operation of the floating piston assembly **80** will be hereinafter more fully described but, as a general proposition, it may be stated that the principal function of the floating piston assembly **80** is to control the rate of transfer of fluid from one side thereof to the other thereby providing, in addition to the emergency bypass and time delay functions, for a relatively easy door opening movement and a correspondingly slowed door closing action. The actual force to accomplish a door closing operation is provided by the stored energy of a helical compression spring **102**. As shown in Figures 1 and 6, the spring **102** surrounds the piston rod **70** within the cylinder **30** and bears at its right hand end against the fixed disc **90** of the floating piston assembly and at its left hand end against another disc or follower **104**. Both the disc **90** and the follower **104** are cupped inwardly or otherwise suitably shaped to receive the opposite ends of the spring **102** and, as will be noted particularly in Figures 1 and 2, the follower **104** is formed with a guide bearing **106** surrounding the piston rod **70** and having a rounded nose **108** bearing against the wiper assembly **44** and, through the latter, against the closure cap **36**. In actual practice it will be understood that during the initial assembly operation the compression spring **102** is pre-loaded slightly so that it will, at all times, yieldingly urge the piston assembly **80** and, through engagement of the latter with the stop pin **82**, the piston rod **70** inwardly or to the right as shown throughout the various figures of the drawing.

In the modified form of the device as illustrated in Figures 16 and 17, an additional coil spring **110** surrounds the piston rod **70** adjacent the right hand end of the latter and preferably lies within the primary compression spring **102**. The compression spring **110** bears at its right hand end against the fixed disc **90** and at its left hand end against a cup shaped disc **112** which surrounds the piston rod **70** and bears against a limiting means in the form of a stop pin **114**. The operation of this modified form of the device will likewise be hereinafter more fully described.

As mentioned above, the principal function of the floating piston assembly **80** is to control the rate of flow of fluid from one side thereof to the other and in order to provide for different rates of fluid flow during opening and closing movements, the center disc **92** of the floating piston assembly operates somewhat in the manner of a valve by alternately opening and closing the passageway or orifice **96** as the disc **92** moves away from or towards the fixed disc **90**. At such time as the center disc **92** lies against the face of the fixed disc **90**, the only path of fluid flow past the floating piston assembly is through the orifice **100** formed between the inside diameter of the thimble **86** and the outside diameter of the piston rod **70**. In order to provide the orifice **100** with accurately controllable dimensions, the piston rod **70** is machined or otherwise suitably formed in such manner as to provide a flat **116** as particularly illustrated in Figures 6, 7 and 8. In order to provide the emergency bypass feature of the floating piston assembly, as will be hereinafter more fully described, the piston rod **70** is still further cut away along a portion of its length adjacent the flat **116** to provide a second flat **118** of greater depth. The piston rod **70** to the left of the flat **118**, as shown in Figure 1, is of uniform circular cross-section until it reaches the flattened end portion **72**.

Referring now particularly to Figures 1, 2, 9 10 and 11 of the drawings, it will be noted that both the annular washer **42** and the disc shaped gasket seal **46** are formed as composite members preferably comprising two thin sheets of synthetic rubber or the like securely bonded to the opposite faces of a relatively stiff plastic member. This plastic may conveniently be of the phenolic thermoplastic type. As shown in Figure 9, this laminated construction of seal **46** comprises the outer synthetic rubber layer **120**, inner synthetic rubber layer **122**, and the relatively rigid or stiff plastic member **124** lying therebetween. It is to be particularly noted in Figure 9 that the outer rubber layer **120** is of a larger diameter than both the inner element **122** and the spacer **124**. The gasket **46** at the right hand end of the cylinder **30** is similarly constructed except that it is not provided with a central aperture as in the case of the washer **42**. In each case, however, the packing assembly lies partially within and partially around the flared end of the cylinder in such manner that, when the closure cap **36** or **40** is crimped around its associated cylinder end, the inner element **122** forms a seal within the flared cylinder end while the projecting lip of the outer element **120** is firmly held between the closure cap and the end of the cylinder wall.

As in the case of the gasket seal **46** and the annular washer **42**, the wiper assembly **44** which comprises a plurality of composite, laminated elements, utilizes similar principles to seal around the piston rod **70**. As shown in Figure 9, the wiper assembly **44** comprises three such elements, each of which includes a pair of synthetic rubber, or the like, members bonded to opposite sides of a relatively rigid or stiff plastic member of similar composition to that used in seals **42** and **46**. In the case of the washers comprising the wiper assembly **44**, however, the outside diameter of all of the synthetic rubber and plastic elements is the same whereas the inside diameter of one of the synthetic rubber elements of each laminate is of smaller dimensions than the inside diameters of its associated synthetic rubber and plastic elements. Thus, although each of the laminates **42** and **44** is formed by the use of suitable dies in a punch press operation working upon laminated sheet material, in the one case the extra sealing lip is provided on the outer diameter, that is in the case of the element **42**, whereas in the case of the elements comprising the assembly **44**, the sealing lip is provided at the inner diameter in order to achieve a proper wiping action on the rod **70**.

In connection with the wiper assembly **44**, and contrary to the commonly accepted theory of operation, I have discovered that the principal function of the wiper assembly **44** is to prevent the entrance of air into the cylinder **30**. In other words, as the piston rod **70** is withdrawn from the cylinder **30**, the total available volume or empty space within the cylinder becomes somewhat greater so that a partial vacuum is created. If air is allowed to enter the cylinder at this time, then when the piston rod **70** is reinserted into the cylinder **30**, that is, as the empty volume of the cylinder **30** is reduced, the fluid within the cylinder tends to be compressed and it is the resultant building up of pressure within the fluid which has, in the past, been a principal cause of leakage. Accordingly, in accordance with the present invention the individual washers of the wiper assembly **44** are so arranged about the piston rod **70** as to provide their maximum wiping effectiveness as the rod is being withdrawn from the cylinder.

It will also be particularly noted in Figure 9 that there is provided a substantial clearance between the outermost washer of the wiper assembly **44** and the internal diameter of the annular washer **42**. Since the innermost washer of the wiper assembly **44** bears against the rounded nose **108** of the thimble or sleeve **106** against which the force of the compression spring **102** is directed, as the compression of the spring **102** is increased the pressure of the rounded nose **108** against the inner washer is likewise increased thereby giving a proportional increase in the sealing action of the washer against the rod **70**. On the other hand, contrary to the usual arrangement of a conventional gland packing, there is no rigid confining force surrounding the wiper assembly **44** so that whatever swelling may take place due to fluid absorption, or the like, will not tend to increase the pressure of the wiper elements against the rod **70**.

Operation

Before proceeding with a complete description of the operation of the device, reference will be made to the improved method and apparatus for assembling the device as illustrated in Figures 18, 19 and 20, and to my improved method of mounting the same in operative position upon a door as illustrated in Figures 21 through 24. Referring now specifically to Figure 18, the first step in assembling the device is to place the gasket seal **46** in position partially within and partially around the flared cylinder end **34** and securely hold the same in sealing position by means of crimping the closure cap **40** therearound. It will be understood that the closure cap **40** has previously been riveted to the mounting bracket **50** so that the bottom end of the device as shown in Figure 18 is completely assembled by this simple operation. The floating piston assembly and piston rod are then assembled by forcing the stop pin **82** into position and sliding the complete floating piston assembly over the flattened rod end **72**. The compression spring **102** is next slid over the flattened rod end **72** and the follower **104** and wiper assembly **44** likewise slid over the flattened rod end **72**. At this point an assembly tool in the form of a simple cylinder **126** is slid over the flattened rod end **72** and, with the rod and floating piston assembly in a suitable jig, or the like, the cylinder **126** is forced inwardly against the wiper assembly **44** and against the force of the compression spring **102** and held in place by means of a removable stop pin **128** which is temporarily inserted through one of the holes provided in the flattened rod end **72**.

At this point the rod and floating piston assembly may be inserted downwardly into the cylinder **30** and the latter may be filled to the desired point in any convenient manner as indicated by the filling nozzle **130**. It will be understood that the level of liquid within the cylinder **30** may be adjusted to give most efficient operation and I have found that while various types of hydraulic fluid may be employed, a mixture of water and the well-known anti-freeze sold under the trade name "Prestone" (substantially ethylene glycol) provides efficient all weather operation.

The rod end of the cylinder **30** is now ready to be closed and in order to accomplish this, the composite annular washer **42** is slid over and around the cylindrical assembly tool **126** followed by the closure cap **36** which is then crimped around the flared end **32** of the cylinder **30** thereby securely sealing the latter. This portion of the assembly is illustrated in Figure 19 and upon completion of the above enumerated steps, the pin **128** may be withdrawn thereby permitting the assembly tool **126** to be slid upwardly by the force of the compression spring **102** thereby forcing the wiper assembly **44** into the annular space within the washer **42** and into firm sealing engagement with the closure cap **36**.

It will be understood that during the entire assembly operation thus far described, substantially no pressure has been placed upon the fluid within the cylinder **30**. This is contrary to the usual practice in which the closure, containing a packing gland or the like is slid over the rod end and screwed onto the cylinder thereby producing a residual pressure within the contained fluid. By eliminating such residual pressure there is no tendency on the part of the assembled device to leak following the final assemlby operation as illustrated in Figure 20. Additionally, and of considerable importance, if at any time it should become necessary or desirable to add fluid to the device after final assembly, it is a relatively simple matter to reapply the assembly tool **126** to compress the spring **102** and thereby provide an aperture into which adidtional fluid may be poured following which the tool **126** may be removed in the manner previously described. In this way it is unnecessary to remove the closure cap **36** for the purpose of adding fluid at any time during the life of the device.

After the device has been assembled in the manner just described, it is now ready for installation upon a door in a manner as illustrated schematically in Figures 21 through 24. Referring particularly to Figure 21, the door closer is shown in completely installed condition with the bracket **64** secured to the door jamb **62** by means of the screw **66** and the fitting **50** attached to a portion of the frame of the door **48** by means of the screw **54**. It will be particularly noted in Figure 21 that when the door closer is properly installed, the screw or bolt **78** which attaches the piston rod **70** to the clevis or yoke **68** of the bracket **64** extends through the hole **76** which is nearer to the cylinder **30** rather than through the more remote hole **74**. For convenience in the following description the hole or aperture **76** will be referred to as the inner hole and the hole or aperture **74** will be referred to as the outer hole.

Referring now to Figure 22, the initial step in the installation of the door closer is shown in full lines. After the bracket **64** has been mounted on the door jamb **62**, the bolt **78** is inserted through the yoke **68** and through the outer hole **74** in the flattened end **72** of the piston rod **70**. With the door **48** firmly closed, the bracket **50** is next attached to the door frame by means of the screw **54**. Following this, the door **48** is partially opened thereby exerting a force on the spring **102**, compressing the same partially, and causing the rod **70** to project somewhat farther from the cylinder **30**. At this point the manual locking ring **132** is slid to the right along the piston rod **70** to bear against the closure cap **36** as shown in dotted lines in Figure 22, thereby locking the cylinder rod **70** in partially extended position in a manner well known to those skilled in the art.

After the piston rod **70** has been locked in partially extended position, pressure may be removed from the door **48** and the bolt **78** removed from the clevis or yoke **68** and the outer hole **74**. Following removal of the bolt **78**, the door **48** may be closed slightly thereby causing the piston rod **70** to move slightly to the left relative to the bracket **64** so that the bolt **78** may be reinserted through the yoke **68** and, this time, through the inner hole **76**. Following this operation, the door **48** may be pushed out slightly thus relieving the force upon the manual locking ring **132** and permitting the latter to be slid to the left whereupon the door may be permitted to close under the force of the compression spring **102**. Since the door attaching bracket **50** is not moved during this initial assembly operation, the final position of the piston rod **70**, as shown in Figure 24 and also in Figure 21, is slightly extended thereby placing an accurately predetermined amount of residual compression upon the spring **102** and thereby exerting a continuous slight force tending to hold the door **48** firmly in closed position. It is to be understood that the spring **102** has been initially pre-loaded by the original assembly operation and that the additional loading accomplished through utilization of the inner and outer holes in the rod end in the manner just described serves merely as a slight additional loading to keep the rod **70** a small distance away from the right hand closure cap **40** when the door is fully closed. Of considerable importance also is the fact that since the spacing of the holes **74** and **76** is accurately predetermined to give the desired residual compression in the spring **102**, the likelihood of faulty installation is minimized.

The operation of the door closer is illustrated in Figures 1 through 5 which particularly show the relative positions of the cylinder, floating piston assembly, and piston rod at various stages in the operating cycle. As illustrated in Figure 1, the door closer is assumed to be fully assembled and installed between a door and door jamb in the manner previously described. With the door closed, the various parts of the door closer will occupy approximately the positions illustrated in Figure 1 wherein it

will be noted that the piston rod **70** is spaced away from the right hand closure cap **40** a distance approximately equal to the distance between the inner and outer holes **76** and **74**. Thus, the resilient pre-loaded compression force of the spring **102** is applied through the stop pin **82** to the piston rod **70** and is continuously effective to cause the door to remain in closed position. As shown in Figure 1, the movable center disc **92** of the floating piston assembly **80** will probably occupy some intermediate position between the fixed discs **88** and **90** so that the level of the liquid (which occupies the major portion of the space within the cylinder **30**) is substantially even at opposite sides of the floating piston assembly.

With the door closer in the "door closed" or rest position of Figure 1, if the door is moved to start a door opening operation the parts of the door closer will assume the relative positions as shown in Figure 2. As illustrated in this view, the piston rod **70** is moving to the left and, by means of the engagement of the stop pin **82** with the thimble **86**, is carrying with it the floating piston assembly **80** thereby tending to further compress the spring **102**. During this movement of the floating piston assembly **80**, the movable center disc **92** will be moved to the right against the face of the fixed disc **88** by reason of the slight frictional engagement of the outer periphery of the disc **92** with the inner wall of the cylinder and, primarily, by the pressure of the fluid at the left hand side of the floating piston assembly. With the movable center disc **92** in the position as illustrated in Figure 2, it will be noted that the annular orifice **96** is substantially in registry with the orifices **98** so that fluid at the left hand side of the floating piston assembly is afforded a relatively unobstructed path of flow around the outside of the fixed disc **90**, through the orifice **96**, and through the orifices **98** into the space within the cylinder **30** at the right hand side of the floating piston assembly **80**. At the same time, fluid at the left hand side of the floating piston assembly may also flow to the right hand side thereof through the orifice **100** which is provided between the inside diameter of the thimble **86** and the flat **116** on the piston rod **70**. Such flow of fluid through the orifice **100** is, however, much smaller than the unobstructed flow around the disc **90** and through the orifices **96** and **98** and, during this phase of the operation of the door closer, is of relatively minor significance.

After the door has been opened to the desired extent, normally the person using the door will simply release the same thus permitting the door closer to return the door to closed position. If the door is operated in this manner, the relative position of the parts of the door closer after the door has been released is illustrated in Figure 3 wherein, as shown by the arrow, the piston rod **70** is moving to the right or into the cylinder **30**. Since there is no external force being applied to the door at this time, the only force tending to close the door is derived from the stored energy of the compression spring **102** which bears against the fixed disc **90** and thimble **86** thereby transmitting such force through the stop pin **82** to the piston rod **70**. As the door closes under the force of the compression spring **102** as shown in Figure 3, the fluid at the right hand side of the floating piston assembly **80** must now pass back to the left hand side of the floating piston assembly. However, both the slight frictional engagement of the movable center disc **92** with the inner wall of the cylinder **30** and the pressure of the fluid within the cylinder **30** at the right hand side of the floating piston assembly will now cause the movable disc **92** to move to the left relative to the fixed discs **88** and **90** so that it will lie flat against the face of the fixed disc **90**. In this position of the movable center disc **92**, the annular orifice **96** will be substantially obturated thereby closing the path of fluid flow through the floating piston assembly as illustrated in Figure 2. Since the path of fluid flow through the orifices **98** and **96** and around the outer periphery of the fixed disc **90** is now closed, the fluid at the right hand side of the floating piston assembly must now pass to the left hand side of the floating piston assembly through the relatively small orifice **100**. Since, as previously mentioned, the orifice **100** can be carefully calibrated by controlling the dimensions of the flat **116** and the size of the inner diameter of the thimble **86**, it will be apparent that if the door is allowed to return to closed position solely under the impetus of the compression spring **102** in the manner illustrated in Figure 3, such door closing movement will be at a relatively slow rate under the control of fluid flow through the relatively small orifice **100**.

Although the door closer is intended to operate normally in the manner illustrated in Figure 3, it occasionally happens, particularly when the door is used by children, that an external force will be applied to the door over and above that applied by the compression spring **102** tending to force or slam the door closed. When this occurs, the parts of the door closer assume the positions as illustrated in Figure 4 wherein the automatic bypass becomes effective thereby preventing damage to the closer. As shown in Figure 4, if, during a normal closing movement of the door is previously described in connection with Figure 3, an external force is applied tending to force the door closed, the pressure of the fluid within the cylinder **30** at the right hand side of the floating piston assembly **80** will increase more rapidly than it may be dissipated by flow through the relatively restricted orifice **100**. As a result, the entire floating piston assembly **80** will be forced to the left relative to the piston rod **70** and into a position such that the thimble **86** will now surround that portion of the piston rod **70** in the region of the flat **118**. Since the flat **118** is considerably deeper than the flat **116**, the effect is to provide a relatively much larger orifice **134** thereby relieving the excess pressure on the fluid at the right hand side of the floating piston assembly and permitting the fluid to pass freely to the left hand side of the floating piston assembly so long as the external force is applied to the door.

If the external force applied to the door tending to force the same closed is no greater than a predetermined amount which can be absorbed by movement of the floating piston assembly in the manner illustrated in Figure 4 to open up the larger orifice **134**, the floating piston assembly will move back to the position as illustrated in Figure 3 as soon as the external force is removed. However, since the entire floating piston assembly **80** may move in an unobstructed manner between limits defined by the stop pin **82** and the closure cap **36**, if a force tending to close the door is applied externally in an amount greater than that which can be absorbed by movement of the floating piston assembly to the position of Figure 4, the piston rod **70** will simply continue to move relative to the floating piston assembly **80** into some position such as that illustrated in Figure 5. It is to be clearly understood that such continued movement of the piston rod **70** relative to the floating piston assembly **80** can in no way damage the door closer since, as previously pointed out, the entire floating piston assembly is free to move relative to the piston rod **70**.

Still referring to Figure 5, and although the position of the parts as illustrated in this view has been described as representing an extreme condition beyond that which can be accommodated by the emergency bypass position of Figure 4, it may occasionally be desirable to operate the door deliberately in such manner as to force the floating piston assembly into a position such as illustrated in Figure 5. For example, if the person using the door should have an armful of bundles, or the like, or for any other reason should wish to hold the door open for a brief time delay interval, it is only necessary to apply a door closing force of a magnitude sufficient to move the floating piston assembly into the position of Figure 5. In this position the flow of fluid from the right hand side of the floating piston assembly to the left hand side thereof is still further restricted to the actual clearance provided between

the inside diameter of the thimble **86** and the outside diameter of the piston rod **70**. The orifice thus provided is extremely small since there is no flat on the piston rod at this point and, as a result, the closing force of the spring **102** will be effectively blocked by the pressure of the fluid at the right hand side of the floating piston assembly until such time as a sufficient volume of fluid has leaked through this very small orifice around the piston rod to permit the floating piston assembly **80** to move back or to the right in Figure 5 to a position over the flat **118**. Since the orifice between the inside diameter of the thimble **86** and the outside diameter of the piston rod **70** is so extremely small, the net effect of placing the floating piston assembly into the position of Figure 5 is to introduce a time delay in the normal door closing action of the spring **102** during which interval the user may pass through the door and following which the spring **102** will again become effective to close the door in a normal manner.

In the modified form of the device, as illustrated in Figures 16 and 17 of the drawings, the construction of the parts is substantially identical to that already described except for the addition of the second coil spring **110** which extends between the fixed disc **90** and the follower **112** which in turn is held in place against the stop pin **114**. In Figure 16 the parts are shown in the positions which they would normally occupy with the door closed as in Figure 1. However, when an external force is applied tending to close the door in a manner as previously described in connection with the operation illustrated in Figures 4 and 5, the floating piston assembly **80** of Figure 16 will move to the position as illustrated in Figure 17. In this way, an enlarged orifice **134** is again uncovered as in Figure 4, thereby preventing damage to the closer mechanism. However, with the modified form of the device, as illustrated in Figures 16 and 17, it is possible by proper selection of the extra compression spring **110** to more accurately predetermine the amount of excess force which must be applied to the door in order to bring about the emergency bypass actuation of the floating piston assembly. Thus, by merely changing the strength of the auxiliary compression spring **110** and without any substantial modification of the remainder of the door closer assembly, it is possible to adapt the modified form of the device, as shown in Figures 16 and 17, to a wide variety of different installation conditions.

When the door closer is installed in the manner illustrated in Figures 21 through 24, it will be recalled that the pre-loaded compressive force of the coil spring **102** is continuously applied to the door **48** in such manner as to tend to hold the latter firmly in closed position. Despite this advantage, however, it will still be apparent that the stored energy of the compression spring **102** is at its lowest value near the very end of a door closing operation. Furthermore, it is at this exact point that a slight additional push is normally required in order to firmly engage the door latch with its keeper. In accordance with the present invention I have provided for such an action as illustrated in Figures 12 through 15.

Referring specifically to Figures 12 through 15, it is to be noted first of all that the door closer has been shortened considerably by breaking the views and, in each case, the figure shows only the upper half of the door closer above the center line of the piston rod **70** in order to provide a sufficiently enlarged scale to illustrate the action which takes place in operation. As shown in Figure 12, the door closer is assumed to be fully installed, in the manner previously described, upon a door and its associated jamb and the door is assumed to be closed or in the rest position. At this time, the movable center disc **92** is further assumed to occupy a position somewhere intermediate the fixed discs **88** and **90** and, although there is a relatively unobstructed path for fluid flow past the floating piston assembly **80**, since the parts are at rest there is no flow taking place. It is to be particularly noted in Figure 12 that, since the cylinder **30** is initially filled with liquid to a point which almost occupies its entire volume, there is a relatively small residual volume of air which remains in the cylinder **30**. This air, as shown in Figure 12, lies along the top of the cylinder **30** which is mounted in horizontal position and the level of liquid at the right hand side of the floating piston assembly **80** is substantially the same as the liquid level at the left hand side thereof.

When a door opening operation is begun, the movable disc **92**, as previously described, will move to the right relative to the fixed discs **88** and **90** and will lie against the face of the fixed disc **88** thereby opening up a relatively unobstructed path of fluid flow around the outer periphery of the fixed disc **90** and through the orifices **96** and **98**. A path of fluid flow through the inner orifice **100** is also available but is of relatively much smaller dimensions than that previously mentioned. Accordingly, as the initial door opening movement takes place, and particularly in view of the ease of flow of the air as compared to the liquid, there is a tendency for substantially all of the air lying adjacent the top of the cylinder **30** at the left hand side of the floating piston assembly to flow over the fixed disc **90** and thence downwardly through the orifices **96** and **98** before any appreciable quantity of the liquid at the left hand side of the floating piston assembly begins to move to the opposite side of the latter. During such initial door opening movement, therefore, substantially the total volume of air within the cylinder **30** will move to the right hand side of the floating piston assembly so that, as illustrated in Figure 13, the relative proportion of air to liquid at the right hand side of the floating piston assembly tends to increase.

When the door is fully opened, the floating piston assembly will occupy its maximum position to the left and, at that time, the relative volume of air to liquid at the right hand side of the floating piston assembly will again be reduced so that the liquid level will approach the previous position which it occupied with the parts at rest. However, as the door begins to close, as shown in Figure 14, the movable center disc **92** immediately moves against the face of the fixed disc **90** thereby closing the path of fluid flow through the orifice **96**. Since, at this time, the level of the liquid at the right hand side of the floating piston assembly lies above the only available path of fluid flow which is through the centrally located orifice **100**, the air tends to remain at the right hand side of the floating piston assembly and, as the latter moves to the right, the relative volume of air to liquid at the right hand side of the floating piston assembly tends to increase as liquid moves to the left hand side of the floating piston assembly through the orifice **100**.

As the relative proportion of air to liquid increases during movement of the floating piston assembly to the right in a door closing operation, eventually the piston rod **70** and the floating piston assembly **80** will reach a position as shown in Figure 15 wherein sufficient liquid has passed through the orifice **100** so that the liquid level at the right hand side of the floating piston assembly is low enough to permit air to likewise pass through the orifice **100**. In view of the viscosity of the liquid and its inherent greater resistance to flow, at this point the air at the right hand side of the floating piston assembly will surge relatively freely through the orifice **100**, and, since this position of the parts is predetermined in such manner as to occur just prior to the final closing movement of the door closer, it follows that such final closing movement is relatively unimpeded and provides the necessary impetus to force the door latch into firm engagement with its associated keeper.

Although I have shown and described herein certain preferred embodiments of apparatus solely for the purpose of illustration, it will be obvious that numerous modi-

fications, alterations and deviations will occur to those skilled in the art without departing from the spirit or scope of the invention as set forth in the following claims. Having thus described my invention what I claim as new and desire to secure by Letters Patent is as follows:

1. A door closer comprising a generally elongated, hollow cylinder having outwardly flared ends, closure caps crimped around the opposite flared cylinder ends, one of said caps having a central aperture therein and the other of said caps having an external hinged bracket for attachment to a door, gasket seals held within each of said flared cylinder ends by its associated cap, a solid cylindrical piston rod extending into said hollow cylinder through said apertured cap having a stop pin at its inner end and a bracket at its outer end for connection to a door jamb, a piston freely slidable axially along said rod within said hollow cylinder between said apertured cap and said stop pin, said piston comprising a tubular thimble having an internal diameter slightly larger than said solid rod, axially spaced discs fixed at opposite ends of said thimble having outside diameters substantially smaller than the internal diameter of said hollow cylinder, and a center disc of resilient material movable axially of said thimble between said fixed discs having its inside diameter substantially larger than the outside diameter of said thimble and its outside periphery in slidable sealing engagement with the inner wall of said hollow cylinder, a compression spring extending between said apertured cap and one of said fixed discs urging said piston inwardly, the other of said fixed discs having a plurality of apertures substantially in registry with the annular space between the inside periphery of said center disc and the outside periphery of said thimble, and a plurality of adjacent flats extending along said rod, said flats being of different widths, thereby to provide orifices of different areas between said rod and the inside periphery of said thimble at different positions of said piston along said rod whereby fluid may pass from one side of the piston to the other, within said cylinder, at variable rates governed by the areas of the respective orifices.

2. A door closer comprising a hollow cylinder, closure caps on the opposite cylinder ends, one of said caps having a central aperture therein, gasket seals held within each of said cylinder ends by its associated cap, a solid cylindrical piston rod extending into said hollow cylinder through said apertured cap having a stop pin at its inner end, a piston freely slidable axially along said rod within said hollow cylinder between said apertured cap and said stop pin, said piston comprising a tubular thimble having an internal diameter slightly larger than said solid rod, axially spaced discs fixed at opposite ends of said thimble having outside diameters substantially smaller than the internal diameter of said hollow cylinder, and a center disc of resilient material movable axially of said thimble between said fixed discs having its inside diameter substantially larger than the outside diameter of said thimble and its outside periphery in slidable sealing engagement with the inner wall of said hollow cylinder, a compression spring extending between said apertured cap and one of said fixed discs urging said piston inwardly, the other of said fixed discs having a plurality of apertures substantially in registry with the annular space between the inside periphery of said center disc and the outside periphery of said thimble, and a plurality of adjacent flats extending along said rod, said flats being of different widths, thereby to provide orifices of different areas between said rod and the inside periphery of said thimble at different positions of said piston along said rod whereby fluid may pass from one side of the piston to the other, within said cylinder, at variable rates governed by the areas of the respective orifices.

3. A door closer comprising a hollow cylinder, closure caps on the opposite cylinder ends, one of said caps having a central aperture therein, a piston rod extending into said hollow cylinder through said apertured cap having a stop pin at its inner end, a piston freely slidable axially along said rod within said hollow cylinder between said apertured cap and said stop pin, said piston comprising a tubular thimble having an internal diameter slightly larger than said rod, axially spaced discs fixed at opposite ends of said thimble having outside diameters substantially smaller than the internal diameter of said hollow cylinder, and a center disc of resilient material movable axially of said thimble between said fixed discs having its inside diameter substantially larger than the outside diameter of said thimble and its outside periphery in slidable sealing engagement with the inner wall of said hollow cylinder, a compression spring extending between said apertured cap and one of said fixed discs urging said piston inwardly, the other of said fixed discs having a plurality of apertures substantially in registry with the annular space between the inside periphery of said center disc and the outside periphery of said thimble, and a plurality of adjacent flats extending along said rod, said flats being of different widths, thereby to provide orifices of different areas between said rod and the inside periphery of said thimble at different positions of said piston along said rod whereby fluid may pass from one side of the piston to the other, within said cylinder, at variable rates governed by the areas of the respective orifices.

4. A door closer comprising a cylinder, a piston rod extending into said cylinder having a stop pin at its inner end, a piston freely slidable axially along said rod within said cylinder, said piston comprising a tubular thimble having an internal diameter slightly larger than said rod, axially spaced discs fixed at opposite ends of said thimble having outside diameters substantially smaller than the internal diameter of said cylinder, and a center disc of resilient material movable axially of said thimble between said fixed discs having its inside diameter substantially larger than the outside periphery of said thimble and its outside diameter in slidable sealing engagement with the inner wall of said cylinder, spring means bearing against one of said fixed discs urging said piston against said stop pin and into said cylinder, the other of said fixed discs having a plurality of apertures substantially in registry with the annular space between the inside periphery of said center disc and the outside periphery of said thimble, and a plurality of adjacent flats extending along said rod, said flats being of different widths, thereby to provide orifices of different areas between said rod and the inside periphery of said thimble at different positions of said piston along said rod whereby fluid may pass from one side of the piston to the other, within said cylinder, at variable rates governed by the areas of the respective orifices.

5. A door closer comprising a closed cylinder substantially filled with hydraulic fluid, a piston rod extending into said cylinder in pressure sealed relation therewith, a piston freely slidable axially along said rod within said cylinder, stop means on said rod limiting relative movement of said piston in one direction, and spring means yieldingly urging said piston against said stop means and into said cylinder, said piston comprising a tubular thimble having an internal diameter slightly larger than said rod, axially spaced discs fixed at opposite ends of said thimble having outside diameters substantially smaller than the internal diameter of said cylinder, and a center disc of resilient material movable axially of said thimble between said fixed discs having its inside diameter substantially larger than the outside diameter of said thimble and its outside periphery in slidable sealing engagement with the inner wall of said cylinder, one of said fixed discs having a plurality of apertures substantially in registry with the annular space between the inside periphery of said center disc and the outside periphery of said thimble.

6. A door closer comprising a cylinder adapted to be substantially filled with hydraulic fluid, a piston rod extending into said cylinder, means limiting movement of said piston in one direction relative to said rod, and means yieldingly urging said piston towards said limiting

means, said piston comprising a tubular thimble having an internal diameter slightly larger than said rod, axially spaced discs fixed at opposite ends of said thimble having outside diameters substantially smaller than the internal diameter of said cylinder, and a center disc movable axially of said thimble between said fixed discs having its inside diameter substantially larger than the outside diameter of said thimble and its outside periphery in slidable sealing engagement with the inner wall of said cylinder, one of said fixed discs having a plurality of apertures substantially in registry with the annular space between the inside periphery of said center disc and the outside periphery of said thimble.

7. A door closer comprising a cylinder adapted to be substantially filled with hydraulic fluid, a piston rod extending into said cylinder, a piston slidable axially along said rod within said cylinder, means limiting movement of said piston in one direction relative to said rod, and means within said cylinder yieldingly urging said piston towards said limiting means, said piston comprising a member in slidable sealing engagement with the inner wall of said cylinder, said piston rod having a plurality of reduced sections of different size along which the piston may travel thereby providing a variable orifice between said piston and rod permitting variable flow of fluid past said piston in accordance with the position of said piston relative to said rod, and second orifice means in said piston operable to provide a path of flow of said fluid past said piston during movement of the latter in one direction and to obturate said path of flow of fluid past said piston during movement of the latter in the opposite direction.

8. In a door closer having a cylinder adapted to be substantially filled with hydraulic fluid and a piston rod extending into said cylinder, a piston slidable axially along said rod within said cylinder and comprising a member in slidable sealing engagement with the inner wall of said cylinder, said piston rod having a plurality of reduced sections of different size along which the piston may travel thereby providing a variable orifice between said piston and rod permitting variable flow of fluid past said piston in accordance with the position of said piston relative to said rod, and second orifice means in said piston operable to provide a path of flow of said fluid past said piston during movement of the latter in one direction and to obturate said path of flow of fluid past said piston during movement of the latter in the opposite direction.

9. In a door closer having a cylinder adapted to contain fluid and a piston rod extending into said cylinder, a piston slidable axially along said rod within said cylinder and comprising a member in slidable sealing engagement with the inner wall of said cylinder, said piston rod having a plurality of reduced sections of different size along which the piston may travel thereby providing a variable orifice between said piston and rod permitting variable flow of fluid past said piston during movement of the latter in both directions, and second orifice means in said piston operable to provide a relatively unrestricted path of flow of said fluid past said piston during movement of the latter in one direction and to obturate said path of flow of fluid past said piston during movement of the latter in the opposite direction.

10. A door closer comprising a cylinder adapted to be substantially filled with hydraulic fluid, a piston rod extending into said cylinder, a piston slidable axially along said rod within said cylinder, means limiting movement of said piston in one direction relative to said rod, first spring means biased between said cylinder and said piston and yieldingly urging the latter towards said limiting means, and second spring means biased between said rod and said piston independently urging the latter towards said limiting means, said piston comprising a member in slidable sealing engagement with the inner wall of said cylinder, said piston rod having a plurality of reduced sections of different size along which the piston may travel thereby providing a variable orifice between said piston and rod permitting variable flow of fluid past said piston in accordance with the position of said piston relative to said rod, and second orifice means in said piston operable to provide a path of flow of said fluid past said piston during movement of the latter in one direction and to substantially obturate said path of flow of fluid past said piston during movement of the latter in the opposite direction.

11. In a door closer having a cylinder adapted to contain fluid and a piston rod extending into said cylinder, a piston movable relative to said rod within said cylinder, means limiting movement of said piston in one direction relative to said rod, first spring means biased between said cylinder and said piston and yieldingly urging the latter towards said limiting means, and second spring means biased between said rod and said piston independently urging the latter towards said limiting means, said piston rod having a plurality of reduced sections of different size along which the piston may travel thereby providing a variable orifice between said piston and rod permitting variable flow of fluid past said piston in accordance with the position of said piston relative to said rod, and second orifice means in said piston operable to provide a path of flow of said fluid past said piston during movement of the latter in one direction and to substantially obturate said path of flow of fluid past said piston during movement of the latter in the opposite direction.

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