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J. T. PARRETT ET AL

3,483,798

TELESCOPIC HYDRAULIC ACTUATOR

Filed March 30, 1967

2 Sheets-Sheet 1

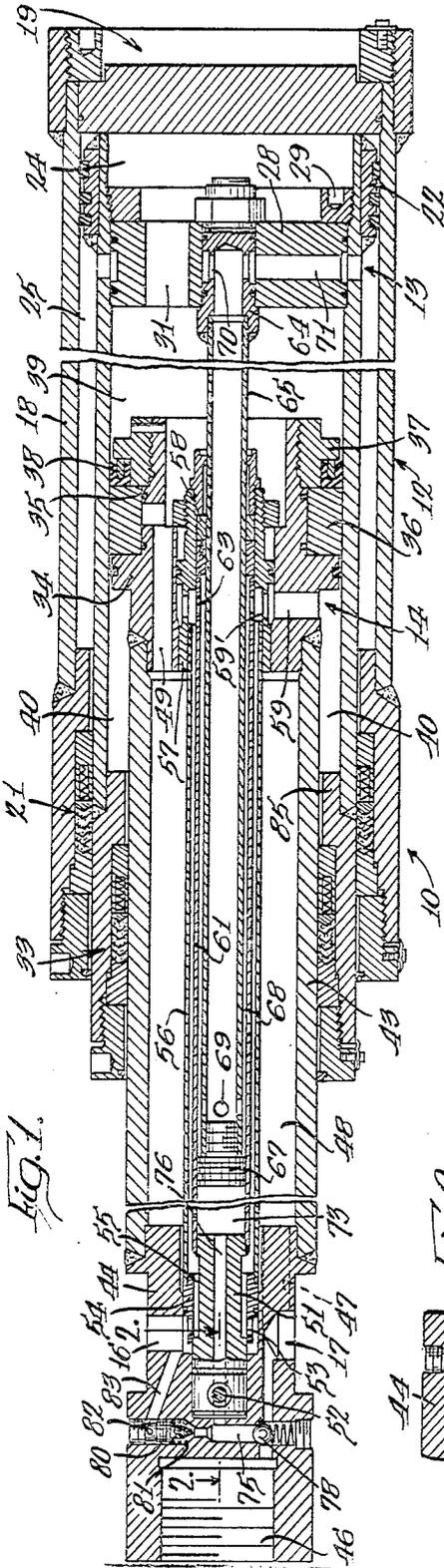


Fig. 1.

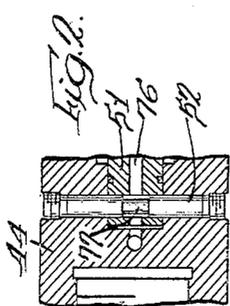


Fig. 2.

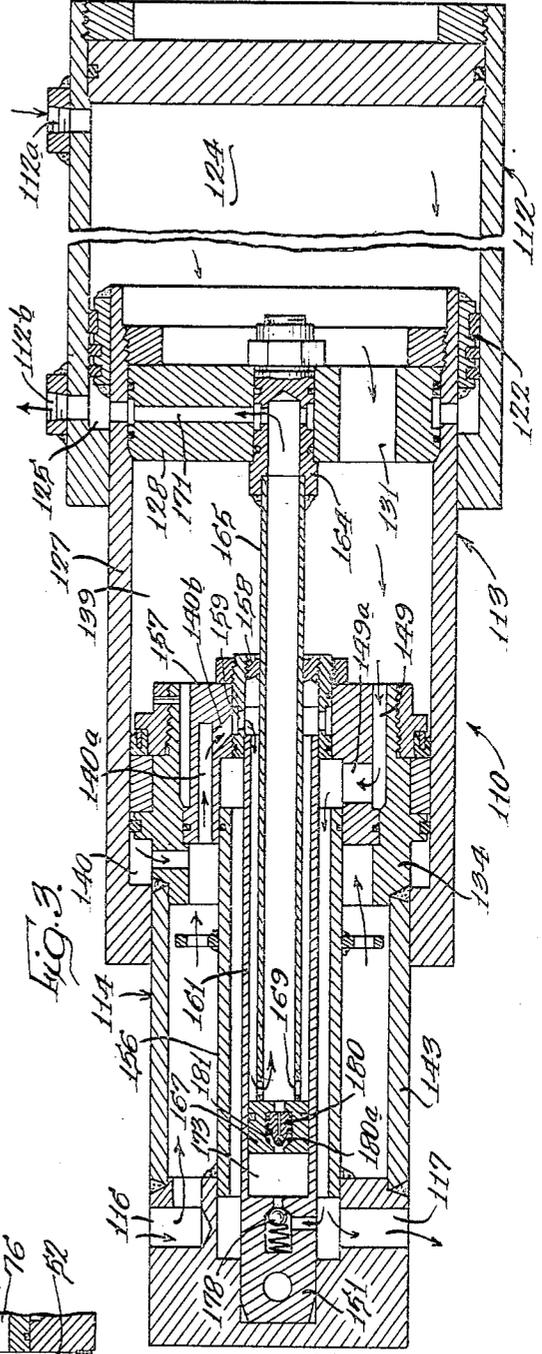


Fig. 3.

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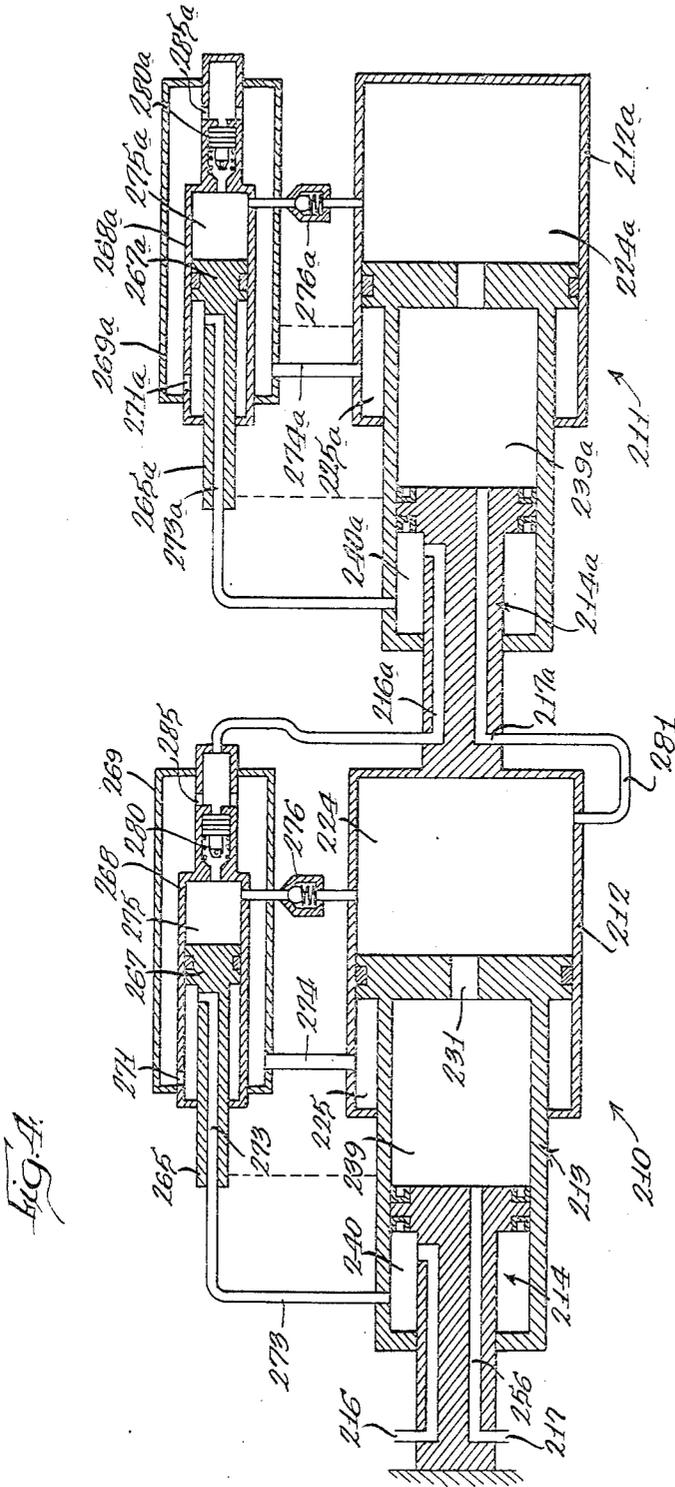
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2 Sheets-Sheet 2



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TELESCOPIC HYDRAULIC ACTUATOR

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18 Claims

ABSTRACT OF THE DISCLOSURE

A double acting telescopic hydraulic actuator having at least two pistons and two cylinders with feedlines for delivering fluid to the proper chambers during expansion and contraction, the feedlines having a piston and cylinder arrangement carried by the main piston and communicating with fluid pressure so that they are placed under tension rather than compression by the hydraulic fluid.

BACKGROUND OF THE INVENTION

Hydraulic actuators have been provided in the past for extending the telescopic sections of a mobile crane and other mobile equipment having extensible sections. One type of hydraulic actuator for this purpose includes telescopic piston and cylinder devices in which the larger piston has a rod which defines a cylinder for a smaller piston. Each piston defines opposed expanding and contracting fluid chambers in the associated cylinder so that upon porting fluid to one side of the pistons they sequentially extend, and upon porting fluid to the other side of the pistons they sequentially retract, thereby extending and retracting the associated boom.

It will be readily apparent that due to the relative movement of the telescopic fluid actuator sections there is a problem conveying fluid from one chamber to the other and from one end of the entire device to the other due to the relative movement between the parts.

SUMMARY OF THE INVENTION

In accordance with the present invention, telescopic feed tubes are provided interconnecting the rod end chambers which are pressurized during contraction of the boom and connected to drain during extension of the boom. The large chambers associated with each piston are interconnected by passages directly through the piston, thus permitting communication with the relatively movable larger chambers defined by the pistons.

As exemplified in one embodiment of the present invention a hydraulic feed tube is connected to the larger piston and extends within a tube fixed within the smaller piston serving to interconnect the chambers defined by the rod ends of the pistons. A further sleeve in the smaller piston communicates the feed tube with the extended end of the rod fixed to the smaller piston thereby permitting connection with a fluid source, or, alternatively, with still another actuator assembly.

The relatively slidable feed tubes in all the embodiments are constructed so that they are under a continuous axial tensile force when pressurized thereby eliminating the usually inherent compressive force on the actuator feed tubes and permitting the use of feed tubes of indefinite length. In another construction according to the present invention, plural hydraulic actuator assemblies are connected in end to end fashion with the interconnections between plural relatively movable fluid chambers being effected without the use of any flexible tubing.

In still another construction two selectively high and low pressure ports are provided in the larger cylinder and in the rod associated with the smaller piston so that

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either the larger cylinder or the smaller piston may be the stationary member with the appropriate fittings to a source of fluid under pressure and a tank, and still another actuator assembly may be driven by fluid from the first actuator assembly.

In another adaptation of the present invention four relatively movable pistons and double acting cylinders are provided in which the various chambers defined by the pistons are interconnected for extension and retraction of the actuators by telescopic feedlines without the need of any flexible couplings.

Other features and advantages of the invention will be apparent from the following description of certain embodiments thereof taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a longitudinal section of a telescopic fluid actuator, broken away for clarity, according to the present invention;

FIG. 2 is a fragmentary section taken generally along line 2—2 of FIG. 1;

FIG. 3 is a longitudinal section of a somewhat modified telescopic fluid actuator adapted for parallel connection with further actuator assemblies; and

FIG. 4 is a schematic diagram of two hydraulic actuator assemblies connected together in parallel circuit fashion.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, a fluid actuator assembly 10 is shown consisting generally of a cylinder 12, an intermediate piston and rod assembly 13 slidable therein, and a smaller piston and rod assembly 14 slidable in the assembly 13. The fluid actuator shown in FIG. 1 is adapted to be connected to extend a boom or the like by connecting the smaller piston and rod assembly 14 to the stationary portion of the frame of the associated mobile crane, and by connecting the cylinder 12 to the movable portion of the boom. Toward this end, ports 16 and 17 are adapted to be connected alternatively to a source of fluid under pressure or a suitable tank. Pressurization of port 17 causes the serial extension of cylinder 12 and then piston and rod assembly 13, while pressurization of port 16 causes the serial retraction of the piston and rod assembly 13 and then the cylinder 12, as will appear more clearly hereinafter.

Cylinder 12 includes an elongated tubular section 18 having one end closed by a suitable cap assembly 19 and the other end open and carrying a seal assembly 21. Slidable within tube section 18 is the piston and rod assembly 13 having a piston 22 sealingly engaging inner surface 23 of tube section 18 and defining therein a pressure chamber 24 on one side thereof and a rod end chamber 25 on the other side thereof. The seal assembly 21 effectively seals the end of chamber 25. Piston 22 is mounted on a rod sleeve 28 having a plug 28 fixed in the piston end thereof by a threaded retainer 29. The plug 28 effectively forms a part of the piston 22. The chamber 24 communicates with the interior of rod sleeve 27 through a suitable axial passage 31 in the plug 28. The other end of the sleeve 27 carries a seal assembly 33.

Slidable within sleeve 27 is the piston and rod assembly 14. The piston end is defined by a stepped cylindrical member 34 having a reduced portion 35 carrying a ring 36 retained in place by an annular threaded retainer 37. Suitable seals such as at 38 are provided for sealing the piston assembly. This piston defines in sleeve 27 a large pressure chamber 39 and a rod end chamber 40. Piston and rod assembly 14 includes a rod sleeve 43 fixed to piston member 34 at one end and at the other end carry-

ing a rod fitting 44. Seal assembly 33 seals the outer periphery of rod 43 and the chamber 40.

Fitting 44 has an enlarged boss with a threaded opening 46 therein adapted to be mounted on a suitable threaded member (not shown) carried by the frame of the crane. An axial passage 47 interconnects port 17 with the interior 48 of rod sleeve 43. To provide communication between port 17 and chambers 39 and 24 a further axial passage 49 is provided in piston member 34 so that communication is provided between port 17 and these chambers through passage 47, chamber 48, passage 49, chamber 39, passage 31 and chamber 24.

Port 16 continuously communicates with the rod end chambers 25 and 40. Toward this end fitting 44 has a cylindrical member 51 fixed therein by cross pin 52 as shown clearly in FIG. 2. Surrounding member 51 is a sleeve 54 having radial ports 53 communicating with port 16 and defining a chamber 55 with a reduced portion on member 51. Fixed to the sleeve 54 is an elongated tube 56 extending through the entire length of rod sleeve 43 and fixed at its other end to a sleeve 57 fixed within a central bore in piston 34. Sleeve 57 carries a seal member 58 sealingly engaging the tube 65.

Piston 34 has a plurality of radial passages 59 communicating the interior of tube 56 with chamber 40 through ports 59' in sleeve 57 so that in effect port 16 is in communication therewith.

Port 16 also communicates with chamber 25, and towards this end a tube 61 is provided spaced inwardly from tube 56, fixed at one end to cylindrical member 51 and at the other end to a smaller diameter portion of the sleeve 57.

Carried by the plug 28 is a fitting 64 having a feed tube 65 fixed at one end thereto and carrying at its other end a piston 67 defining a chamber 68 between the tubes 61 and 65. The interior of tube 56 (and hence the port 16) communicates with chamber 25 through radial ports 63 in one end of tube 61, chamber 68, radial ports 69 in tube 65, radial openings 70 in fitting 64 and radial passages 71 defined in plug 28 and rod sleeve 27.

To prevent the tube 65 from being exposed to a compressive force from the high pressure hydraulic fluid flowing to the actuator, chamber 73, defined by the piston 67 in tube 61, is maintained at low pressure regardless of whether port 16 or port 17 is the pressurized one. To achieve this end, chamber 73 communicates with a cross passage 75 in fitting 44 through central passage 76 in member 51 and reduced stem portion 77 on retaining pin 52. Spring biased check valve 78 in passage 75 prevents communication between port 17 and passage 75 when port 17 is pressurized, and permits communication between passage 75 and port 17 when the pressure in passage 75 exceeds that in port 17 (i.e. when port 17 is at low pressure). A differential pressure valve 80 is biased to its open position shown by a spring 81. Valve 80 has a reduced portion defining a fluid pressure chamber 82 continuously communicating with port 16 through passage 83. Spring 81 is of such strength that when port 16 is the pressurized one of the ports, valve 80 will close preventing communication between chamber 73 and port 16, but when port 16 is connected to drain the valve 80 will open providing communication between chamber 73 and port 16.

In describing the operation of the fluid actuator assembly 10 shown in FIG. 1 it will be assumed that the rod and piston assembly 14 is connected to a stationary portion of the associated frame (not shown) with the ports 16 and 17 connectable either with a source of fluid under pressure or drain through a suitable control valve (not shown), and the cylinder 12 is connected to drive and extend the boom or the like itself. As shown in FIG. 1, the telescopic sections of the actuator are partially extended. For purposes of describing the operation, however, it should be assumed that the actuator assembly 10

is fully retracted with the piston 34 abutting the piston plug 28 so that chamber 39 is of a minimum size.

For extending the actuator and boom, port 17 is pressurized and port 16 is connected to tank through the control valve. High pressure fluid then flows to chambers 39 and 24. Due to the larger diameter of piston 22 (i.e. the diameter of piston 22 compared with that of piston 34), the cylinder assembly 12 will extend to the right (in FIG. 1) before the piston and rod 13.

The extension of cylinder 12 causes chamber 25 to reduce discharging fluid at low pressure through radial passages 71 in plug 28, radial openings 70, the interior of tube 65, radial ports 69, radial ports 63, the interior of tube 56, and out port 16 which is then connected to a suitable tank through the valve mentioned above.

At or near the time cylinder 12 reaches its limit of extension, the pressure of fluid in chamber 39 causes the piston and rod assembly 13 to begin its extension moving away from piston 34. At the same time, tube 65 and piston 67 slide in tube 61 which is stationary with respect to rod and piston 14. Chamber 73, adjacent piston 67, communicates with the port 16 which is then at low pressure through valve 80 which is then in its open position through the force of spring 81. In this manner, a compressive fluid force on tube 65 is prevented when port 17 is pressurized and port 16 is connected to drain. Communication between port 17 and chamber 73 is then prevented by check valve 78.

Movement of piston and rod assembly 13 with respect to the piston and rod 14 causes contraction of rod end chamber 40 so that fluid discharges therefrom through radial passages 59, ports 59' in sleeve 57, the interior of tube 56 and out discharge port 16. The extension of piston and rod 13 then continues until the associated boom reaches a suitable stop or the piston 34 engages stop 85 carried by the sleeve 27.

When it is desired to retract the boom by the actuator 10, port 16 is pressurized and port 17 is connected to drain. Fluid under pressure is then delivered to the rod end chambers 25 and 40 through the interior of tube 56, radial passages 59, the interior of sleeve 61, ports 69, the interior of sleeve 65 and radial passages 71. This will initially cause movement of the piston and rod assembly 13 to the left retracting the feed tube 65 and piston 67 into feed tube 61. This continues until the piston and rod assembly 13 is fully retracted at which time the cylinder 12 begins its retraction. It should be noted that while piston and rod assembly 13 is retracting, chamber 73 remains in communication with low pressure through check valve 78 which is open by fluid discharging from chamber 73. At this time valve 80 is closed preventing communication of chamber 73 with high pressure port 16. Tube 65 is actually under a tensile load due to the force of high pressure fluid acting on the right side thereof. Thus, even when retracting no compressive force is placed on feed tube 65, so that it may be constructed of any desired length without the danger of it collapsing under the compressive force of hydraulic fluid in the system.

Cylinder 12 continues retracting until it engages the piston 22 where the actuator is fully retracted.

The telescopic hydraulic actuator assembly 110 shown in FIG. 3 is generally similar to that shown in FIG. 1, except that cylinder 112 is adapted to be connected to the stationary (or frame connected) portion of the crane with piston and rod assembly 114 being the portion connectable to drive the extensible member. Furthermore, ports 116 and 117 are provided in the piston and rod assembly 114, not for the purpose of connecting the actuator assembly to the hydraulic source as in FIG. 1, but instead for the purpose of parallel connecting the assembly 110 with another actuator assembly so that two assemblies may be used for extending a boom of greater length.

More specifically, cylinder 112 has ports 112a and 112b adapted selectively to be connected to a source of hydraulic fluid under pressure or a suitable tank through a control valve (not shown). Piston 122 is generally similar to piston 22 described above with respect to FIGURE 1 and is slidably arranged in cylinder 112. Extending from the piston assembly 122 is a sleeve rod 127 having a plug 128 therein. Plug 128 carries a fitting 164 (identical to fitting 64) with tube 165 therein. Carried on the end of tube 165 is a piston 167 similar in function to piston 67 except that it has a differential pressure valve 180 therein. Valve 180 serves the same purpose as valve 80 in the FIG. 1 embodiment in that it connects chamber 173 with port 116 when that port is the low pressure one of the ports. Toward this end, valve 180 has passages 180a therein which provide communication between the chamber 173 and the interior of tube 165 when the valve member is open. Spring 181 urges the valve to its open position, but yields under the force of high pressure fluid in tube 165 permitting the valve to close under this latter condition. When port 116 is at high pressure and port 117 is at low pressure communication is established between chambers 173 and low pressure through check valve 178 mounted in cylindrical member 151 carrying tube 161. In this manner chamber 173 remains in communication with drain regardless which of the ports 116 and 117 is pressurized.

Piston 134 has a sleeve 157 fixedly mounted therein and carrying a seal member 158 sealingly engaging tube 165. Sleeve 157 fixedly receives one end of tube 156 and one end of tube 161.

Assuming the actuator 110 to be completely retracted with cylinder 112 supported by a relatively stationary portion of the associated crane and rod 114 carrying and driving the cylinder end of another actuating assembly 110 (not shown in FIG. 3) with the ports 116 and 117 connected to the ports 112b and 112a, respectively, of the additional actuator, with the other end of the other actuating assembly connected to drive the extensible member (e.g. boom), the operation would be as follows. With port 112a pressurized, fluid under pressure will flow into chamber 124, through passage 131 into chamber 139, through passages 149 and 149a in sleeve 157, through the interior of tube 156, out port 117 and hence to the corresponding extension chambers in the adjacent actuator 110. The piston 122 in each actuator will then begin movement until they approach or reach their end of stroke at which time the piston and rod assemblies 114 will begin extension away from the pistons 122. Fluid from the contracting chambers in the adjacent actuator flows into port 116 through the interior of rod sleeve 143, where it combines with fluid exhausting from rod chamber 140, with the combined flow exhausting through axial passages 140a and 140b, through radial passages 159, into the interior of tube 161, through ports 169, passing through tube 165 into radial passages 171, combining with fluid exhausting from chamber 125 and out port 112b.

When retraction of the boom or the like is desired port 112b is pressurized and port 112a is connected to drain which pressurizes chambers 125 and 140 associated with each actuator assembly and connects chambers 124 and 139 to drain. Fluid flow through the feed tube then reverses with high pressure fluid flowing into chamber 125, through passages 171, tube 165, passages 140a, into chamber 140, and through the interior of sleeve 143 out the port 116 to the adjacent cylinder where it pressurizes the rod ends of the pistons associated therewith. Fluid exhausting from the associated actuator passes into port 117, within tube 156, through passages 149, chamber 139, passage 131, chamber 124, and out port 112a to the tank.

The hydraulic actuator arrangement shown in FIG. 4 is similar to the parallel connection of actuator assemblies described above with reference to FIG. 3, although the actuators shown in FIG. 4 have their feed

tubes connected externally rather than internally as in both the FIGS. 1 and 3 embodiments.

More specifically with reference to FIG. 4, the actuator assembly shown in seen to include two identical actuators 210 and 211 hydraulically interconnected for cooperative extension and retraction. The details of the actuators will be described with reference to actuator 210 with the understanding that actuator 211 is the same. Actuator 210 includes a piston and rod assembly 214 having ports 216 and 217 at the extending end thereof adapted to be connected to a suitable source of fluid under pressure or tank selectively. The rod portion of piston and rod assembly 214 is adapted to be connected to the frame or base of the mobile crane, and the other end (cylinder 212a) of assembly 211 is adapted to be connected to drive the boom upwardly and/or outwardly. Slidable on the piston portion of piston and rod assembly 214 is a piston and rod assembly 213. The piston portion of piston and rod 214 defines chambers 239 and 240 in a cylinder defined by the rod portion of assembly 213. Cylinder 212 is slidable on the piston portion of assembly 213 and defines chambers 224 and 225 therein on the opposite sides of the piston. Fixed to the piston and rod assembly 213 by suitable means (not shown) is a tube 265 having a piston 267 at one end thereof slidable within a stepped tube 268. Tube 268 is fixed within a surrounding sleeve 269 that communicates with the enlarged end of tube 268 through ports 271. Passage 273 extending through tube 265 communicates with the rod end of piston 267. Passage 273 also communicates with chamber 240 through a suitable conduit 273. The interior of sleeve 269 communicates with chamber 225 through conduit 274. Chamber 275, defined by the piston 267 in tube 268, communicates with chamber 224 in cylinder 212 through check valve 276 which prevents flow from chamber 224 into chamber 275.

It should be noted that tube 268 and sleeve 269 are fastened together as a unit and both are fixed to or carried by the cylinder 212 by suitable means not shown. Thus, the tube 265 moves with the piston and rod assembly 213 and the tube 268 moves with the cylinder 212.

The actuator assembly 211 is identical to the assembly 210, as noted above, so that the reference numerals applied are the same except for the addition of the subscripts *a* thereto. Rod 214a is fixedly carried by the end of cylinder 212, and the end of cylinder 212a is adapted to drive the movable portion of an associated extensible boom in a mobile crane or the like.

In the operation of the FIG. 4 embodiment it is assumed that initially all of the pistons and cylinders are retracted and pressure is applied to port 217 with port 216 connected to drain. Chambers 239 and 224 will receive high pressure fluid from port 217, passage 256 and passage 231, as will chambers 239a and 224a in actuator 211, through a conduit 281 interconnecting the end of chamber 224 with port 217a. Chambers 224 and 224a will begin expanding, moving cylinders 212 and 212a outwardly (to the right in FIG. 4), sliding the tubes 268 and 269 (and 268a and 269a) with respect to the piston 267 (and 267a). At the same time fluid will flow from the chambers 225 and 225a, through conduits 274 and 274a into the interior of tubes 269 and 269a. From their fluid from these contracting chambers flows through ports 271 and 271a into tubes 268 and 268a and through passages 273 and 273a into chambers 240 and 240a.

Fluid exhausting from chamber 240a passes out port 216a into the smaller diameter portion of tube 268 from where it passes through radial ports 285 into the interior of tube 269 where it combines with the flow exhausting from chamber 225 through passage 274. Fluid in chamber 240 passes through rod 214 and out port 216 which is then connected to drain. As the tube 268 moves with respect to piston 267 (and likewise as tube 268a moves with respect to piston 267a) chambers 275 and 275a communicate with low pressure through valves 280 and 280a seated in the stepped portion of tubes 268 and 268a,

respectively. The springs biasing valves 280 and 280a open the valves at this time. This assures communication of chambers 275 and 275a with the low pressure during extension of the actuator to prevent compression of the feed tubes 265 and 265a. During this portion of the extension valves 276 and 276a remain closed due to the higher pressure in chambers 224 and 224a than in the associated feed tube chambers 275 and 275a.

To retract the actuators 210 and 211, port 216 is pressurized and port 217 is connected to drain, the latter of which effectively connects chambers 224, 224a, 239, 239a to drain, while rod end chambers 240, 240a, 225, 225a are connected to high pressure in port 216 in the reverse manner of that described above when port 216 is connected to drain. The cylinders then retract sequentially. Note that during retraction of the actuators that valves 276 and 276a open permitting fluid to discharge from chambers 275 and 275a into chambers 224 and 224a, respectively. Further, valves 280 and 280a are closed by high fluid pressure in ports 285 and 285a acting thereon preventing communication between high pressure fluid within sleeves 269 and 269a and chambers 275 and 275a.

What is claimed is:

1. An extensible actuator assembly comprising: a first cylinder, a first piston slidable in said cylinder and having a first rod fixed thereto, said first rod defining a second cylinder, a second piston slidable in said second cylinder and having a second rod extending therefrom, said pistons each defining with said cylinders a pair of rod end chambers and a pair of chambers opposite said rod end chambers, means for selectively delivering fluid to one pair of said chambers, and means for selectively conveying fluid to the other pair of said chambers including first tube means fixed with respect to said first piston, means communicating the rod end chamber associated with said first piston with said first tube means, second tube means fixed with respect to one of said first cylinder and said second piston, means communicating the rod end chamber associated with the second piston with said second tube means, one of said tube means being slidable within the other, and means preventing any axial compressive fluid force on the inner one of said tube means.

2. An extensible actuator assembly comprising: a first cylinder, a first piston slidable in said cylinder and having a first rod fixed thereto, said first rod defining a second cylinder, a second piston slidable in said second cylinder and having a second rod extending therefrom, said piston each defining with said cylinders a pair of rod end chambers and a pair of chambers opposite said rod end chambers, means for selectively delivering fluid to one pair of said chambers, means for selectively conveying fluid to the other pair of said chambers including first tube means fixed with respect to said first piston, means communicating the rod end chamber associated with said first piston with said first tube means, second tube means fixed with respect to one of said first cylinder and said second piston, means communicating the rod end chamber associated with the second piston with said second tube means, one of said tube means being slidable within the other, means for preventing an axial compressive fluid force on said one of said tube means, said means for preventing a compressive fluid force on said one tube means including piston means on one end of said one tube means slidable in said other tube means, said piston means defining a low pressure chamber in said other tube means opposite said one tube means, and means for maintaining said low pressure chamber at low pressure to prevent compression of said one tube means.

3. An extensible actuator assembly comprising: a first cylinder, a first piston slidable in said cylinder and having a first rod fixed thereto, said first rod defining a second cylinder, a second piston slidable in said second cylinder and having a second rod extending therefrom, said pistons

each defining with said cylinders a pair of rod end chambers and a pair of chambers opposite said rod end chambers, means for selectively delivering fluid to one pair of said chambers, means for selectively conveying fluid to the other pair of said chambers including first tube means fixed with respect to said first piston, means communicating the rod end chamber associated with said first piston with said first tube means, second tube means fixed with respect to one of said first cylinder and said second piston, means communicating the rod end chamber associated with the second piston with said second tube means, one of said tube means being slidable within the other, means for preventing an axial compressive fluid force on said one of said tube means, said means for preventing a compressive fluid force on said one tube means including piston means on one end of said one tube means slidable in said other tube means, said piston means defining a low pressure chamber in said other tube means opposite said one tube means, and means for maintaining said low pressure chamber at low pressure to prevent compression of said one tube means, said means for maintaining said low pressure chamber at low pressure is effective regardless of whether the rod end chambers or the opposite chambers are the pressurized ones.

4. An extensible actuator assembly comprising: a first cylinder, a first piston slidable in said cylinder and having a first rod fixed thereto, said first rod defining a second cylinder, a second piston slidable in said second cylinder and having a second rod extending therefrom, said pistons each defining with said cylinders a pair of rod end chambers and a pair of chambers opposite said rod end chambers, means for selectively delivering fluid to one pair of said chambers, and means for selectively conveying fluid to the other pair of said chambers including first tube means fixed with respect to said first piston, means communicating the rod end chamber associated with said first piston with said first tube means, second tube means fixed with respect to one of said first cylinder and said second piston, means communicating the rod end chamber associated with the second piston with said second tube means, one of said tube means being slidable within the other, and means for preventing an axial compressive fluid force on said one of said tube means, said second tube means being fixed with respect to said first cylinder, said first tube means being fixed with respect to said first piston and slidable within said first tube means, said first and second tube means being external to said first cylinder.

5. An extensible boom as defined in claim 1, wherein said first tube means extends within said first rod and through said second piston, said second tube means slidably receiving said first tube means and being fixed within said second piston means.

6. An extensible actuator assembly comprising: a first cylinder, a first piston slidable in said cylinder and having a first rod fixed thereto, said first rod defining a second cylinder, a second piston slidable in said second cylinder and having a second rod extending therefrom, said pistons each defining with said cylinders a pair of rod end chambers and a pair of chambers opposite said rod end chambers, means for selectively delivering fluid to one pair of said chambers, including first port means in the projecting end of said second rod, and means for selectively conveying fluid to the other pair of said chambers including second port means in the projecting end of said second rod, means communicating said second port means with the rod end chamber associated with said second piston, and first tube means continuously communicating with said rod end chamber associated with said first piston, second tube means continuously communicating with said rod end chamber associated with the rod end chamber associated with said second piston, said tubes being constructed to provide a fluid passageway isolated from said first port means, the end of one of said tube means being slidable within the other of said tube means.

7. An extensible boom as defined in claim 6, wherein said first tube means is fixed within said second rod and communicates with said second port means, said second tube means being fixed within said first piston and having a portion thereof slidable within said first tube means.

8. An extensible boom as defined in claim 6, wherein said first and second tube means are external to said first cylinder.

9. An extensible boom as defined in claim 6, including third port means in said first cylinder communicating with the opposite chamber therein, fourth port means in said first cylinder communicating with said rod chamber therein, said first and third port means and said second and fourth port means being selectively pressurized or drained.

10. An extensible boom as defined in claim 9, including hydraulic load means connected to one of said first and second port means or said third and fourth port means.

11. An extensible boom as defined in claim 10, wherein said load includes a third cylinder, a third piston slidable in said third cylinder, a third rod fixed to said third piston and having a fourth cylinder defined therein, a fourth slidable in said fourth cylinder and having a rod extending therefrom, means fixedly connecting one of said fourth piston or said third cylinder with respect to one of said first cylinder or said second piston, means communicating said first and third port means with the fluid chambers in said third and fourth cylinder means opposite the rod end chambers, and means communicating the second and fourth port means with the rod end chambers associated with the third and fourth pistons including third tube means communicating with one of the rod end chambers associated with the third and fourth pistons, and fourth tube means communicating with the other rod chamber associated with the third and fourth piston means, one of said third and fourth tube means being slidable within the other.

12. An extensible boom as defined in claim 6, wherein one of said tube means has piston means at one end thereof slidable in said other tube means and defining low pressure chamber means therein, and means for maintaining said low pressure chamber means at relatively low pressure to prevent compressive force on said tube means.

13. An extensible actuator assembly comprising: a first cylinder, a first piston slidable in said cylinder and having a first rod fixed thereto, said first rod defining a second cylinder, a second piston slidable in said second cylinder and having a second rod extending therefrom, said pistons each defining in their associated cylinder a rod end chamber and a chamber opposite the rod end chamber, means for selectively delivering fluid to one pair of said chambers, including first port means in said second rod at the projecting end thereof, and means for selectively pressurizing the rod chambers including second port means in said second rod at the projecting end thereof, first annular passage means in said second rod communicating with said second port means, means communicating the rod chamber associated with said second piston with said first passage means, tube means fixed in said second rod communicating with said first passage means adjacent said second piston, second tube means fixed to said first piston and extending within said first tube means, and means continuously communicating the rod chamber associated with said first piston with said second tube means.

14. An extensible actuator assembly comprising: a first cylinder, a first piston slidable in said cylinder and having a first rod fixed thereto, said first rod defining a second cylinder, a second piston slidable in said second cylinder and having a second rod extending therefrom, said pistons each defining in their associated cylinder a rod end chamber and a chamber opposite the rod end chamber, means for selectively delivering fluid to one pair of said chambers, including first port means in said second rod at the projecting end thereof, means for selectively pressurizing-

ing the rod chambers including second port means in said second rod at the projecting end thereof, first annular passage means in said second rod communicating with said second port means, means communicating the rod chamber associated with said second piston with said first passage means, tube means fixed in said second rod communicating with said first passage means adjacent said second piston, second tube means fixed to said first piston and extending within said first tube means, means communicating the rod chamber associated with said first piston with said second tube means, piston means fixed to the end of said second tube means and sealingly engaging said first tube means and defining chamber means in said first tube means opposite said second tube means, and valve means selectively communicating said chamber means to the low pressure one of said first and second port means.

15. An extensible actuator assembly comprising: a first cylinder, a first piston slidable in said cylinder and having a first rod fixed thereto, said first rod defining a second cylinder, a second piston slidable in said second cylinder and having a second rod extending therefrom, said pistons each defining in their associated cylinder a rod end chamber and a chamber opposite the rod end chamber, means for selectively delivering fluid to one pair of said chambers, including first port means in said second rod at the projecting end thereof, means for selectively pressurizing the rod chambers including second port means in said second rod at the projecting end thereof, first annular passage means in said second rod communicating with said second port means, means communicating the rod chamber associated with said second piston with said first passage means, tube means fixed in said second rod communicating with said first passage means adjacent said second piston, second tube means fixed to said first piston and extending within said first tube means, means communicating the rod chamber associated with said first piston with said second tube means, piston means fixed to the end of said second tube means and sealingly engaging said first tube means and defining chamber means in said first tube means opposite said second tube means, and valve means selectively communicating said chamber means to the low pressure one of said first and second port means, the valve means being in said second rod adjacent said port means.

16. An extensible actuator assembly comprising: a first cylinder, a first piston slidable in said cylinder and having a first rod fixed thereto, said first rod defining a second cylinder, a second piston slidable in said second cylinder and having a second rod extending therefrom, said pistons each defining in their associated cylinder a rod end chamber and a chamber opposite the rod end chamber, means for selectively delivering fluid to one pair of said chambers, including first port means in said second rod at the projecting end thereof, means for selectively pressurizing the rod chambers including second port means in said second rod at the projecting end thereof, first annular passage means in said second rod communicating with said second port means, means communicating the rod chamber associated with said second piston with said first passage means, tube means fixed in said second rod communicating with said first passage means adjacent said second piston, second tube means fixed to said first piston and extending within said first tube means, means communicating the rod chamber associated with said first piston with said second tube means, piston means fixed to the end of said second tube means and sealingly engaging said first tube means and defining chamber means in said first tube means opposite said second tube means, and valve means selectively communicating said chamber means to the low pressure one of said first and second port means, said valve means including a valve slidable in said piston means.

17. An extensible actuator assembly comprising: a cylinder, a piston slidable in said cylinder and having a rod fixed thereto sealingly and slidably engaging said

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cylinder, said piston defining with said cylinder a rod end chamber and a chamber opposite said rod end chamber, means for selectively delivering fluid to one chamber including first port means in the projecting end of said rod, and means for selectively delivering fluid to the other chamber including first tube means fixed with respect to said cylinder, second tube means fixed with respect to said piston and slidably receiving said first tube means, means continuously communicating said second tube means with said rod chamber, said first and second tube means being constructed so that said first tube means continuously communicates with said rod chamber as said piston extends with respect to said cylinder, first and second port means in the projecting end of said rod communicating with said other chamber.

18. An extensible actuator assembly comprising: a cylinder, a piston slidable in said cylinder and having a rod fixed thereto sealingly and slidably engaging said cylinder, said piston defining with said cylinder a rod end chamber and a chamber opposite said rod end chamber, means for selectively delivering fluid to one chamber, and means for selectively conveying fluid to said rod chamber including first tube means fixed with respect to

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said cylinder, second tube means fixed with respect to said piston and slidably receiving said first tube means, means communicating the rod end chamber with said second tube means, and means preventing any axially compressive fluid force on the inner one of said tube means.

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