United States Patent [19]

Koga et al.

[11] **3,871,265**

[45] **Mar. 18, 1975**

[54] **HYDRAULIC CYLINDER ASSEMBLY FOR TELESCOPIC BOOM**

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[73] Assignee: **Kayabakogyokabushikikaisha**, Tokyo, Japan

[22] Filed: **Feb. 28, 1973**

[21] Appl. No.: **336,785**

[30] **Foreign Application Priority Data**

Mar. 2, 1972 Japan 47-25883

[52] **U.S. Cl.** **91/189**, 91/411

[51] **Int. Cl.** **F15b 13/07**

[58] **Field of Search** 91/411, 189, 420; 92/51; 212/55

[56] **References Cited**

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Primary Examiner—Irwin C. Cohen
Assistant Examiner—Edward Look
Attorney, Agent, or Firm—Saul Jecies

[57] **ABSTRACT**

A hydraulic cylinder assembly for a telescopic boom mounted on a truck crane or the like is disclosed which may sequentially extend or retract the telescopic boom members. The hydraulic cylinder assembly has a very simple hydraulic circuit and eliminates any need for adjustment. A valve is inserted in a passage of a first cylinder fixed to the outer boom and into which the working oil enters under pressure when the telescopic boom is extended. The valve is adapted to be opened by the working oil under pressure when the first cylinder is extended and also to be mechanically opened when a second cylinder fixed to the intermediate boom member telescopically fitted into the outer boom member is fully retracted. Another valve is inserted into a passage interconnecting the passage of the first cylinder and a port of the second cylinder to which flows the working oil under pressure when the second cylinder is extended. This valve is adapted to be mechanically opened when the first cylinder is extended to its full length and also to be opened under the pressure of the working oil generated in the second cylinder when the latter is retracted.

3 Claims, 5 Drawing Figures

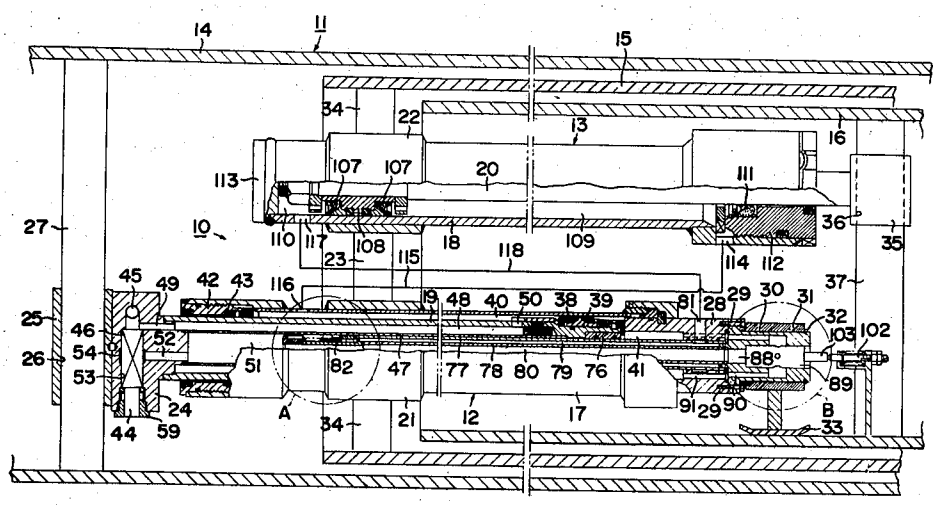
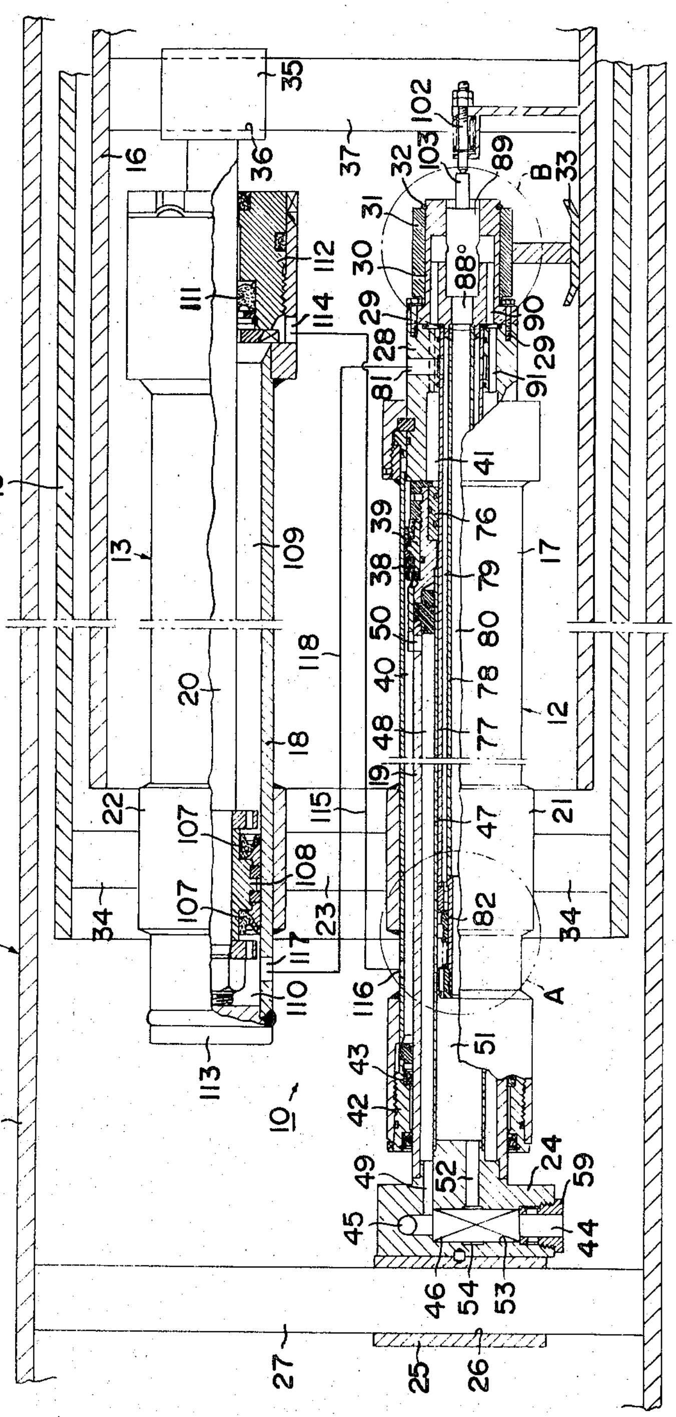


FIG. 1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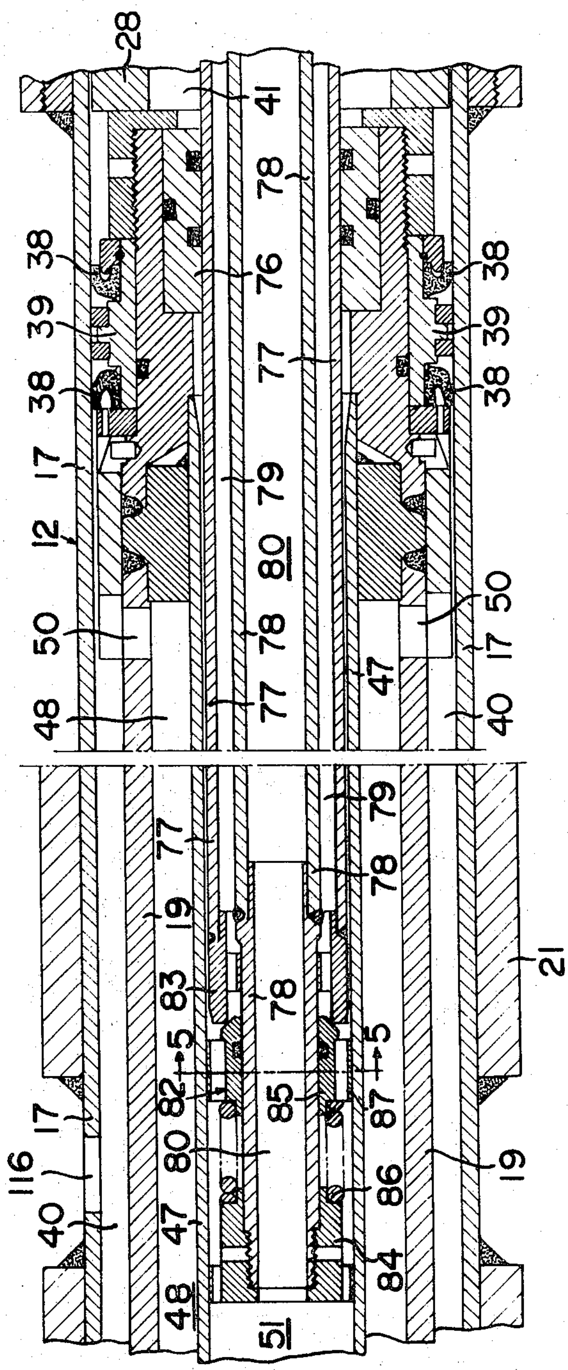
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FIG. 2

FIG. 3

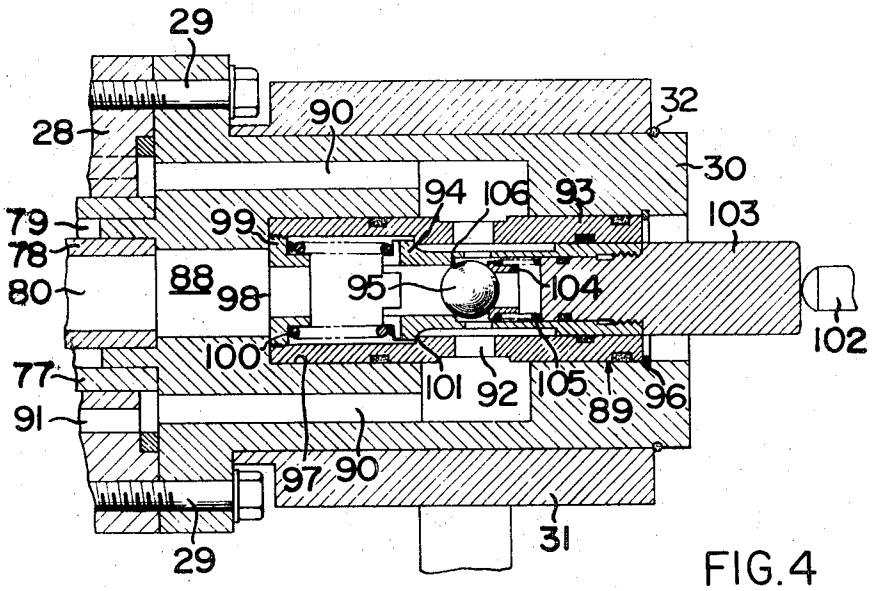


FIG. 4

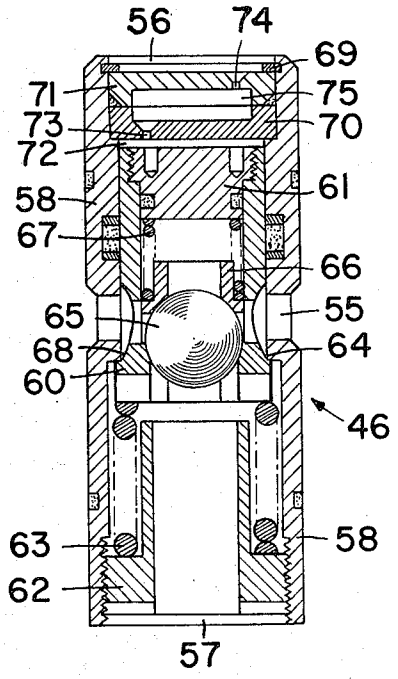
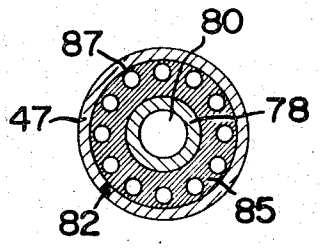


FIG. 5



HYDRAULIC CYLINDER ASSEMBLY FOR TELESCOPIC BOOM

BACKGROUND OF THE INVENTION

The present invention relates to a hydraulic cylinder assembly in which a plurality of cylinders may be extended or retracted according to a predetermined sequence, and more particularly a hydraulic cylinder assembly adapted to extend or retract a plurality of telescopic boom members of a telescopic boom mounted on a truck crane or, a vehicle adapted to provide an elevated working platform, or the like.

In general, in the truck crane or the vehicle of the type described above, a multi-stage hydraulic cylinder is disposed within a telescopic boom and the piston rods and cylinder barrels of the hydraulic cylinders are fixed to the associated telescopic boom members so that, when the hydraulic cylinders are actuated according to a predetermined sequence, the telescopic boom memebers of the telescopic boom may also be extended or retracted according to a predetermined sequence. Therefore the hydraulic cylinders are intercommunicated through a sequential circuit so that the construction of the hydraulic cylinders and the associated piping system or hydraulic circuit are very complex and expensive. Furthermore there is a danger that the pipe lines in the telescopic boom are frequently damaged when the boom is extended or retracted. Moreover, the adjustment of the sequential circuit is extremely complex because the hydraulic component parts such as valves in the circuit must be actuated with a higher degree of accuracy when each hydraulic cylinder is fully extended or retracted.

SUMMARY OF THE INVENTION

One of the objects of the present invention is therefore to provide a hydraulic cylinder assembly for a telescopic boom which is simple in construction and requires a minimum number of pipe lines.

Another object of the present invention is to provide a hydraulic cylinder assembly for a telescopic boom which may eliminate the valve opening and closing time adjustment so that the mounting of the hydraulic cylinder assembly on the telescopic boom may be much facilitated.

Another object of the present invention is to provide a hydraulic cylinder assembly in which the hydraulic cylinders may be actuated correctly according to a predetermined sequence.

Another object of the present invention is to provide a hydraulic cylinder assembly of the ytpe described which is inexpensive to fabricate.

Briefly stated the present invention is characterized in that a sequential circuit for effecting the sequential control of a plurality of hydraulic cylinders is eliminated, and in that a first valve is inserted into a passage of a first cylinder fixed to an outer boom member into which flows the working oil under pressure when the first hydraulic cylinder is extended, the first valve being adapted to be opened by the pressure of the working oil under pressure when the first cylinder is extended and also to be mechanically opened when a second cylinder which is fixed to an intermediate boom member is fully retracted; and a second valve is inserted into a passage interconnecting the passage of the first cylinder and a port of the second cylinder through which the working oil under pressure enters into the second cylinder for extending the same, the second valve being adapted to be mechanically opened by the first cylinder when the latter is extended to its full length and also to be opened by the pressure of the working oil generated in the second cylinder when the latter is retracted. Therefore the pipe line system within the telescopic boom may be much simplified, so that the damages and troubles thereof may be minimized. Furthermore, the complex valve opening and closing time adjustment may be eliminated so that the mounting of the hydraulic cylinder assembly on the telescopic boom may be much facilitated. Moreover, the operation for extending or retracting of the hydraulic cylinders within the assembly according to a predetermined program or sequence becomes very reliable and dependable so that the telescopic boom members may also be extended or retracted according to a predetermined sequence.

The above and other objects, features and advantages of the present invention will become more apparent from the following description of one preferred embodiment thereof taken in conjunction with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING:

FIG. 1 is a longitudinal sectional view of a hydraulic cylinder assembly for a telescopic boom in accordance with the present invention;

FIG. 2 is a fragmentary view thereof illustrating on an enlarged scale a portion encircled by A in FIG. 1;

FIG. 3 is a fragmentary view thereof illustrating on an enlarged scale a portion encircled by B in FIG. 1;

FIG. 4 is a longitudinal sectional view on an enlarged scale of a holding valve incorporated in the hydraulic cylinder assembly shown in FIG. 1; and

FIG. 5 is a cross-sectional view, showing a detail of FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT:

FIG. 1 shows a hydraulic cylinder assembly in accordance with the present invention incorporated within a boom **11**. The hydraulic cylinder assembly **10** comprises a lower or base cylinder **12** and an upper or forward cylinder **13** disposed in parallel with each other, and the boom **11** comprises an outer boom **14** and a middle boom **15** and an inner boom **16** which are telescopically fitted into the outer boom **14**.

Each of the lower and upper cylinders **12** and **13** generally comprises a cylinder barrel **17** or **18** and a piston rod **19** or **20** slidably fitted into the cylinder barrel **17** or **18**. The cylinder barrels **17** and **18** are joined together with a connecting pin **23** and ring members **21** and **22** fitted over the cylinder barrels **17** and **18** respectively.

The piston rod **19** extended out of the lower cylinder **12** of the hydraulic cylinder assembly **10** is provided with a piston rod head **24** joined to a bracket **25** having a hole **26** into which is fitted a connecting pin **27** having both ends securely fixed to the inner wall of the outer boom **14**. The cylinder barrel **17** is provided with a cylinder bottom **28** to which is attached a valve body **30** with screws **29**, and an annular member **31** is fitted over the valve body **30** and securely held in position by means of a snap ring **32**. A guide member **33** extending from the annular member **31** slidably rests upon the inner surface of the inner boom **16** so that the lower cylinder **12** is supported. The cylinder barrels **17** and

18 which are joined together with the connecting pin 23 are also securely fixed to the middle or intermediate boom 15 with connecting pins 34 extending from the ring members 21 and 22 fitted over the cylinder barrels 17 and 18. The upper cylinder 13 is connected to the inner boom 16 through a connecting pin 37 fitted into a hole 36 of a bracket 35 fixed to the free end of the piston rod 20. Therefore, when the lower cylinder 12 is actuated, the middle or intermediate boom 15 is extended or retracted in unison with the inner boom 16 with respect to the outer boom 14. Similarly, when the upper cylinder 13 is actuated the inner boom 16 is extended or retracted with respect to the intermediate or middle boom 15. Thus, by actuating the lower and upper cylinders 12 and 13, the middle or intermediate boom 15 and the inner boom 16 may be extended or retracted with respect to the outer boom 14.

To the base end of the hollow piston rod 19 of the lower cylinder 12 is fixed a piston 39 which slidably contacts with the inner wall of the cylinder barrel 17 through seals 38 and which divides the cylinder barrel 17 into two chambers 40 and 41. The chamber 40 is sealed by seals 43 interposed between a cylinder head 42 fixed to the cylinder barrel 17 and the piston rod 19 whereas the chamber 41 is closed by the cylinder bottom 28.

Within the piston head 24 of the piston rod 19 are formed a port 44 for introducing the working oil for extending the boom, a port 45 for introducing the working oil for retracting the boom and a holding valve 46, the ports 44 and 45 being selectively communicated with a pump or tank so that the boom extending or retracting speed by the lower and upper cylinders 12 and 13 may be controlled. A pipe 47 which extends between the piston 39 and the piston rod head 24 defines a boom-retracting oil passage 48 between the inner wall of the piston rod 19 and the outer wall of the pipe 47. The boom-retracting oil passage 48 is communicated with the port 45 through a passage 49 formed through the piston rod head 24 and with the chamber 40 through a bore 50 formed through the piston rod 19. A boom-extending oil passage 51 which is defined within the pipe 47 is communicated through a passage 52 formed through the piston rod head 24 with an annular groove 54 formed in the wall of a cylinder bore 53 in which is housed the holding valve 46.

As shown in FIG. 4 the holding valve 46 comprises a valve case 58 provided with intermediate openings 55 formed at the center portion thereof and a boom-retracting oil opening 56 and a boom-extending oil opening 57 formed at the upper and lower ends thereof respectively. The valve case 58 is fitted into the bore 53 in the piston rod head 24 of the lower cylinder 12; it is securely held in position by a plug 59 which is formed with the boom-extending port 44 and is screwed into the bore 53. The intermediate opening 55 of the valve case 58 is communicated with the boom-extending oil passage 51 in the pipe 47, through the passage 52 and the annular groove 54 formed in the piston rod head 24; the boom-extending opening 57 is communicated with the boom-extending oil port 44; and the boom-retracting oil opening 56 is communicated with the boom-retracting oil passage 48 between the piston rod 19 and the pipe 47.

Within the valve case 58 there is slidably disposed a valve body 60 which interrupts or permits the communication between the boom-extending oil opening 57 and the intermediate ports 55. A plug 61 is screwed into the opening of the valve body 60 on the side of the boom-retracting oil opening 56. The valve body 60 is normally pressed against a valve seat 64 under the force of a spring 63 which is loaded between the lower end of the valve body 60 and a spring seat 62 which is screwed into the boom-extending oil opening 57, so that the intercommunication between the intermediate ports 55 and the boom-extending oil opening 57 is interrupted. Within a valve body 60 is disposed a check valve 65 which is normally pressed against a valve seat 68 under the force of a spring 67 loaded between the plug 61 and a spring seat 66 so that the working oil flow from the intermediate ports 55 to the boom-extending oil opening 57 is interrupted but the working oil flow from the boom-extending oil opening to the intermediate ports 55 is permitted. A pair of cup-shaped members 70 and 71 are held in position by a snap ring 69 in the boom-retracting oil opening 56 of the valve case 58 in such a manner that their recesses may form a chamber 75 and that a pilot chamber 72 may be formed between the bottom of the cup-shaped member 70 and the upper end of the valve body 60. The pilot chamber 72 is communicated with the boom-retracting oil opening 56 through the chamber 75 between the pair of cup-shaped members 70 and 71 and orifices 73 and 74 formed therethrough, respectively, so that only when the working oil under pressure is fed to the boom-retracting oil port 45, it may be directed from the boom-retracting opening 56 through the orifice 74, the chamber 75 and the orifice 73 into the pilot chamber 72. As a result the valve body 60 is caused to move downwardly in FIG. 4 against the spring 63 away from the valve seat 64 so that the communication between the intermediate ports 55 and the boom-extending oil opening 57 may be established.

The valve body 30 is fixed to the cylinder bottom 28 of the lower cylinder 12; from it, and within the pipe 47 extends a first pipe 77 through the cylinder bottom 28 and a spacer 76 of the piston 30, and in like manner a second pipe 78 extends within the first pipe 77. As a result, two communication passages 79 and 80 are defined between the first and second pipes 77 and 78 and within the second pipe 78.

One end of the passage 79 is communicated with a bore 81 formed through the first pipe 77 and the cylinder bottom 28 whereas the other end is communicated with the boom-extending oil passage 51 within the pipe 47 through a valve 82. As best shown in FIG. 2 the valve 82 comprises a valve seat 83 fixed to the base of the first pipe 77, a spring seat 84 fixed to the base of the second pipe 78, a valve body 85 disposed between the valve seat 83 and the spring seat 84 and slidably fitted over the second pipe 78, and a spring 86 loaded between the spring seat 84 and the valve body 85 so that the latter may be normally pressed against the valve seat 83. The valve body 85 acts as a check valve; when fluid flows from passage 79 towards the passage 51 the valve body 85 opens against the action of spring 86. The fluid flow from passage 51 to passage 79 is prevented by body 85 which is now pressed against seat 83 by spring 86. When the lower cylinder 12 is entended to the full length, a flange 87 (shown in detail in FIG. 5) of the valve body 85 engages with the spacer 76 attached to the piston 39, so that the valve body 85 is mechanically forced to move away from the valve seat against the spring 86. As a result the working oil may

flow freely between the passage 79 and the boom-extending oil passage 51. Only when the lower cylinder 12 is extended to its full length is the valve 82 mechanically opened in the manner described above.

The other passage 80 is communicated with the boom-extending oil passage 51 at its one end and with the chamber 41 through a valve 89 fitted into a passage 88 formed in the valve body 30, a passage 90 formed in the valve body 30 and a passage 91 formed in the cylinder bottom 28.

As shown in FIG. 3 the valve 89 comprises a valve case 93 provided with intermediate openings 92, a first valve body 94 slidably fitted into the valve case 93 and a second valve body 95 disposed within the first valve body 94. The valve 89 is securely held in position in a cylinder bore 97 formed in the valve body 30 by a snap ring 96 in such a manner that a left opening 98 of the valve case 93 is communicated with the passage 88 on the left side of the valve body 30 and the intermediate openings 92 are communicated with the passage 90 within the valve body 30.

The first valve body 94 is normally pressed into engagement with a valve set 101 under the force of a spring 100 which is loaded between the first valve body 94 and a spring seat 99 which is screwed into a left opening 98 of the valve case 93, so that due to such engagement the communication between the intermediate openings 92 of the valve case 93 and the left opening 98 is interrupted. When the inner boom 16 is retracted to the full extent so that a push lever 102 fixed to the inner wall thereof engages with a push rod 103 extending from the right end of the valve body 94, the valve body 94 is mechanically moved away from its valve seat 101.

the second valve body 95 is normally pressed against a valve seat 106 formed on the valve body 94 under the force of a spring 105, loaded between the inner end of the push rod 103 and a spring seat 104 which attached to the second valve body 95, so that the flow from the passage 90 to the passage 88 is prevented but the flow from passage 88 into the passage 90 is permitted.

The piston rod 20 of the upper cylinder 13 is provided with a piston 108 which slidably contacts with the inner wall surface of the cylinder barrel 18 through seals 107 and divides the cylinder barrel 18 into two chambers 109 and 110. The chamber 109 is closed by seal 111 disposed between the piston rod 20 and a cylinder head 112 slidably fitted over the piston rod 20, and the chamber 110 is sealed by a cylinder bottom 113 fixed to the base of the cylinder barrel 18. The chamber 109 is hydraulically communicated with the chamber 40 of the lower cylinder 12 through a hole 114 formed through the cylinder head 112, a line 115 and a hole 116 formed through the cylinder barrel 17, and the chamber 110 is hydraulically communicated with the passage 79 in the lower cylinder 12 through a hole 117 formed through the cylinder barrel 18, a line 118 and a hole 81 formed through the cylinder 12.

Next the mode of operation of the hydraulic cylinder assembly 1 with the above construction will be described. Assume that the boom-extending oil port 44 of the lower cylinder 12 is communicated with the pump whereas boom-retracting oil port 45 is communicated with the tank. The working oil under pressure forces the check valve 65 in the holding valve 46 to open and then via ports 55 and passage 52 flows into the boom-extending oil passage 51. The communication between passage 79 in the pipe 77 and the passage 80 in the pipe 78 is interrupted because the valve 82 is closed, so that the working oil under pressure flows through the passages 80 and 88 and pushrod 103 opens valve body 94 including working oil under pressure to pass through intermediate opening 92 and passages 90 and 91 in the operating chamber 41. As a result the lower cylinder 12 is gradually extended as the working oil under pressure flows into the chamber 41, so that the intermediate boom 15 is extended. The working oil in the chamber 40 in the lower cylinder 12 is returned to the tank through the port 50, the boom-retracting oil passages 48 and 49 and the boom-retracting oil port 45. As the lower cylinder 12 extends, both pipes 77 and 78 are pulled by the valve cylinder 30 to move to the right in FIG. 1, and immediately before the lower cylinder 12 is extended to its full length, the flange 87 of the valve body 85 of the valve 82 engages with the spacer 76 of the piston 39 so that the valve body 85 moves away from the valve seat 83 against the spring 86. As a result the communication between the boom-extending oil passage 51 and the passage 79 is established. When the lower cylinder 12 is extended to its full length the working oil under pressure is forced into the chamber 110 of the upper cylinder 13 through the boom-extending oil passage 51, the passage 79, the port 81, the line 118 and the port 117 so that the upper cylinder 13 is gradually extended. As a result the inner boom 16 is gradually extended. The working oil in the chamber 109 of the upper cylinder 13 is returned to the tank through the port 114, the pipe line 115, the port 116, the chamber 40 in the lower cylinder 12, the port 50, the passages 48 and 49 and the boom-retracting oil port 45. Therefore the upper cylinder 13 begins its extending movement only after the lower cylinder is already extended to its full length. In other words, only after the intermediate or middle boom 15 has been extended to its full length will the inner boom 16 itself begin to extend.

In order to retract the booms, the boom-retracting oil port 45 of the lower cylinder 12 is communicated with the source of the working oil under pressure whereas the port 44 is communicated with the tank. The working oil under pressure flows into the boom-retracting oil passage 48 and moves the valve body 60 away from its valve seat 64 against the action of spring 63, thereby opening the intermediate ports 55. As a result the boom-extending oil passage 51 is communicated with the boom-extending oil port 44. The working oil under pressure in the passage 48 is forced into the chamber 40 through the port 50, so that the lower cylinder 12 may start to retract. However, the flow of the working oil from the chamber 41 is interrupted because the valve 89 is closed, which means that the lower cylinder 12 is not retracted at this time. The working oil under pressure in the chamber 40 is forced into the chamber 109 of the upper cylinder 13 through the port 116, the pipe line 115 and the port 114 so that the upper cylinder 13 is gradually retracted. As a result the inner boom 16 is gradually retracted. The working oil in the chamber 110 flows through the port 117, the pipe line 118, the port 81 and the passage 79 and opens the valve 82 to return to the tank through the passages 51 and 52, the intermediate openings 55 and the boom-extending oil port 44. When the upper cylinder 13 is fully retracted the inner boom 16 is also fully retracted so that its push lever 102 engages with the push rod 103

so that the first valve body **94** in the valve **89** is moved away from its valve seat against the force of spring **100.** Therefore the chamber **41** of the lower cylinder **12** is opened to the tank through the passages **91** and **90,** the valve **89,** the passages **80** and **51** and the boom-extending oil port **44,** so that the lower cylinder may now retract gradually. That is, only after the inner boom **16** is fully retracted will the intermediate or middle boom **15** start to retract.

So far the present invention has been described with reference to a hydraulic cylinder assembly comprising two cylinders, but it will be understood that there may be provided a multi-stage hydraulic cylinder assembly comprising a plurality of cylinders similar in construction to the lower cylinder and a top cylinder.

The preferred embodiment of the present invention has been described in detail with reference to the accompanying drawing, but it will be understood that various modifications and variations can be effected without departing the true spirit of the present invention.

What is claimed is:

1. A hydraulic cylinder assembly for a telescopic boom of the type in which a plurality of telescopic boom members including a middle and an inner boom member are sequentially extended or retracted, comprising

a first and a second hydraulic cylinder unit, respectively coupled with said middle and said inner boom members and being mounted for movement between a fully upwardly extended and a fully downwardly retracted position;

a first passage provided in said first unit and having an inlet for pressurized hydraulic fluid, and a second passage connecting said first passage with an inlet of said second unit;

a normally closed first valve in said first passage and operative to open under the pressure of fluid entering through said inlet thereof, so that said first unit becomes extended;

a normally closed second valve in said second passage and operative to open when fluid pressure in said second unit exceeds a predetermined value;

a normally closed third valve in said inlet passage;

first abutment means operative to open a third valve in automatic response to said second unit reaching fully retracted position; and

second abutment means operative to open said second valve in automatic response to said first unit reaching fully extended position.

2. A hydraulic cylinder assembly as defined in claim **1**; and further comprising connecting means connecting said first unit with said middle boom member, and said second unit with said inner boom member.

3. A hydraulic cylinder assembly as defined in claim **1,** wherein said second abutment means is provided on said first cylinder unit, and said first abutment means is provided on the inner boom member connected with said second unit.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,871,265 Dated March 18, 1975

Inventor(s) Ryosuke Koga et al.

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

Sheet 3 of the drawings should appear as shown on the attached sheet.

Signed and Sealed this

seventeenth Day of February 1976

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks

FIG. 3

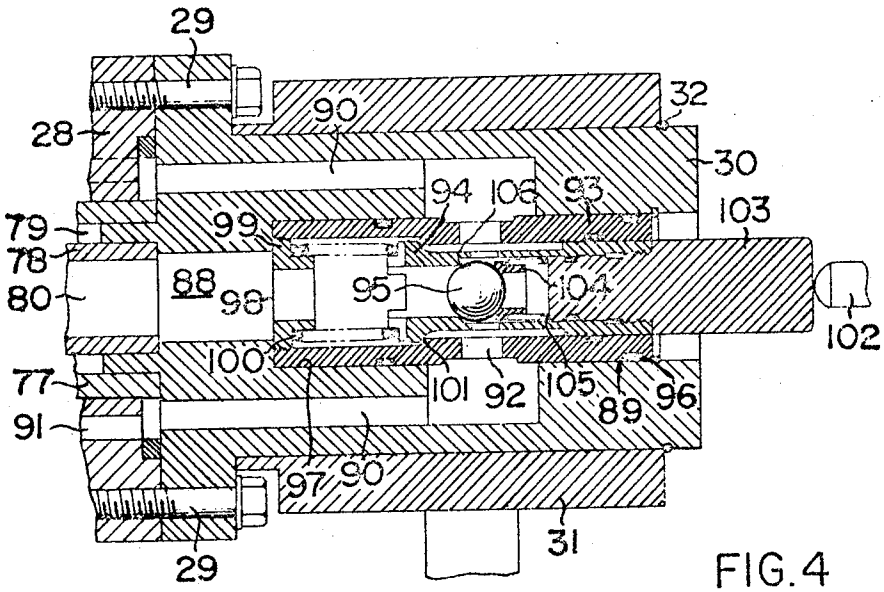


FIG. 4

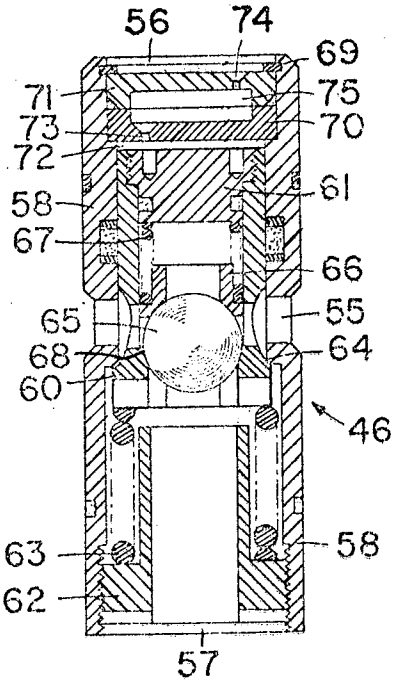


FIG. 5