

United States Patent

(11) 3,592,108

- [72] Inventors **Borje Oscar Rosman**
4031 Thorneaks, Ann Arbor, Mich. 48104;
Robert L. Firth, 4817 Sunnyslope Road,
Minneapolis, Minn. 55424
- [21] Appl. No. **797,420**
- [22] Filed **Feb. 7, 1969**
- [45] Patented **July 13, 1971**
- Continuation-in-part of application Ser. No.**
660,454, Aug. 14, 1967

- | | | | |
|-----------|--------|----------------|----------|
| 3,149,541 | 9/1964 | Hutter et al. | 91/422 |
| 3,259,026 | 7/1966 | Madland et al. | 91/422 X |
| 3,335,642 | 8/1967 | Rosaen | 92/110 |
| 3,426,649 | 2/1969 | Koppers | 91/422 X |
| 3,447,424 | 6/1969 | Billings | 91/422 |

Primary Examiner—Martin P. Schwadron

Assistant Examiner—Leslie J. Payne

Attorney—Hauke, Gifford & Patalidis

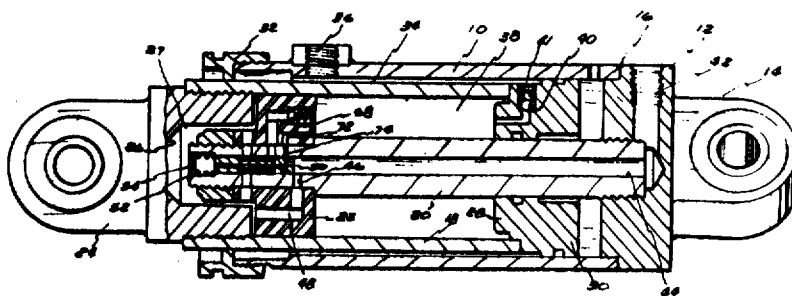
- [54] FLUID CYLINDER**
12 Claims, 11 Drawing Figs.

- [52] U.S. Cl. 92/110,
91/422, 92/52, 92/112
- [51] Int. Cl. F01b 31/00
- [50] Field of Search 92/110,
108, 107, 111, 112, 113, 165, 163, 51, 52, 53; 91/169,
422

- [56] References Cited**
UNITED STATES PATENTS

- | | | | |
|-----------|--------|---------------|----------|
| 2,783,744 | 3/1957 | Tennis..... | 92/163 X |
| 2,932,281 | 4/1960 | Mokowitz..... | 91/422 X |

ABSTRACT: A fluid cylinder comprising inner and outer tubular members telescopically joined for relative movement between extended and retracted positions. A piston carried by the outer tubular member is slidably disposed in the inner tubular member and the inner end of the inner tubular member forms a second piston. Ports and passages are provided to selectively direct fluid to the areas on opposite sides of each of the two pistons. Various valving arrangements are employed to regulate fluid flow between the various chambers formed within the cylinder to thereby regulate the speed of extension and retraction.



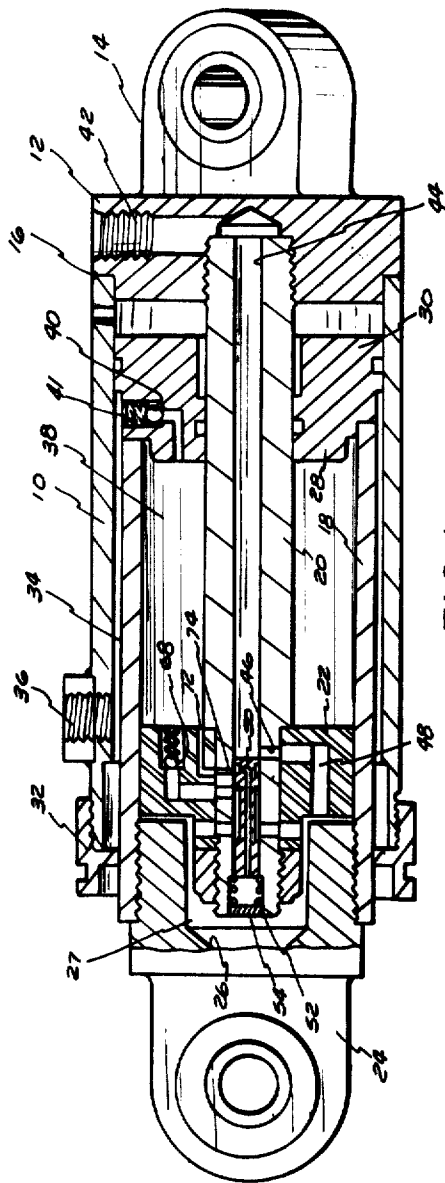


FIG. 1

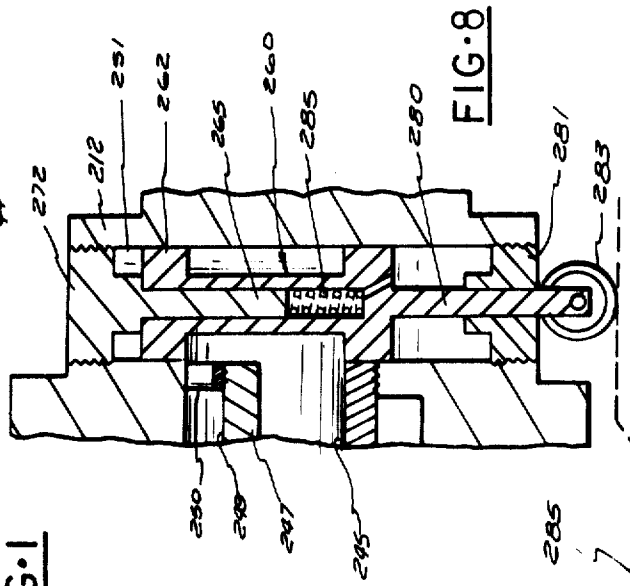


FIG. 8

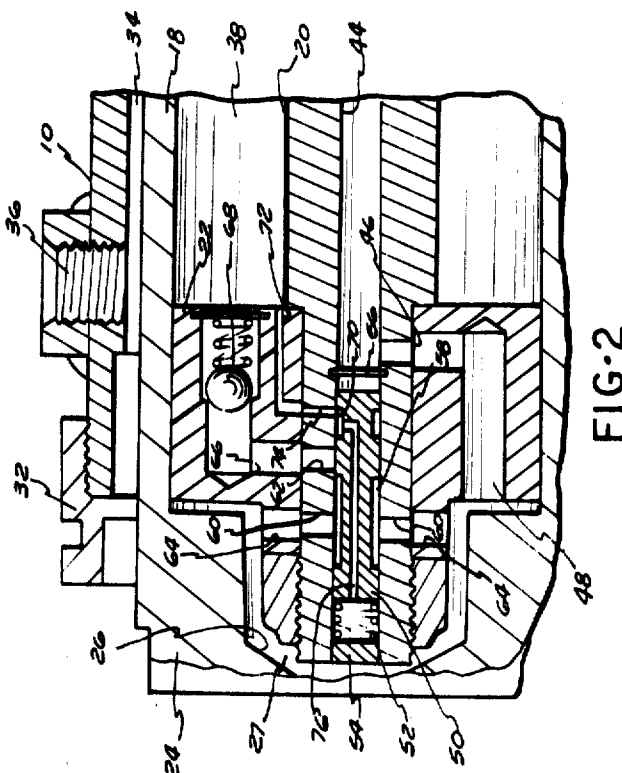
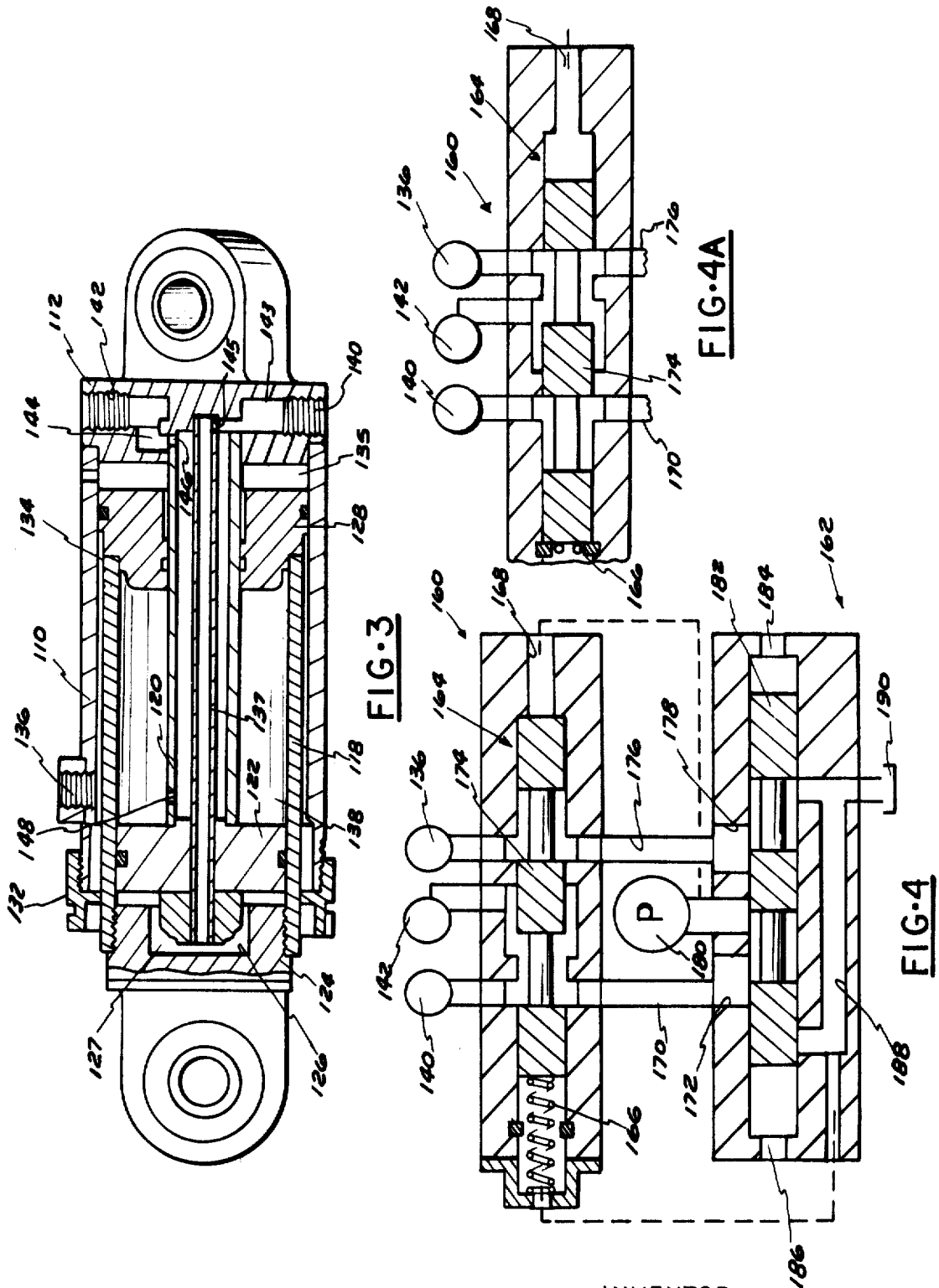


FIG. 2

INVENTOR
ROBERT L. FIRTH
BORJE O. ROSAEN

BY
Hauke Krass Gifford & Patalas
ATTORNEYS



INVENTOR
 ROBERT L. FIRTH
 BORJE O. ROSAEN
 BY *Hauck, Kross, Gifford & Antalis*
 ATTORNEYS

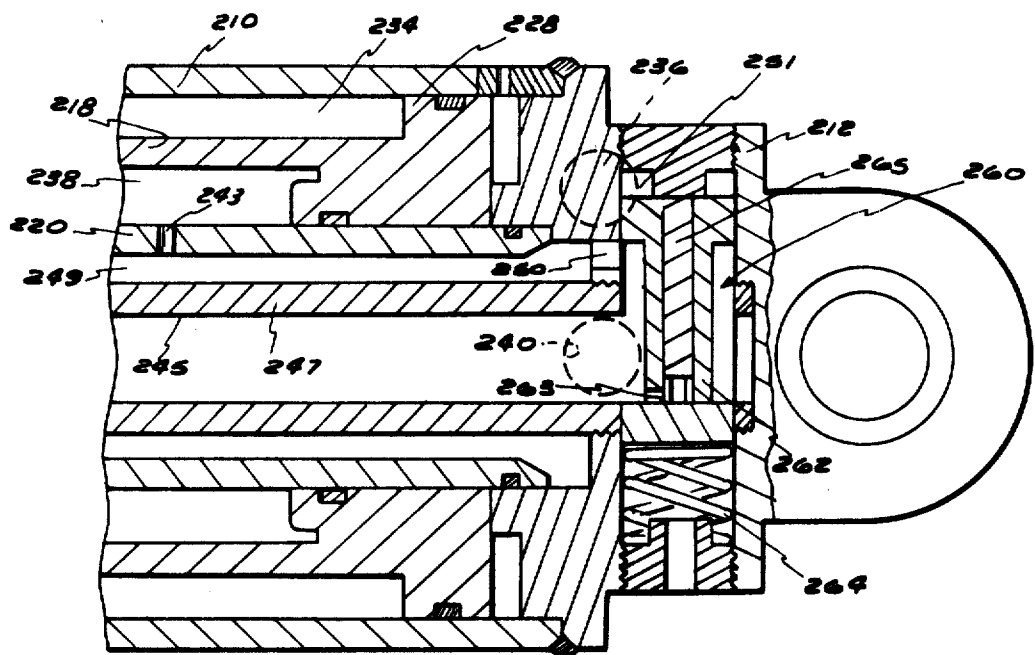


FIG. 5

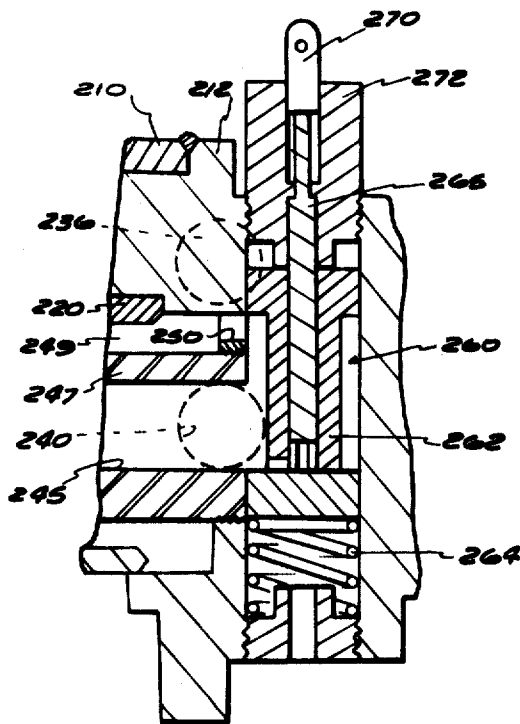


FIG. 6

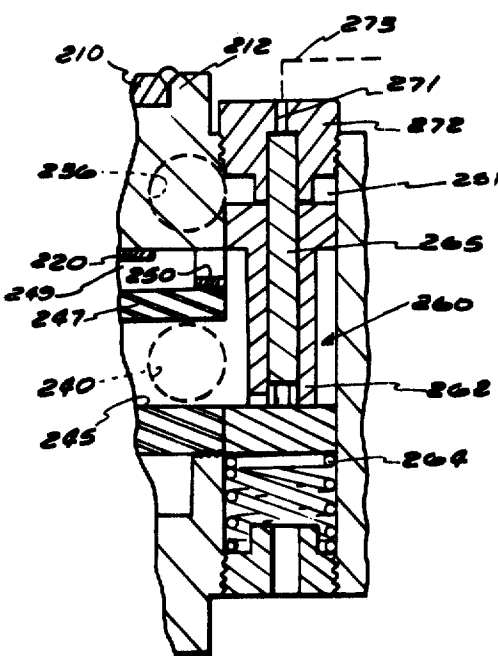


FIG. 7

INVENTOR
ROBERT L. FIRTH
BORJE O. ROSAEN

BY Hauke Knoss Gelled & A. T. K. K.

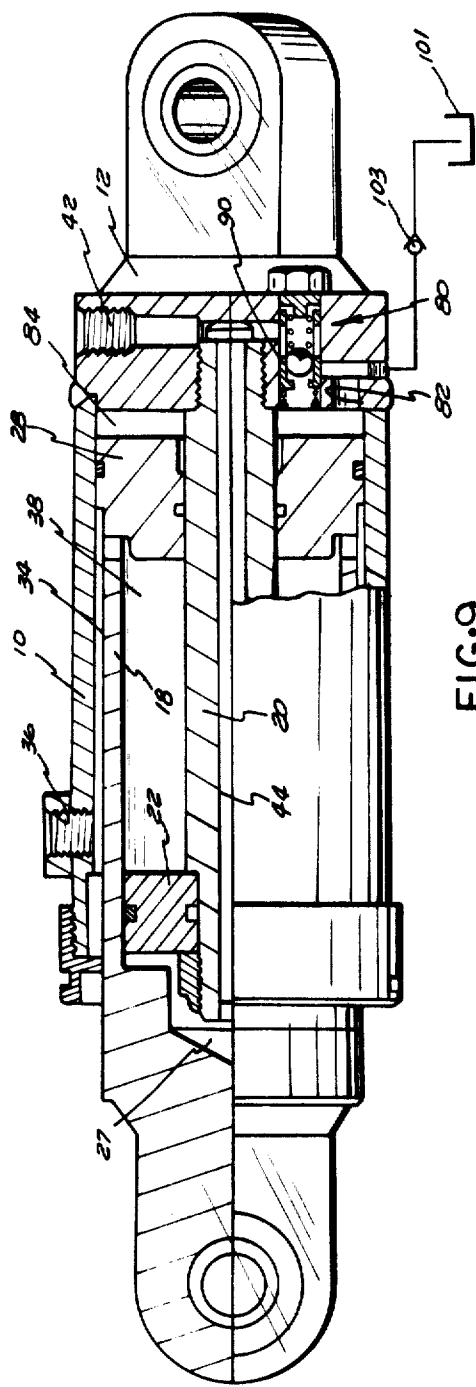


FIG. 9

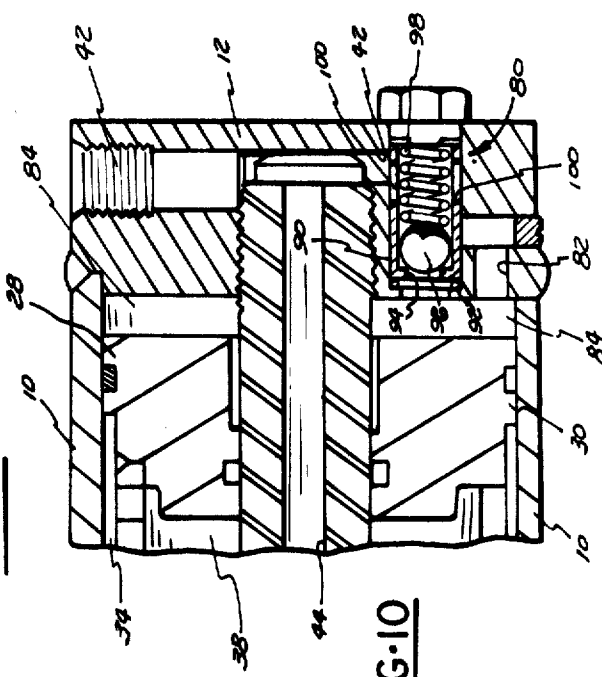


FIG. 10

INVENTOR
ROBERT L. FIRTH
BORJE O. ROSAEN
BY

Haucke Krauss Gifford & Patalas
ATTORNEYS

FLUID CYLINDER

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of copending application Ser. No. 664,454, filed Aug. 14, 1967 and is related to U.S. Pat. No. 3,335,642, issued Aug. 15, 1967.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to fluid cylinders of the general type disclosed in the aforementioned patent and patent application, and more particularly to such fluid cylinders in which means are provided for selectively or automatically producing different speeds as between retraction and extension or as between different portions of the extension or retraction strokes.

2. Description of the Prior Art

Fluid cylinders are widely employed as a means for converting fluid power into a reciprocating mechanical motion. There are a number of different types of such cylinders but generally they comprise a tubular member having its opposite ends closed; and piston slidably disposed in the tubular member has a rod extending through one or both of the closed ends. Means are provided for introducing hydraulic fluid under pressure alternately between the opposite sides of the piston to reciprocate the rod relative to the tubular member.

One problem inherent in conventional fluid cylinders has been the difficulty in providing a construction wherein an equal displacement is to be provided on each side of the piston so that an equal line pressure applied to each side of the piston will produce equal thrust. The aforementioned U.S. Pat. No. 3,335,642 provides a construction formed of telescoping tubular members in which the effective area between the tubular members is added to the rod member side of the piston and in this way the effective piston area on each side of the piston is equal.

Copending application Ser. No. 660,454 discloses an important improvement on this type of construction wherein the blind end of the inner tubular member is formed into a second piston and the areas on each side of the two pistons are utilized to substantially increase the thrust which can be achieved by a cylinder of a given diameter.

There is yet another problem associated with conventional fluid cylinders. If a fixed fluid delivery rate is supplied to the cylinder, the cylinder rod travel speed can only be varied by varying the piston and rod diameters or by providing a regenerative circuit for transferring oil from the rod end to the blind end during extension. In cylinders having a regenerative circuit the speed can only be increased during extension and it is not possible in either of these types of cylinders to provide multiple speeds in one or both directions.

Further, where the cylinder is constructed to provide a retraction speed substantially greater than the extension speed the exhaust flow rate during retraction will be correspondingly greater requiring larger lines and producing high line losses.

SUMMARY OF THE PRESENT INVENTION

The invention which will be described subsequently in greater detail includes a number of modifications similar to the constructions described in the aforementioned patent and patent application, but including valve means positioned intermediate the chambers regulating piston movement; or between the ports and such chambers for the purpose of either selectively or automatically regulating the speed of movement of the piston rod.

The construction of the present invention, unlike previous constructions, makes it possible to provide a cylinder in which the cylinder rod travel speed during retractions is greater than those produced upon extension, but in which exhaust flow rates are maintained equal. Further, in some modifications it is possible to provide multiple speeds in either or both directions.

DESCRIPTION OF THE DRAWINGS

A clearer understanding of the present invention will be more apparent upon reference to the accompanying drawings in which like reference characters refer to like parts throughout the several views and in which:

FIG. 1 is a longitudinal cross-sectional view of one preferred embodiment of the present invention;

FIG. 2 is a fragmentary view illustrating the embodiment of FIG. 1 in a different operation position;

FIG. 3 is a view similar to FIG. 1 but illustrating another preferred embodiment of the present invention;

FIG. 4 is a diagrammatic view illustrating a fluid circuit including the fluid cylinder of FIG. 3 in one operative position;

FIG. 4A is a fragmentary diagrammatic view of the fluid circuit illustrated in FIG. 4 but illustrating another operative position of the fluid cylinder;

FIG. 5 is a fragmentary cross-sectional view illustrating yet another preferred fluid cylinder of the present invention;

FIGS. 6, 7 and 8 are fragmentary cross-sectional views, each illustrating a preferred modification of the cylinder shown in FIG. 5;

FIG. 9 is a view similar to FIGS. 1, 3 and 5 but illustrating another preferred embodiment of the present invention; and

FIG. 10 is an enlarged fragmentary cross-sectional view of the structure shown in FIG. 9.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings for a more detailed description of the present invention, one preferred fluid cylinder is illustrated in FIGS. 1 and 2 as comprising an outer tubular member 10 closed at one end by a cap 12. A mounting element 14 is fixed to or integrally form with the cap 12, which in turn is fixed to the outer tubular member 10, as by welding, as shown at 16. An inner tubular member 18 is telescopically received through the open end of the outer tubular member 10.

A hollow piston rod 20 is mounted to the cap 12 and extends into the inner tubular member 18. A piston 22 is mounted to the end of the rod 20 opposite the cap 12 and is axially slidably received within the inner tubular member 18. The end of the tubular member 18 opposite the cap 12 is closed by a mounting member 24 which is provided with an inner cavity 26 for receiving the end of the piston rod 20. The cavity 26 and the interior end of the inner tubular member 18 form a chamber 27.

The inner tubular member 18 is closed at the end opposite the mounting member 24 by a piston 28. The piston 28 is provided with a radially enlarged portion 30 which axially slidably engages inner surface of the outer tubular member 10. The piston rod 20 extends through the piston 28 so that the piston 28 is axially movable with respect to the piston rod 20. An internally flanged member 32 is carried at the end of the outer tubular member 10 opposite the cap 12. The flanged member 32 axially slidably engages the outer surface of the inner tubular member 18 to act as a stop for limiting axial separation of the tubular members 10 and 18.

The flanged member 32 and the enlarged portion 30 of the piston 28 space the tubular members apart to form a radial chamber 34 therebetween; and a port 36 carried by the outer tubular member 10 provides a means for connecting the chamber 34 to a source of fluid power. A chamber 38 is formed in the inner tubular member 18 intermediate the pistons 22 and 28 and is connected to the chamber 34 by a one way check valve 40. Check valve 40 is biased to the closed position as illustrated in FIG. 1 by means of a spring 41.

A port 42 is provided in the cap 12 and provides the means for connecting a central passage 44 formed in the piston rod 20 with a source of fluid power. A radial passage 46 formed in the piston rod 20 connects the passage 44 with an axial passage 48 formed in the piston 22. The axial passage 48 extends to the side of the piston 22 opposite the chamber 38 so that fluid pressure from the port 42 is transmitted to the chamber 27.

As can best be seen in FIG. 2 a valve member 50 is carried within the end of the piston rod 20 and is axially slidable within the passage 44. A spring 52 seats against a plug 54 and urges the valve member 50 toward a snap ring 56. The valve member 50 is provided with a first peripheral recess 58 which in the position of the valve member 50 shown in FIG. 1 connects radial ports 60 provided in the piston rod 20 with a port 62 also formed in piston rod 20. The ports 60 connect with passages 64 formed through the piston 22 to chamber 27. The port 62 connects with the chamber 38 through a passage 66 and a one way check valve 68.

In the position of the valve member 50 shown in FIG. 2 a second peripheral recess 70 and passages 72 and 74 provided in the piston 22 and the rod 20 respectively connect the chamber 38 with a passage 76. The passage 76 is formed in the valve member 50 and connects with the spring end of the valve member 50 to provide a means of exhausting the chamber carrying the spring 52 when the spring is compressed.

As the cylinder has thus far been described, it is apparent that axial separation of the tubular members 10 and 18 produces extension of the cylinder and telescoping movement to the position of FIG. 1 produces retraction. The purpose of this embodiment is to provide a cylinder in which retraction can be at a speed greater than that of extension without changing the exhaust flow rate so that there is no need for larger exhaust lines and the high line losses attendant with such larger lines is not produced in this embodiment.

In the construction illustrated in FIGS. 1-2 this is achieved by utilizing chamber 38 as a storage area during retraction and exhausting this chamber during the next extension of the cylinder. By varying the relative cross-sectional areas of chambers 27, 34 and 38 the ratio between the rate of retraction and the rate of extension can be varied. For instance, in a construction in which the cross-sectional areas of chambers 34 and 38 are equal and in which their sums equal the cross-sectional area of chamber 27 the retraction speed will be twice that of the speed of extension. A three to one ratio can be achieved by making the cross-sectional area of chamber 38 twice that of chamber 34 with the sum of these areas equal to the area of chamber 27.

The fluid cylinder of FIGS. 1 and 2 is extended by directing fluid through port 42. This fluid flows through the passage 44 of piston rod 20 to the passages 46 and 48 into the chamber 27. Because the check valve assembly 68 is closed until its spring is overcome, pressure builds up in chamber 27 and acts to move the valve member 50 against the spring 52 and toward the position illustrated in FIG. 2. This movement of the valve member 50 closes communication between passages 64 and 66. The chamber containing the spring 52 is vented through passages 76, 70, 74 and 72 to the chamber 38 past the check valve 40 into chamber 34 and out port 36. Because the sum of the volumes of chambers 34 and 38 are substantially equal to the volume of chamber 27 the rate of flow exhausting from port 36 is the same as the rate of flow into the cylinder through port 42.

To retract the cylinder, fluid is directed through port 36 into chamber 34. The check valve 40 is urged by the fluid pressure and the spring 41 toward a closed position. Relieving pressure at port 42 permits the spring member 52 to move the control valve 50 toward the position shown in FIG. 1 to open communication between passages 62, 66, recess 58 and passages 60 and 64. Thus, as the cylinder is being moved to a retracted position by fluid pressure in chamber 34 two separate paths are opened up for fluid to be exhausted from the larger volume chamber 27. Substantially half the fluid from chamber 27 is exhausted through the port 42 by way of passages 48, 46 and 44 and the other half is exhausted into chamber 38 through passages 64, 60, 58, 62 and 66 to be stored until the next extension stroke.

Thus, it is apparent that because the area of chamber 34 is substantially half that of chamber 27 the speed of retraction will be twice that of extension but the particular valving ar-

range between these chambers and chamber 38 provides a substantially equal exhaust flow rate from ports 36 and 42 during extension and retraction.

FIGS. 3, 4 and 4A illustrate another preferred embodiment of the present invention designed to provide two speed operation in both directions. The construction of the cylinder is similar to the one shown in FIGS. 1 and 2 and comprises an outer tubular member 110 and an inner tubular member 118 with a cap 112 fixed to the outer tubular member 110 to define a chamber 135. A hollow piston rod 120 is fixed to the cap 112 and a piston 122 carried by the rod 120 is received by the inner tubular member 118. The rod 120 axially slidably extends through a second piston 128 which closes one end of the inner tubular member 118. The opposite end of the inner tubular member 118 is closed by a mounting member 124.

The inner tubular member 118 defines a chamber 138 between the pistons 122 and 128. A cavity 126 formed in the mounting member 124 defines a chamber 127 on the blind side of the piston 122. A chamber 134 is formed by the outer tubular member 110 intermediate the piston 128 and a flanged member 132 carried by the tubular member 110.

An inner tube 137 is carried within the piston rod 120 and extends through the piston 122 to register with the chamber 127. A port 140 and passages 143 and 145 formed in the cap member 112 and the piston rod 120 respectively provide a fluid path through the tube 137 to the chamber 127.

A port 142 and a passage 144 formed in the cap member 112 and an opening 146 and 148 formed in the piston rod 120 provide a fluid path to the chamber 138.

FIGS. 4 and 4A illustrate schematically a preferred valving arrangement for use with the cylinder illustrated in FIG. 3. The purpose of this valving arrangement is to isolate the area of chamber 138 from the other chambers and to add and subtract it to and from the other areas to produce the desired variation in speed.

The valving arrangement preferably comprises a speed selector portion 160 and a directional valve portion 162. The speed selector portion 160 comprises a three land spool valve 164 urged by a spring 166 to the position shown in FIG. 4 and movable by fluid pressure sufficient to overcome the spring 166 through a port 168 to the position shown in FIG. 4A. Movement of spool valve 164 can be moved by other means, of course, as for instance manually if this is preferred. In the position of the spool valve 164 illustrated in FIG. 4 ports 140 and 142 of the fluid cylinder are connected to each other and through the speed selector portion 160 to a conduit 170. The conduit 170 is connected with a port 172 formed in the directional valve 162. The central land 174 of the spool valve 164 closes communication between the ports 142 and 136 and the port 136 is connected through the speed selector portion 160 and a conduit 176 to a port 178 provided in the directional valve 162.

Fluid pressure either automatically or selectively provided to the port 168 from a pump 180 sufficient to overcome the spring 166 moves the spool valve 164 toward the position shown in FIG. 4A. In this position the port 140 is isolated from the port 142 by the central land 174 and the ports 142 and 136 are connected to each other and to the conduit 176. The port 140 is connected to the conduit 170.

The directional valve portion 162 comprises a three land spool valve 182 movable between positions wherein the pump 180 is connected to either the port 172 or the port 178. Movement of the spool valve 182 is controlled by alternately providing fluid pressure and exhausting at ports 184 and 186 by manual or automatic means (not shown). The directional valve portion 162 is also provided with passages 188 connecting either the port 178 or the port 172 with a fluid reservoir 190 when the other port 178 or 172 is connected with the pump 180.

In operation the position of the spool valve 182 determines whether the fluid cylinder will extend or retract. The position of the spool valve 164 determines whether movement of the cylinder, either retracting or extending, will be at "fast" speed

or at "slow" speed. With the spool valves 164 and 182 positioned as shown in FIG. 4 fluid under pump pressure will be supplied to ports 140 and 142 and exhausted from port 136. Thus, fluid will be exhausted from chamber 134 and delivered to chambers 127 and 138. The effective area of the piston 122 exposed to fluid pressure within the chamber 127 is substantially twice that exposed to pressure within the chamber 138 so the cylinder will be moved toward an extended position. As the cylinder extends chamber 138 contracts and the fluid emptying from this chamber is added to the expanding chamber 127 through the connection provided by the speed selector portion 160 of the valve. Thus the cylinder will extend at a faster rate than it would if it were only being provided with fluid by the pump 180.

When the pressure in chamber 138 has increased to a predetermined value the pressure at port 168 will have increased sufficiently to overcome the spring 166 and to cause the spool valve 174 to shift to the position shown in FIG. 4A. In this position the port 142 is exhausted to the reservoir 190 to relieve the pressure in chamber 138. The fluid from chamber 138 will be exhausted to the reservoir 190 rather than being added to the chamber 127 and the result is a substantially one-half reduction in the speed of cylinder extension.

Retraction of the cylinder is accomplished in substantially the same way except that the spool valve 182 is either automatically or selectively shifted from the position shown in FIG. 4 to the left to connect the port 178 to the pump 180 and the port 172 to the reservoir 190. With the spool valve 182 in this position and the speed selector portion 160 in the position shown in FIG. 4 the ports 140 and 142 are exhausted to the reservoir and fluid under pressure from the pump 180 is directed through the port into the chamber 134 to retract the cylinder at fast speed. Retraction at slow speed is produced by movement, either selectively or automatically, of the spool valve 164 to the position shown in FIG. 4A. This opens chamber 138 to fluid pressure to double the effective piston area and assuming a constant pumping volume to cause a reduction in cylinder speed of substantially one-half.

FIG. 5 is a fragmentary view illustrating a fluid cylinder similar to those described above and which provides two speeds in both directions and a pressure-controlled speed selector built into the cylinder. While it has been preferred to illustrate the speed selector as being built into one end of the cylinder, as will become apparent as the description proceeds the selector could be a separate unit mounted to the side of the cylinder or it could, if desired, be disposed differently from the particular manner disclosed.

The cylinder comprises an outer tubular member 210, an inner tubular member 218, a hollow piston rod 220, an inner tube 247, a piston 228 and a cap 212. A port 236 provides communication by means not shown and externally of the cylinder with a chamber 234 formed between the members 210 and 218. A port 240 provides fluid communication with the interior 245 of the inner tube 247. A chamber 238 is formed on the rod side of the piston (not shown) at the blind end of the inner tubular member 218 and is connected to an annular passage 249 through a port 243. A chamber (not shown) is formed on the opposite side of the piston and is connected to a passage 245 formed by the interior of the inner tube 247.

A valve assembly 260 is mounted in the cap 212 and comprises a spool valve member 262 movable along a guide shaft 265 and urged to the position shown in FIG. 5 by a spring 264 in which a passage 250 connects passages 249 and 245, and the valve member 262 closes chamber 251 from both passages 249 and 245. The chamber 251 is connected with port 236. The valve member 262 is provided with a pressure responsive area 263 which upon a predetermined pressure increase in the passage 245 causes the valve member 262 to move downwardly to open communication between chamber 251 and passage 250 and to close communication between passages 245 and 249.

Extension of the fluid cylinder shown in FIG. 5 at "fast" speed is produced by directing fluid through port 240. Extension of the cylinder causes the chamber 238 to contract and fluid from this chamber is exhausted through the passage 250 and is directed through the passage 245 to be added to the fluid being delivered to produce extension. In this way the volume of fluid delivered to the expanding chamber (not shown) is substantially doubled so that the extending speed is substantially double what it would be if chamber 238 were exhausted to the reservoir. As the pressure builds up in passage 245 the valve 262 will be moved downwardly to exhaust fluid from chamber 238 through the port 236. This reduces by one-half the volume of fluid delivered to produce extension and thus extension speed is cut in half.

Two speed operation during retraction is produced in substantially the same way. Fluid under pressure is directed to the chamber 234 through port 236. The chamber 238 and the passage 245 exhaust through port 240 to produce high-speed retraction. Movement of the spool valve 262 downwardly connects chamber 238 to the port 236 to substantially double the piston area producing retraction and thereby reducing the speed by substantially one-half.

FIGS. 6 and 7 shown modifications of the cylinder shown in FIG. 5 but in which means are provided for selectively overriding the automatic operation of the valve member 260. In FIG. 6 these means are in the form of a shaft 270 fixed to the guide shaft 265 and extending upwardly through a plug 272 so that axial movement of the shaft 270 produces corresponding movement of the guide shaft 265. Moving the lower end of the guide shaft 265 permits the spring 264 to move the valve member 260 upwardly also. The shaft 270 can be manually operated or may be connected to a solenoid (not shown). In this way the speed of extension or retraction can be selected.

FIG. 7 illustrates a modification in which a chamber 271 communicates with the end of the guide shaft 265 to move the guide shaft 265 axially by a hydraulic means including a hydraulic line 273.

FIG. 8 illustrates a modification of FIG. 5 in which a rod 280 is fixed to the lower end of the valve member 262. The rod 280 extends through a plug 281 and carries a wheel 283 at its exterior end. A spring 285 disposed intermediate the guide 265 and the valve urges the valve 262 downwardly and the wheel 283 into engagement with a track 285. The track 285 is preferably connected to the end of the cylinder opposite the cap 212 so that as the cylinder extends and retracts the track 285 engages the wheel 283 to move the valve 262 to thereby produce a change in the speed of extension and retraction of the cylinder. It is apparent that the device of FIG. 8 does not depend on pressure changes to control the speed and with a proper selection of the track 285 the fast- and slow-speed portions of travel can be regulated as desired. Also if desired the track 285 could be replaced by a suitable rotatable cam.

FIG. 9 illustrates a preferred embodiment of the present invention similar to those described above but in which a sequence valve built into the cylinder regulates fluid flow between the chambers to provide two speed regulation with maximum thrust produced at slow speed while the cylinder is extending and standard thrust at the faster of the two extending speeds. In the particular embodiment shown the cylinder retracts at one speed.

The cylinder of FIG. 9 is quite similar in construction to the cylinder illustrated in FIG. 1 except that the passage 44 formed in the piston rod 20 extends completely through the rod 20 to connect the port 42 with the chamber 27. The various passages and valves carried by the pistons 22 and 30 in the FIG. 1 embodiment to connect the chambers 34, 38 and 27 have been eliminated and these have been replaced by a sequence valve assembly 80 carried within the cap member 12. The sequence valve assembly 80 controls communication between port 42 and a passage 82 formed in the cap 12 and a chamber 84 formed by the outer tubular member 10 intermediate the cap 12 and the piston 28.

The sequence valve assembly 80 as can best be seen in FIG. 10 comprises a valve member 90 urged by a spring 92 to a position closing communication between the port 42 and the passage 82. The valve member 90 is hollow and is provided with a central opening 94 registering directly with the chamber 84. The opening 94 is normally closed by a ball valve 96 carried within the valve member 90 and urged toward the closed position by a spring 98. The valve member 90 is provided with circumferential ports 100 opening to the center of the valve member 90. The ports 100 connect with the port 42 and upon movement of the valve member 90 to the left also connect with the passage 82.

The chambers 27 and 84 expand and the chambers 34 and 38 contract as the fluid cylinder extends and providing fluid under pressure to both the chambers 27 and 84 during extension will reduce the speed of extension because one-half of the fluid will be delivered to each of the chambers 27 and 84. The sequence valve assembly 80 is operable to remain closed during the first portion of its stroke so that fluid is delivered under pressure from the port 42 to the chamber 27 to produce fast extension. During this period of operation nonpressurized fluid is drawn from the reservoir 101 through a check valve 103, and a third port (not shown) to fill the chamber 84. If desired this nonpressurized fluid could be drawn from the contracting chamber by way of port 36. As the cylinder reaches the end of its stroke and pressure begins to build up in chamber 27 this pressure acts upon the valve members 90 and 96 by way of port 42 to move the valve member 90 to the left and open communication between port 42 and chamber 84 to thereby provide the remaining extension at slow speed. The ball valve 96 permits fluid to exhaust from chamber 84 and through port 42 when the chamber 84 is contracting during retraction of the cylinder.

It is apparent that a number of fluid cylinders have been disclosed which like those disclosed and claimed in the aforementioned patent and patent application utilize a telescoping construction to produce improved means of providing balanced operation and maximum thrust within given diameter limitations. The present invention adds to these improvements constructions which produce, either selectively or automatically, two-speed operation. The particular manner of achieving this result maintains substantially equal intake and exhaust flow rates and in a number of the embodiments permits multiple speed retraction, an operation which with conventionally constructed fluid cylinders has been difficult to achieve.

It is also apparent that although we have described a number of preferred embodiments and preferred modifications of the present invention many changes and modifications can be made therein without departing from the spirit of the invention as expressed by the scope of the appended claims.

We claim:

1. A fluid cylinder comprising a first tubular member, a piston mounted for reciprocal movement within said first tubular member to divide the interior thereof into a first chamber and a second chamber, a rod member having one end connected to said piston for movement therewith and an opposite end extending exteriorly of said second chamber, a second tubular member telescopically received by said first tubular member and spaced therefrom to define a third chamber, said second tubular member being so connected to said piston to produce relative movement of said first and second tubular members resulting in said third chamber contracting upon contraction of said second chamber and said third chamber expanding upon expansion of said second chamber, means closing the ends of said inner and outer tubular members, means for providing fluid pressure and exhausting fluid from said chambers, the improvement comprising valve means carried within said fluid cylinder connected with said chambers to vary fluid flow to said chambers and fluid exhaust from said chambers in a manner which varies the rate of expansion of at least one of said chambers intermediate its fully contracted and fully expanded positions.

2. The fluid cylinder as defined in claim 1, and in which said valve means is normally operable to block fluid flow to one of said chambers during expansion and to supply fluid flow to that chamber upon being actuated.

3. The fluid cylinder as defined in claim 1 and including a fourth chamber defined by said closing means, said fourth chamber expanding and contracting with said first chamber in which said valve means is normally operable to block fluid pressure to one of said chambers during expansion and to supply fluid pressure to that chamber upon a predetermined pressure being produced in the corresponding expanding chamber.

4. The fluid cylinder as defined in claim 1, and in which said valve means are disposed intermediate said first chamber and said second chamber, said valve means being normally open during initial expansion of said first chamber and being operable to close at a predetermined pressure being produced in said first chamber to reduce the rate of expansion of said first chamber.

5. The fluid cylinder as defined in claim 1, and in which said valve means connects said first and second chambers during initial expansion of said first chamber, moves to a position isolating said first chamber from said second chamber and exhausting said second chamber upon a predetermined expansion of said first chamber.

6. The fluid cylinder as defined in claim 1, and in which said valve means is operable to connect one of said second and third chambers to said fluid pressure source and the other to exhaust during initial expansion of said second and third chambers and to connect said chambers together after a predetermined expansion of said second and third chamber.

7. A fluid cylinder as defined in claim 1, and in which said valve means are disposed intermediate said first, said second and said third chambers and are operable in one position to open fluid communication between said first and second chamber during initial expansion of said first chamber and upon a predetermined pressure increase in said first chamber to a position closing communication between said first and second chamber and opening communication between said second and third chambers.

8. The fluid cylinder as defined in claim 7, and in which said valve means are further operable upon a predetermined increase in the pressure in said third chamber to close communication between said first and second chambers and to open communication between said second and third chambers.

9. The fluid cylinder as defined in claim 7, and including means for selectively actuating said valve means to close communication between said first and second chambers and to open communication between said second and third chambers regardless of the position of said valve means to thereby vary the rate of expansion of said chambers.

10. The fluid cylinder as defined in claim 1, and in which said valve means are disposed intermediate said first, second and third chambers and are operable in one position to open fluid communication between said first chamber and said second chamber upon expansion of said first chamber to a predetermined position and are selectively operable to move to a position closing communication between said first and second chambers and opening communication between said second and third chambers.

11. A fluid cylinder as defined in claim 1, and including a fourth chamber defined by said closing means, said fourth chamber expanding and contracting with said first chamber, in which said valve means comprises a normally closed valve member disposed intermediate said first and said fourth chambers and operable upon a predetermined expansion of one of said chambers to open to thereby reduce the rate of expansion of said chambers.

12. A fluid cylinder comprising a first tubular member, a piston mounted for reciprocal movement within said first tubular member to divide the interior of said first tubular member into a first chamber and a second chamber, a rod member having one end connected to said piston for move-

ment therewith and an opposite end extending exteriorly of said second chamber, a second tubular member telescopically received by said first tubular member and spaced therefrom to define a third chamber, said second tubular member being so connected to said piston to produce relative movement of said first and second tubular members resulting in said third chamber contracting upon contraction of said second chamber, and said third chamber expanding upon expansion of said second chamber, means closing the ends of said inner and outer tubular members, means for providing pressure fluid and exhausting pressure fluid from said chambers, the improvement comprising first valve means carried by said rod member, said first valve means being operable in a first position to prevent fluid communication between said first and second chambers when said first chamber is provided with said pressure fluid and operable in a second position to open

fluid communication between said first and second chambers when said pressure fluid is exhausted from said first chamber, whereby a portion of the pressure fluid in said first chamber is exhausted to said second chamber and another portion of said fluid pressure in said first chamber is exhausted through said fluid exhausting means; and second valve means being operable in a first position to open fluid communication between said second and third chambers when said first chamber is provided with said pressure fluid, and operable in a second position to close fluid communication between said second and third chambers when said fluid is exhausted from said first chamber, whereby the rate of contraction of said first chamber is less than the rate of expansion of said first chamber.

20

25

30

35

40

45

50

55

60

65

70

75

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,592,108 Dated July 13, 1971

Inventor(s) Borje O. Rosaen

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 6, delete "664,454" and insert --660,454--.

Column 1, line 24, after "and" insert --a--.

Column 2, line 10, after "different" delete "operation
and insert --operative--.

Signed and sealed this 11th day of January 1972.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Acting Commissioner of Patents