United States Patent

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[54] **MULTIPLE-CYLINDER TELESCOPIC ACTUATOR**
7 Claims, 3 Drawing Figs.

[52] **U.S. Cl.** **91/167,** 91/173, 92/108, 92/110
[51] **Int. Cl.** **F01b 7/20,** F15b 11/18
[50] **Field of Search** 91/173, 168, 167; 92/108

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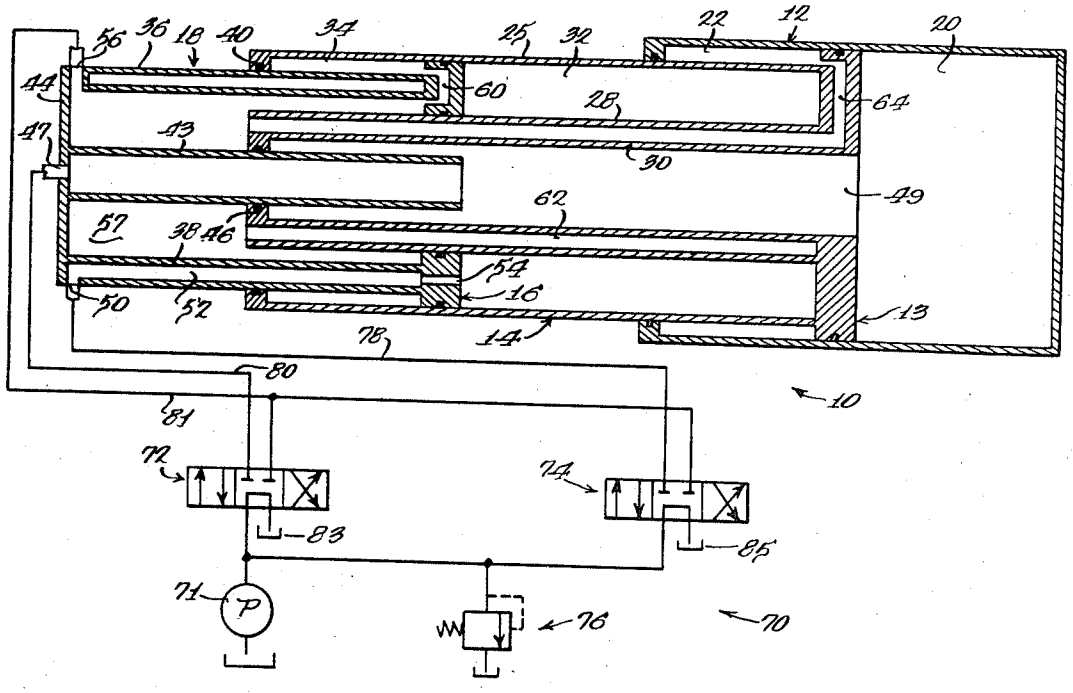
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ABSTRACT: A hydraulic actuator of the type having multiple pistons and cylinders with porting and passages being provided so that each telescopic section may be selectively extended with respect to the others and also including porting and passages for selectively retracting each section with respect to the others.



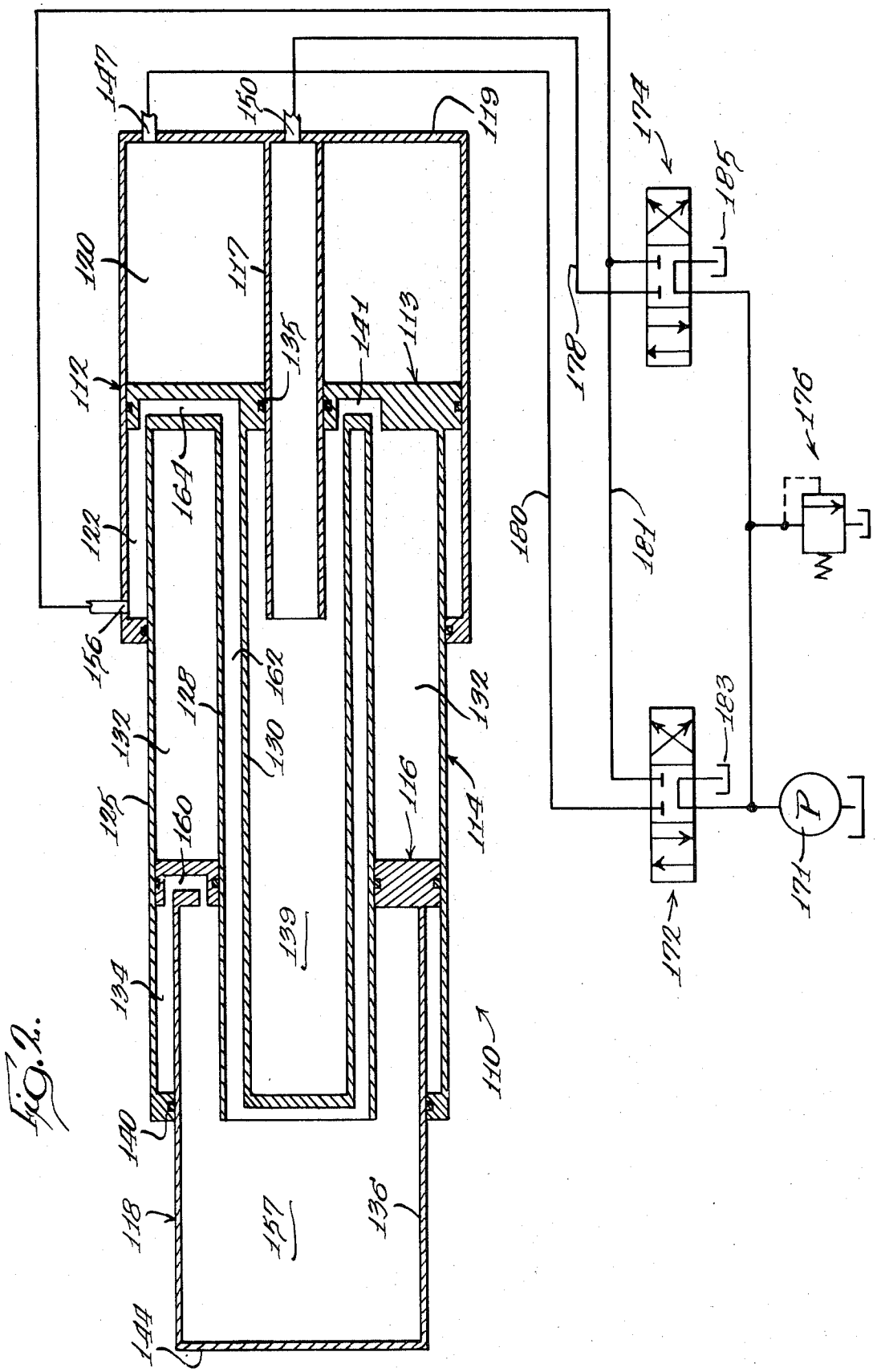

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Fig. 2.

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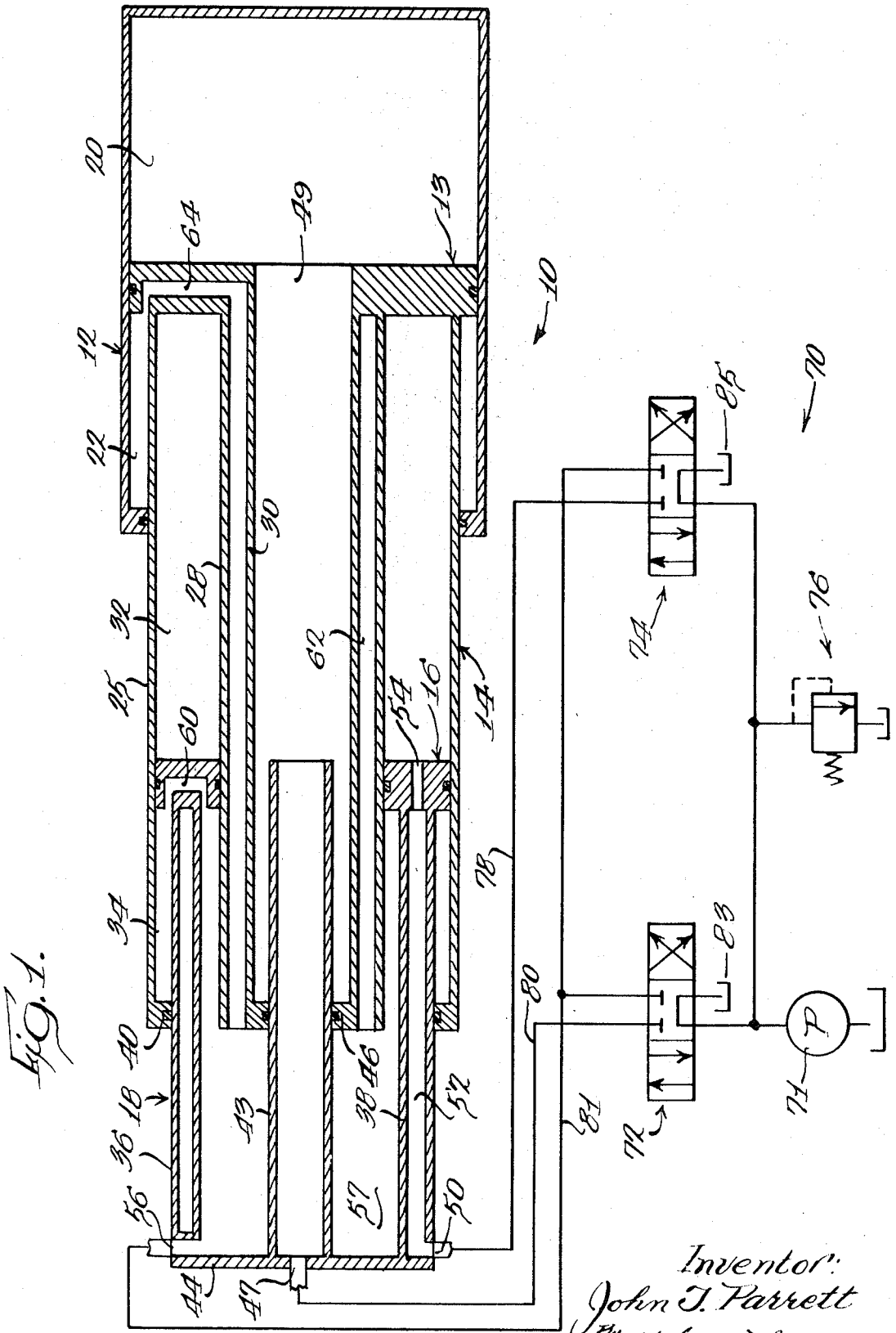


Fig. 1.

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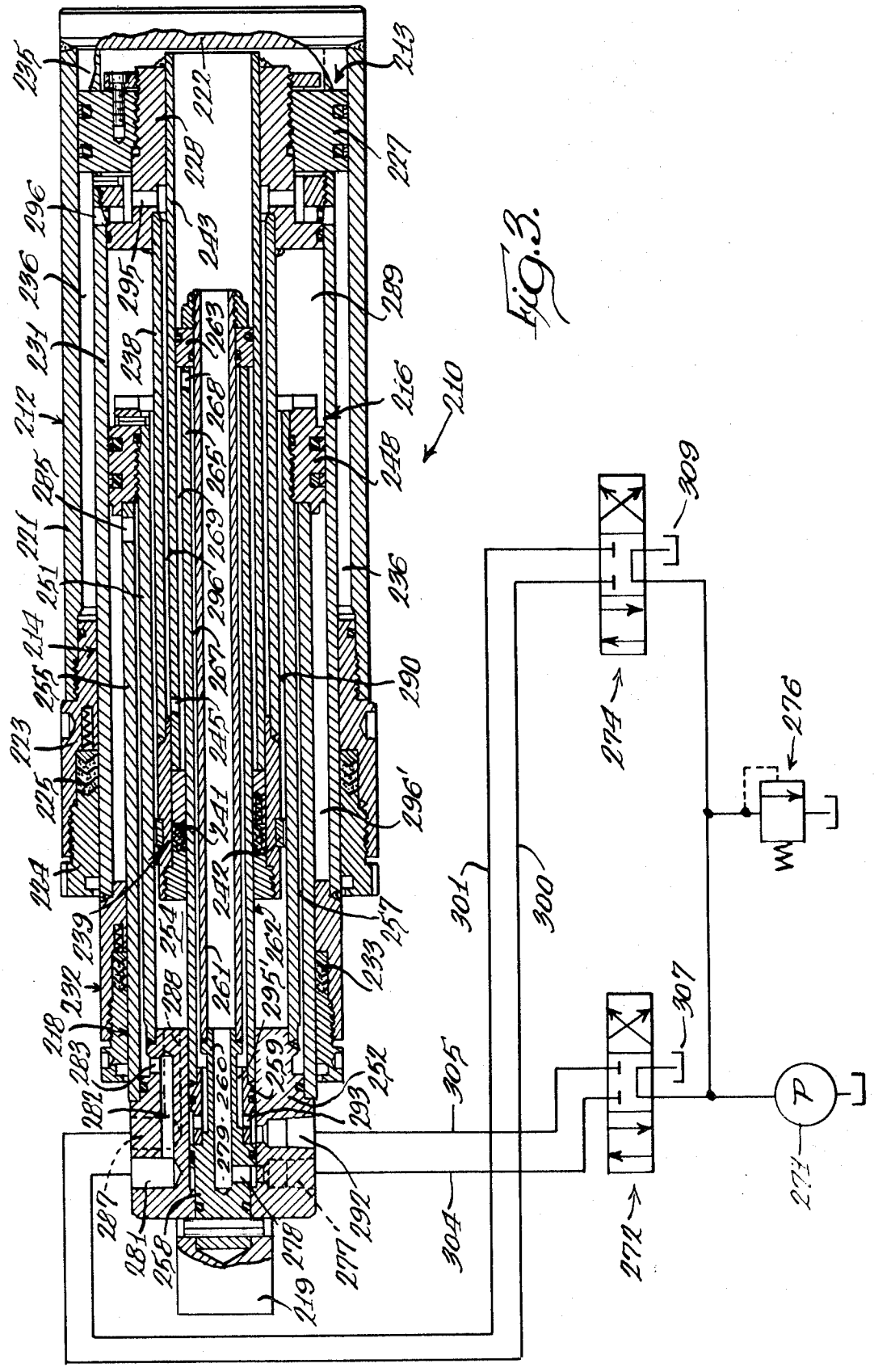


Fig. 3.

MULTIPLE-CYLINDER TELESCOPIC ACTUATOR

BACKGROUND OF THE PRESENT INVENTION

The present invention relates to telescopic hydraulic actuators of a general type known in the prior art. These actuators include a primary cylinder assembly which receives a primary piston having a rod extending from the primary cylinder. This rod defines a secondary cylinder for a secondary piston also having a rod projecting therefrom. If the telescopic cylinder is rod fed, suitable ports are provided on the projecting end of the secondary rod for selectively delivering fluid to and from the actuator. If the actuator is cylinder fed, then supply and return ports are provided on the primary cylinder for selectively delivering fluid to and from the actuator. Of course, in the latter case the primary cylinder would be the stationary member of the actuator while in the former case the projecting rod would be the stationary member of the actuator.

In these prior actuators various tubing and passages are provided between the sections for communicating the ports with the common sides of the two pistons. That is, one port would be connected to supply and return fluid relative to the rod sides of both pistons and the other port would be connected to supply and return fluid selectively to the other sides of both pistons, it being understood that the pistons are pressurized simultaneously in these prior constructions.

With this arrangement the actuator assembly will extend and retract step by step, section by section, depending upon the area and the volume of fluid required to extend or retract each section. Thus, they extend or retract in a predetermined sequence that cannot be controlled by the operator. However, it is desirable in many cases that the operator be able to control the extension and in some cases the retraction of each section independently of the other sections. For example, in some cases it might be desirable to extend only the second section while at other times it might be desirable to extend only the primary section, and such an alternative is not possible in prior known telescopic cylinder constructions.

SUMMARY OF THE PRESENT INVENTION

In accordance with the present invention, a multiple-piston telescopic hydraulic actuator is provided having primary and secondary sections, either of which may be extended independently of the other. Provision is also made for independently retracting either of the sections if desired. Independent extension is achieved by providing separate supply ports in either the projecting rod or the primary cylinder, depending on whether the actuator is rod fed or cylinder fed, communicating through independent passages to supply hydraulic fluid to the extending sides of each of the pistons. The passages are defined in part by telescopic feed tubes for supplying fluid to one of the piston surfaces and annular passages in one of the rods for supplying fluid to the extending surface of the other piston.

In two embodiments a third port is provided communicating with the rod sides of both pistons through annular passageways for selectively retracting each section when desired. In a third embodiment, two additional ports are provided for selectively retracting, if desired, either the primary and secondary sections independently.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a longitudinal section of a rod-fed hydraulic actuator according to the present invention shown in conjunction with a schematic hydraulic circuit;

FIG. 2 is a longitudinal section of a hydraulic cylinder assembly according to the present invention which is cylinder fed shown with a schematic hydraulic circuit; and

FIG. 3 is a longitudinal section of a modified rod-fed hydraulic cylinder assembly shown with a hydraulic circuit.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the embodiment shown in FIG. 1, a rod-fed telescopic hydraulic cylinder assembly **10** is seen to consist generally of a primary cylinder **12**, a primary piston **13**, a secondary cylinder **14**, a secondary piston **16**, and a secondary rod **18**. The piston **13** is slidably received in the interior of primary cylinder **12** and defines therein with secondary cylinder **14** a first fluid chamber **20** in the second rod and fluid chamber **22**.

Projecting from the piston **13** is a rod or sleeve **25** that defines part of the secondary cylinder **14**. Concentrically disposed with rod or sleeve **25** is sleeve **28** fixed with respect to piston **13** and projecting therefrom the same length as rod **25** along with still another concentric inner rod or sleeve **30** within sleeve **28**. The cylinder **14** is defined by the sleeve **25** and sleeve **28**. Slidable in cylinder **14** is piston **16** which is annular in configuration and which slidably engages the interior of tube **25** and the exterior of tube **28**. Piston **16** defines the fluid chamber **32** and rod end fluid chamber **34** within cylinder **14**. Projecting from the piston **16** and defining a portion of the rod **18** are concentric sleeves **36** and **38**. Sleeve **36** slidably engages an annular radial projection **40** on the end of sleeve **25** for the purpose of providing a sealed end to the chamber **34**.

Also forming a part of the rod assembly **18** is the feed tube **43** which extends inwardly from an end cap member **44** and which slidably and sealingly engages a radial inward projection **46** on the end of tube **30** defining a portion of the rod assembly associated with piston **13**.

A port **47** is provided centrally in end cap **44** communicating with the interior of tube **43**. Port **47** communicates with chamber **20** through the interior of tube **43**, the interior of sleeve **30** and through central opening **49** in the piston **13**.

For the purpose of supplying hydraulic fluid to the chamber **32** to extend the secondary section or cylinder **14**, a port **50** is provided adjacent the end of rod assembly **18**. Port **50** communicates with an annular passage **52** in rod **18** defined between the sleeves **36** and **38**. Passage **52** communicates with chamber **32** in cylinder **14** through a plurality of axial passages **54** in piston **16**.

For the purpose of retracting the cylinders **12** and **14**, a third port **56** is provided adjacent the end of rod **18** and communicating with a chamber **57** defined between the sleeve **38** and the tube **43**. Chamber **57** communicates with the rod end chamber **34** associated with the cylinder **14** through a plurality of U-shaped passages **60** in the piston **16**. At the same time chamber **57** communicates with the rod end chamber **22** associated with cylinder **12** through an annular passage **62** defined between the sleeves **28** and **30** and opening to the chamber **57**. Annular passage **62** communicates with chamber **22** through a plurality of generally U-shaped passages **64** in piston **13**. Thus, when port **56** is pressurized both rod end chambers **22** and **34** will be pressurized.

For the purpose of supplying fluid to the actuator assembly **10** and for the purpose of selectively controlling extension and retraction of the cylinders **12** and **14** a hydraulic circuit **70** is provided consisting generally of a supply pump **71**, a primary cylinder control valve **72** and a secondary cylinder control valve **74**. The valves **72** and **74** are identical in construction and are known in the art as closed-center four-way control valves. A pressure relief valve **76** is provided communicating with the outlet of pump **71** for controlling the maximum pressure delivered to the actuator **10**.

With the valves **72** and **74** in their closed-center position shown in FIG. **1**, fluid flow will be blocked relative to the actuator **10** and the cylinders **12** and **14** will remain in the positions shown in FIG. **1**. It should be understood that each of the cylinders **12** and **14** as shown in FIG. **1** are partially extended.

To extend the primary cylinder **12** without extending the secondary cylinder **14**, the secondary cylinder control valve

74 is placed in the central blocking position shown which blocks flow in passage 78 in either direction. This blocks flow relative to port 50 communicating chamber 32 locking the cylinder 14 with respect to the piston 16.

At the same time the valve 72 is shifted to the right communicating passages 80 with the pump 71 and communicating passage 81 with a suitable tank 83. Port 47 is thus pressurized and hydraulic fluid is delivered through the interior of tube 43, the interior of sleeve 30 into chamber 20 causing the cylinder 12 to extend to the right until it reaches its furthestmost position with respect to piston 13 or until the operator moves the valve 72 back to the neutral blocking position. During the extension of cylinder 12 the hydraulic fluid in the rod chamber 22 of cylinder 12 is expelled through passages 64, annular passage 62, chamber 57, port 56 and passage 81 across valve 72 to tank 83.

If it is desired that the secondary cylinder 14 be extended without the primary cylinder 12, the primary control valve 72 is placed in its closed center position shown in the drawing and the control valve 74 is shifted to its right position. Thus, valve 72 in this position blocks flow in line 80 and prevents flow relative to chamber 20 and thereby prevents extension and retraction of the primary cylinder 12 with respect to piston 13. At the same time, line 78 is pressurized by the pump 71 across control valve 74 delivering fluid to port 50. Fluid from port 50 flows through the annular passage 52 in rod 18 and through axial passages 54 into the extension chamber 32 associated with the secondary cylinder 14. This causes extension of the secondary cylinder 14 relative to the piston 16. For the purpose of accommodating contraction of rod end chamber 34 at this time fluid in this chamber is expelled from passages 60, chamber 57, port 56 and line 81 across control valve 74 to tank 85.

For retracting both primary and secondary cylinders 12 and 14 both of the control valves 72 and 74 are shifted to their left positions pressurizing line 81 and communicating lines 78 and 80 to tanks 85 and 83, respectively. This pressurizes port 56 supplying fluid to the rod chamber 34 through passages 60 in piston 16 and to the primary rod end chamber 22 though annular passages 64 and passage 62 in piston 13. The primary and secondary cylinders will thus sequentially retract.

To retract the primary cylinder 12 independently of secondary cylinder 14, valve 72 is shifted to the left and valve 72 is placed in its center blocking position. This pressurizes both chambers 34 and 22 retracting cylinder 12, but cylinder 14 is prevented from retracting because chamber 32 is blocked by valve 74 through line 78.

To retract the secondary cylinder 14 independently of the primary cylinder 12, valve 74 is shifted to the left and valve 72 is placed in its center blocking position. This pressurizes both chambers 34 and 22 retracting cylinder 14, but cylinder 12 is prevented from retracting because chamber 20 is blocked by valve 72 through line 80.

The second embodiment of the present invention illustrated in FIG. 2 is substantially the same as the hydraulic actuator illustrated in FIG. 1 from a functional standpoint, but it differs primarily in that it is a cylinder-fed actuator. The actuator is designated 110 in FIG. 2 and consists generally of a primary cylinder 112 which is adapted to be the stationary element of the actuator, a primary piston 113 slidable in the cylinder 112, a secondary cylinder 114 defined by the rod associated with the cylinder 113, a secondary piston 116 slidable in the cylinder 114 and a secondary rod 118 projecting from the piston 116.

The primary cylinder 112 has a central feed tube 117 fixed to end wall 119 thereof. Piston 113 defines chambers 120 and 122 in the cylinder 112 with the rod or cylinder 114.

Extending from the piston 113 and defining the cylinder 114 are sleeves 125 and 128 concentrically disposed. Slidable between sleeves 125 and 128 is piston 116 which is annular in configuration and slidably engages the interior of sleeve 125 and the exterior of sleeve 128. Also projecting from the piston 113 is a closed-ended tube 130 which is approximately the same length as sleeve 128.

Projecting from the annular piston 116 is sleeve 136 which defines part of the rod 118. Sleeve 136 is closed with an end cap 144. Annular projection 140 on sleeve 125 seals sleeve 136 and chamber 157.

For the purpose of pressurizing chamber 120 of the primary cylinder 112, port 147 is provided in the end wall 119 of cylinder 112.

For the purpose of pressurizing the extending chamber 132 associated with secondary cylinder 114, a port 150 is provided centrally disposed in end wall 119. Port 150 communicates with chamber 132 through the interior of tube 117, which is slidably received in a central opening 135 in piston 113. The interior of tube 117 communicates with chamber 139 within tube 130 and passages 141 in the piston 113 which in turn communicate with the chamber 132.

The rod ends of both the primary cylinder 112 and the secondary cylinder 114 communicate with the port 156. The port 156 is located at the left end of cylinder 112 and directly communicates with chamber 122. Chamber 122 communicates with chamber 134 associated with the secondary cylinder 114 through U-shaped passages 164 which communicate with an annular passage 162 defined between the sleeves 128 and 130. Annular passage 162 communicates with closed chamber 157, and this chamber in turn communicates with rod end chamber 134 through the U-shaped passages 160.

In operation and for the purpose of extending the primary piston 113 with respect to the primary cylinder 112, the latter of which is generally stationary in the use of the actuator shown in FIG. 2, valve 172 is shifted to the right and valve 174 remains in the position shown in the drawing. Fluid valve 174 thus blocks fluid relative to line 178 which prevents the flow of fluid either to or from chamber 132 thereby locking the piston 116 with respect to the cylinder 114. At the same time with valve 172 shifted to the right line 180 is pressurized and line 181 is connected to tank 183. Fluid thus flows from pump 171 under pressure through port 147 into chamber 120 causing extension of the piston 113 and cylinder 114. Fluid in rod end chamber 122 escapes through port 156 and line 181 across valve 172 to tank 183.

If independent extension of piston 116 and rod 118 is desired, valve 172 is placed in the blocking position shown in FIG. 2 and valve 174 is shifted to the right. Valve 172 thus blocks flow through line 180 and prevents the flow of fluid to and from chamber 120 locking piston 113 in the position shown in the drawing.

At the same time, fluid is ported across valve 174 from the pump 171 through line 178 to port 150. Fluid flows from port 150 through tube 117, chamber 139, and passages 141 into the secondary cylinder chamber 132. This causes the extension of piston 116 and rod 118. Fluid in the contracting rod end chamber 134 at this time escapes through passages 160, chamber 157, annular passage 162, passages 164, chamber 122, port 156, line 181 and across valve 174 to tank 185.

If retraction of the actuator is desired, both valves 172 and 174 are placed in their left position, pressurizing line 181 and communicating lines 180 and 178 with tanks 183 and 185, respectively. This pressurized port 156 which in turn delivers fluid to rod end chamber 122 and rod end chamber 134 through passages 164, annular passage 162, chamber 157 and passages 160. The cylinder 114 and the rod 118 will then sequentially retract into the main primary cylinder 112.

To retract the primary cylinder 112 independently of the secondary cylinder 114, valve 172 is shifted to the left and valve 174 is placed in its center blocking position. This pressurizes both chambers 162 and 134 retracting cylinder 112, but cylinder 114 is prevented from retracting because chamber 132 is blocked by valve 174 through line 178.

To retract the secondary cylinder 114 independently of the primary cylinder 112, valve 174 is shifted to the left and valve 172 is placed in its center blocking position. This pressurizes both chambers 162 and 134 retracting cylinder 114, but cylinder 112 is prevented from retracting because chamber 120 is blocked by valve 172 through line 180.

A relief valve 176 is provided communicating with the pump outlet for similar purpose to the valve 76 in the FIG. 1 embodiment.

As may be seen in FIG. 3, a rod-fed telescopic actuator assembly 210 is provided generally consisting of a primary cylinder 212, a primary piston 213, a secondary cylinder 214, defined by the rod associated with piston 213, a secondary piston 216, and a rod assembly 218 associated with the secondary piston 216. Fixed to the projecting end of rod 218 is a boss 219 which is employed to fasten the end of the actuator to a stationary portion of the associated equipment.

The primary cylinder 212 consists of the cylindrical sleeve 221 having a closed right end cap 222 fastened thereto and two externally threaded rings 223 and 224 at the left end thereof which encapsulate a seal 225 sealingly engaging the rod assembly, or secondary cylinder 214 defined thereby.

Piston assembly 213 includes an annular piston member 227 slidably engaging the interior of sleeve 221 and threaded onto a flanged annular sleeve 228. The flanged ring 228 carries at its flanged portion a sleeve 231 which defines a portion of the cylinder 214. Piston 213 defines fluid chambers 235 and 236 in the primary cylinder 212. At the other end of sleeve 231 is a ring assembly 232 which includes a seal 233 sealingly engaging the outside of rod assembly 218.

Also supported within the annular ring 228 and concentrically disposed within the sleeve 231 is sleeve 238 which has fixed to the end thereof a fitting assembly 239 carrying a seal 241 and an alignment ring 242 which guides the sleeve 238 within the rod assembly 218. Ring 242 permits the free flow of fluid thereacross for a purpose described hereinafter.

There is also provided another sleeve 243 fixed to the ring 228 concentrically disposed with respect to sleeve 238 and located therewithin. This latter sleeve is fixed at its other end to the fitting assembly 239 and has a plurality of openings 245 at the left end thereof which provide communication between a chamber 246 formed between the sleeves 238 and 243.

The piston assembly 216 is seen to consist of an annular member 248 having piston rings slidably engaging the interior of sleeve 231. Piston member 248 is threaded on and rotatably fixed to a sleeve 251 which defines a portion of the rod assembly 218. The other end of sleeve 251 is fixed to a porting end cap 252. Sleeve 251 is slidably engaged by ring 242 and defines a chamber 254 therewith. Outwardly of sleeve 251 but concentrically disposed with respect thereto is another sleeve 255 fixed at its right end to piston member 248 and at its left end to the stepped fitting cap or porting cap 252. Sleeve 255 is also part of the rod assembly 218 and defines an annular passage 257 with the sleeve 251. Cylindrical porting members 258 and 259 are seated centrally within the porting cap 252. Porting member 258 has an annular extension 260 which has fixed thereto a sleeve 261 forming a part of a feed tube assembly 262. The sleeve 261 is threaded at its outer end and carries an annular feed tube piston member 263 which slidably and sealingly engages sleeve 243. Fixed to the piston 263 and also forming part of the feed tube assembly 262 is another sleeve 265 which is concentric with respect to the sleeve 261 and is fixed at its left end to the porting member 259 within porting cap 252. The sleeves 261 and 265 define therebetween an annular passage 267 which communicates through an opening 268 in sleeve 265 with passage 269 between sleeves 265 and 243.

For extending the primary cylinder 212 a port 277 is provided in porting cap 252. Port 277 communicates with the interior of sleeve 261 through a radial passage 278 in the port member 258 and an axial passage 279 therein. Axial passage 279 freely communicates with the interior of sleeve 261 which in turn communicates with the interior of sleeve 243 and the latter sleeve opens directly into the primary cylinder chamber 235.

For extending the secondary cylinder 214 another port 287 is provided in end cap 252. Port 287 communicates through an axial passage 288 in end cap 252 with chamber 254. Chamber 254 in turn communicates freely with the secondary cylinder chamber 289 through annular passage 290 defined between the sleeves 251 and 238.

For the purpose of retracting the primary cylinder 212, port 292 is provided in end cap 252. Port 292 communicates with annular passage 267 through a radial passage 293 in port member 259 and a recessed portion 295' on port member 258.

Annular passage 267 communicates with annular passage 269 through ports 268. Annular passage 269 communicates with annular passage or chamber 246 through ports 245. Annular passage 246 communicates with the main cylinder rod and chamber through radial passages 295 in ring 228 and openings 296 in sleeve 231.

For the purpose of retracting the secondary cylinder 214, a port 281 is provided. The port 281 communicates with annular passage 257 through axial passage 282 and radial passage 283 in port member 252. Annular passage 257 in turn communicates with rod chamber 296' associated with the secondary cylinder 214 through openings 285 in sleeve 255.

A control circuit is provided for conveying fluid selectively to the various ports 277, 279, 281, 292 of the actuator 210 to selectively extend each section of the actuator and to selectively retract each section. To extend the primary cylinder 212 valve 272 is placed in its right position and valve 274 is placed in the blocking position shown on the drawing. It should be understood that the valves 272 and 274 are identical in construction to the corresponding valves shown in the FIGS. 1 and 2 embodiments.

With valve 274 in its blocking position shown both lines 300 and 301 will be blocked and these communicate respectively with the ports 287 and 281. The blockage of flow relative to port 282 blocks flow relative to secondary cylinder chamber 289 while the blockage of flow relative to port 281 prevents flow into or out of the rod end chamber 296' associated with the secondary cylinder 214.

At the same time with valve 272 in its right position line 304 is pressurized and line 305 communicates with tank 307. Line 304 delivers fluid to port 277 which in turn supplies fluid through passage 279 and the interior of sleeves 261 and 243 to the main cylinder chamber 235. This causes extension of cylinder 212. As cylinder 212 extends, chamber 236 contracts and fluid is expelled therefrom through openings 296, radial passages 295, annular passage 246, annular passage 269, annular passage 267, radial ports 293, port 292, and line 305 to the tank 307.

If independent retraction of the main cylinder 212 is desired, valve 274 remains in the position shown in the drawing and valve 272 is shifted to its leftmost position pressurizing line 305, and communicating line 304 with tank 307. The pressurization of port 292 causes rod end chamber 236 to be supplied with fluid from pump 271 causing the retraction of cylinder 214. This contracts chamber 235 and fluid is expelled therefrom through port 277, through passage 304 and across valve 272 to the tank 307.

For the selective and independent extension of the secondary cylinder 214, the valve 272 is placed in the blocking center position shown and the valve 274 is shifted to its right position pressurizing line 300 and connecting line 301 to tank 309. With valve 272 in its blocking position, flow relative to ports 277 and 292 is blocked, blocking any flow to or from the main cylinder chambers 235 or 236 thereby locking cylinder 212 with respect to the piston assembly 213.

At the same time with valve 274 in its right position flow from pump 271 will be delivered to the port 287 pressurizing the secondary cylinder chamber 289 through the annular passage 290. Cylinder 214 will thus extend relative to the piston assembly 216 contracting the rod end chamber 296' associated with the secondary cylinder 214. Fluid from the contracting chamber 296' is expelled through openings 285, port 281, line 301 and across valve 274 to the tank 309.

If independent retraction of the secondary cylinder 214 is desired, the valve 272 is placed in the position shown in the drawing and the valve 274 is shifted to its extreme left posi-

tion. This will pressurize line **301** and connect line **300** to tank **309**. With the pressurization of line **301**, fluid from pump **271** will be ported to port **281** and from there through annular passage **257** and openings **285** to the rod end chamber **296'**. This will cause retraction of the cylinder **214** relative to the piston **216**. Chamber **289** will contract under these conditions expelling fluid through passage **288** and port **287**, through passage **300** and across valve **274** to tank **309**. As in the other embodiments, a pressure relief valve **276** provided at the pump outlet is shown.

The cylinders **212** and **214** may also be retracted by the simultaneous pressurization of chambers **236** and **296'**. This is effected by shifting both valves **272** and **274** to their right positions.

I claim:

1. A hydraulic actuator assembly, comprising: first cylinder means, first piston means slidable in said first cylinder means and defining fluid chambers on the opposite sides of the first piston means, first rod means extending axially from said first piston means, said first rod means defining a second cylinder means, second piston means slidable in said second cylinder means and defining fluid chambers on the opposite sides of the second piston means, second rod means extending axially from said second piston means, and control means for selectively moving said first piston means relative to said first cylinder means or said second piston means with respect to said second cylinder means including first valve means for selectively porting fluid under pressure to one of the chambers associated with the first piston means and connecting the other to drain, and second valve means for selectively porting fluid under pressure to one of the chambers associated with the second piston means and connecting the other to drain, said second valve means blocking flow relative to one of the chambers associated with the second piston means when the first valve means is porting fluid under pressure to one of the chambers associated with the first piston means, said first valve means blocking flow relative to one of the chambers associated with the first piston means when the second valve means is porting fluid to one of the chamber associated with the second valve means.

2. A hydraulic actuator assembly, comprising: first cylinder means, first piston means slidable in said first cylinder means and defining first and second fluid chambers on the opposite sides of the first piston means, first rod means extending axially from said first piston means, said first rod means defining a second cylinder means, second piston means slidable in said second cylinder means and defining third and fourth fluid chambers on the opposite sides of the second piston means, second rod means extending axially from said second piston means, control means for moving said first piston means with respect to said first cylinder means without moving said second piston means with respect to said second cylinder means including means for simultaneously pressurizing said first and third chambers and for blocking flow relative to the fourth chamber, and control means for moving said second piston means with respect to said second cylinder means without moving said first piston means with respect to said first cylinder means including first valve means for selectively porting fluid under pressure to one of the chambers associated with the first piston means and connecting the other to drain, and second valve means for selectively porting fluid under pressure to one of the chambers associated with the second piston means and connecting the other to drain, said second valve means blocking flow relative to one of the chambers associated with the second piston means when the first valve means is porting fluid under pressure to one of the chambers associated with the first piston means, said first valve means blocking flow relative to one of the chambers associated with the first piston means when the second valve means is porting fluid to one of the chamber associated with the second valve means.

3. A hydraulic actuator assembly as defined in claim **2**, including means for extending or retracting the first piston means with respect to the first cylinder means or extending or retracting said second piston means with respect to said second cylinder means.

4. A hydraulic actuator assembly as defined in claim **2** wherein said moving means simultaneously pressurizes the rod ends of both of said piston means.

5. A hydraulic actuator assembly as defined in claim **2**, wherein said first and second valve means pressurizes the end of the first piston means opposite said first rod means without pressurizing the second piston means opposite the second rod means.

6. A hydraulic actuator assembly comprising: first cylinder means, first piston means in said first cylinder means, first rod means extending from said first piston means and defining a second cylinder means, second piston means slidable in said second cylinder means, second rod means extending from said second piston means, first port means in said first cylinder means adapted to be connected to a source of fluid under pressure, said first port means communicating with the side of said first piston means opposite said first rod means, second port means in said first cylinder means adapted to be connected to a source of fluid under pressure, tube means fixed with respect to said first cylinder means and communicating with said second port means, said tube means being slidable in said first piston means, and passage means in said first piston means continuously communicating with the interior of said tube means and the side of said second piston means opposite said second rod means.

7. A hydraulic actuator assembly comprising: first cylinder means, first piston means in said first cylinder means, first rod means extending from said first piston means and defining a second cylinder means, second piston means slidable in said second cylinder means, second rod means extending from said second piston means, first port means in said first cylinder means adapted to be connected to a source of fluid under pressure, said first port means communicating with the side of said first piston means opposite said first rod means, second port means in said first cylinder means adapted to be connected to a source of fluid under pressure, tube means fixed with respect to said first cylinder means and communicating with said second port means, said tube means being slidable in said first piston means, and passage means in said first piston means communicating with the interior of said tube means and the side of said second piston means opposite said second rod means, third port means in said first cylinder means adapted to be connected to fluid under pressure, said third port means communicating with the rod side of said first piston means, annular passage means in said first rod means communicating with the rod side of said first piston means, and passage means in said second piston means communicating said annular passage means with the rod side of said second piston means.