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 [33] **Japan**
 [31] **43/91833**

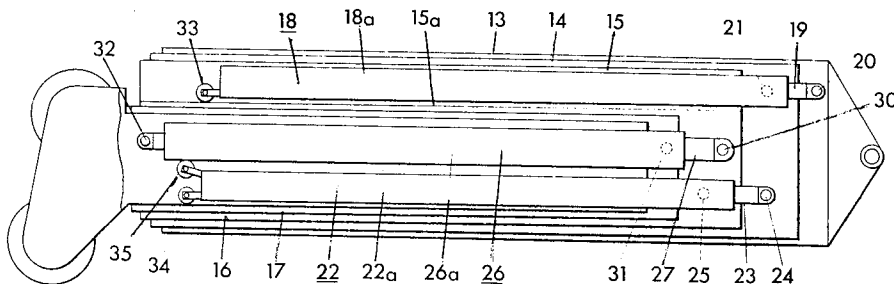
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[54] **EXTENSION MEANS OF A MULTISTAGE**
EXTENSIBLE BOOM
 4 Claims, 11 Drawing Figs.

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 92/146, 60/97 H
 [51] Int. Cl. **F15b 13/07,**
 F15b 15/16
 [50] Field of Search. 91/411,
 413; 60/97 H; 92/118, 146

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ABSTRACT: The present invention discloses an extension means of a multistage extensible boom having more than three boom members and a plurality of hydraulic cylinders and characterized in that each of the hydraulic cylinders is provided with a compressed oil chamber on its extending side and a compressed oil chamber on its retracting side, both of the compressed oil chambers are in serial communication with each other, one of the hydraulic cylinders is connected to the oil pressure supply and discharge circuit, and a plurality of changeover valves controllable by the oil pressure or solenoids are interconnected to respective oil pressure supply circuits connecting the preceding hydraulic cylinder with the succeeding hydraulic cylinder, so that the oil pressure is easily controlled for successively and in regular sequence to actuate respective boom members to an extending or retracting position. A unitary control valve or a plurality of control valves is provided for operating the changeover valves, thereby providing simplicity and accuracy in operation.



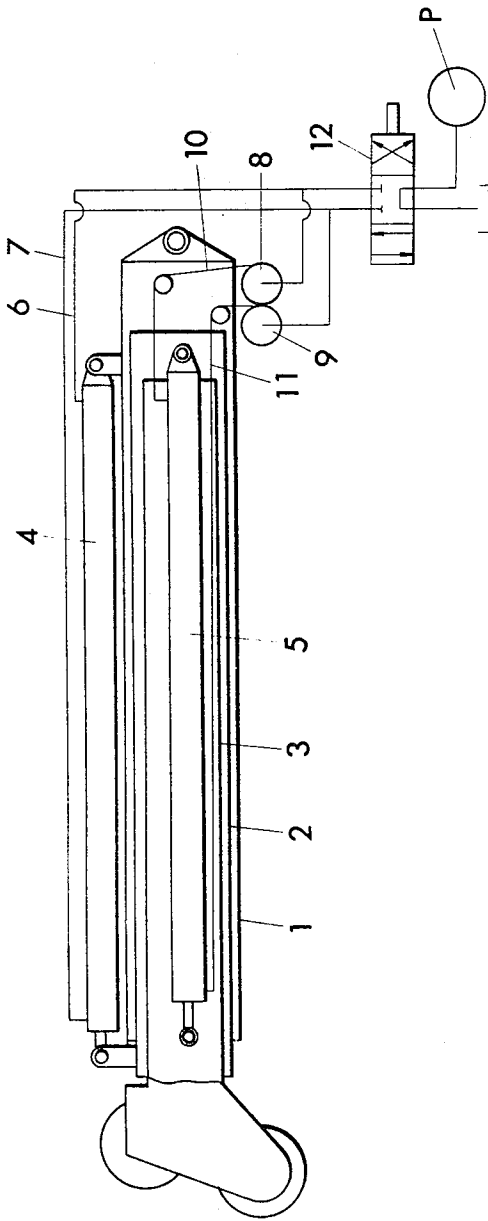


Fig. 1

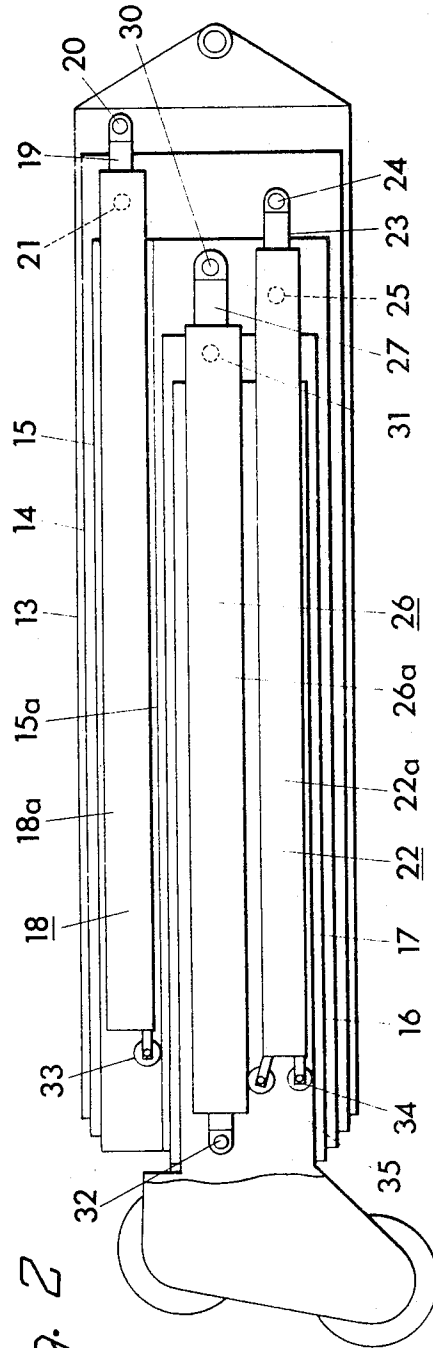


Fig. 2

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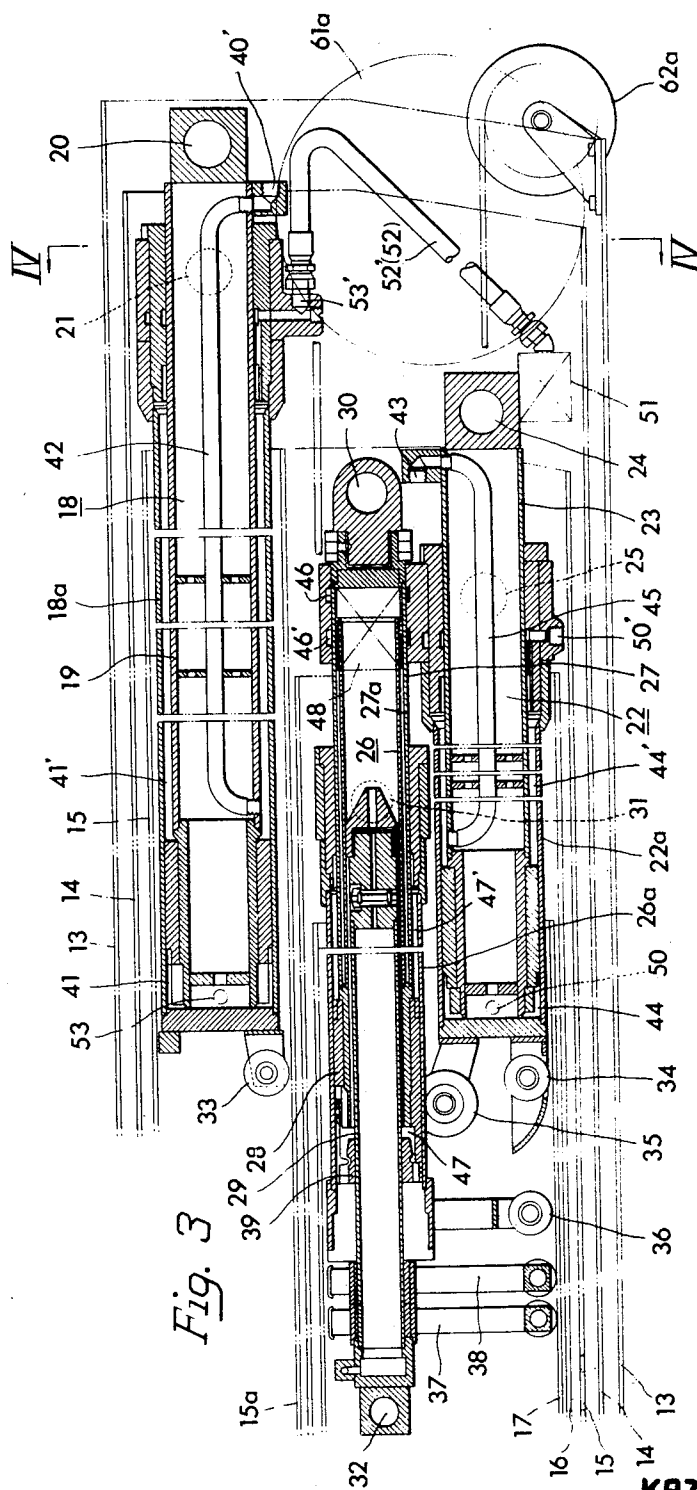


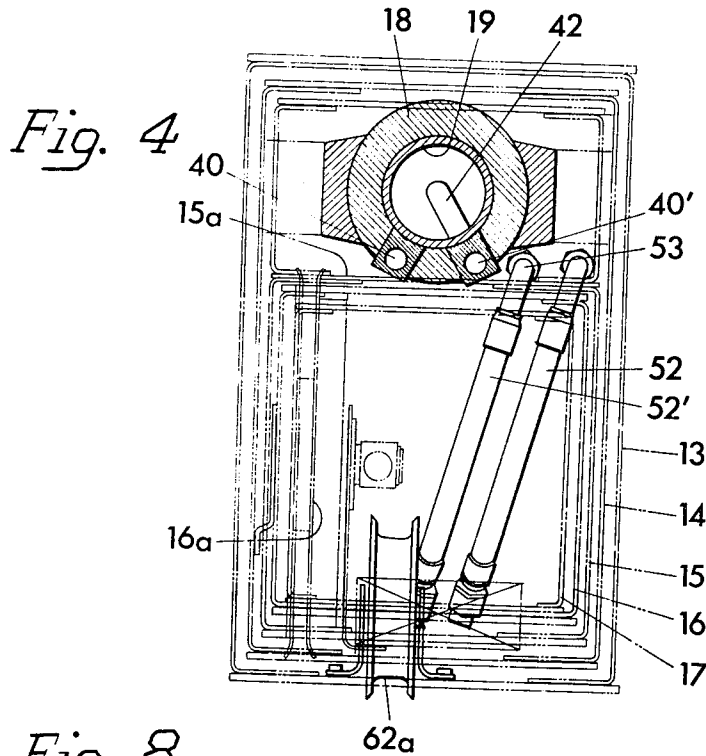
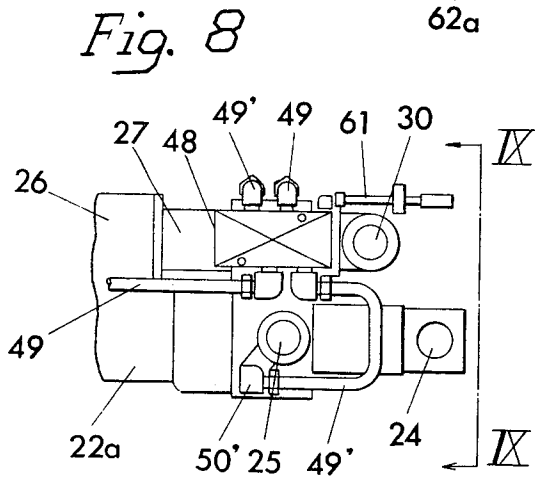
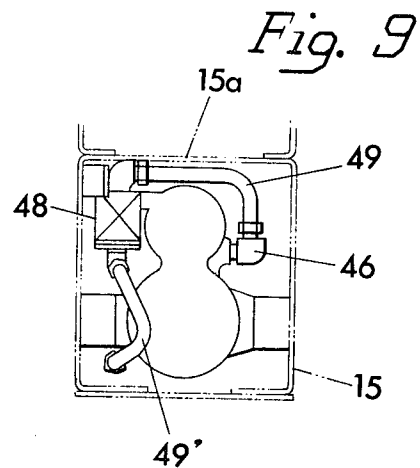
Fig. 3

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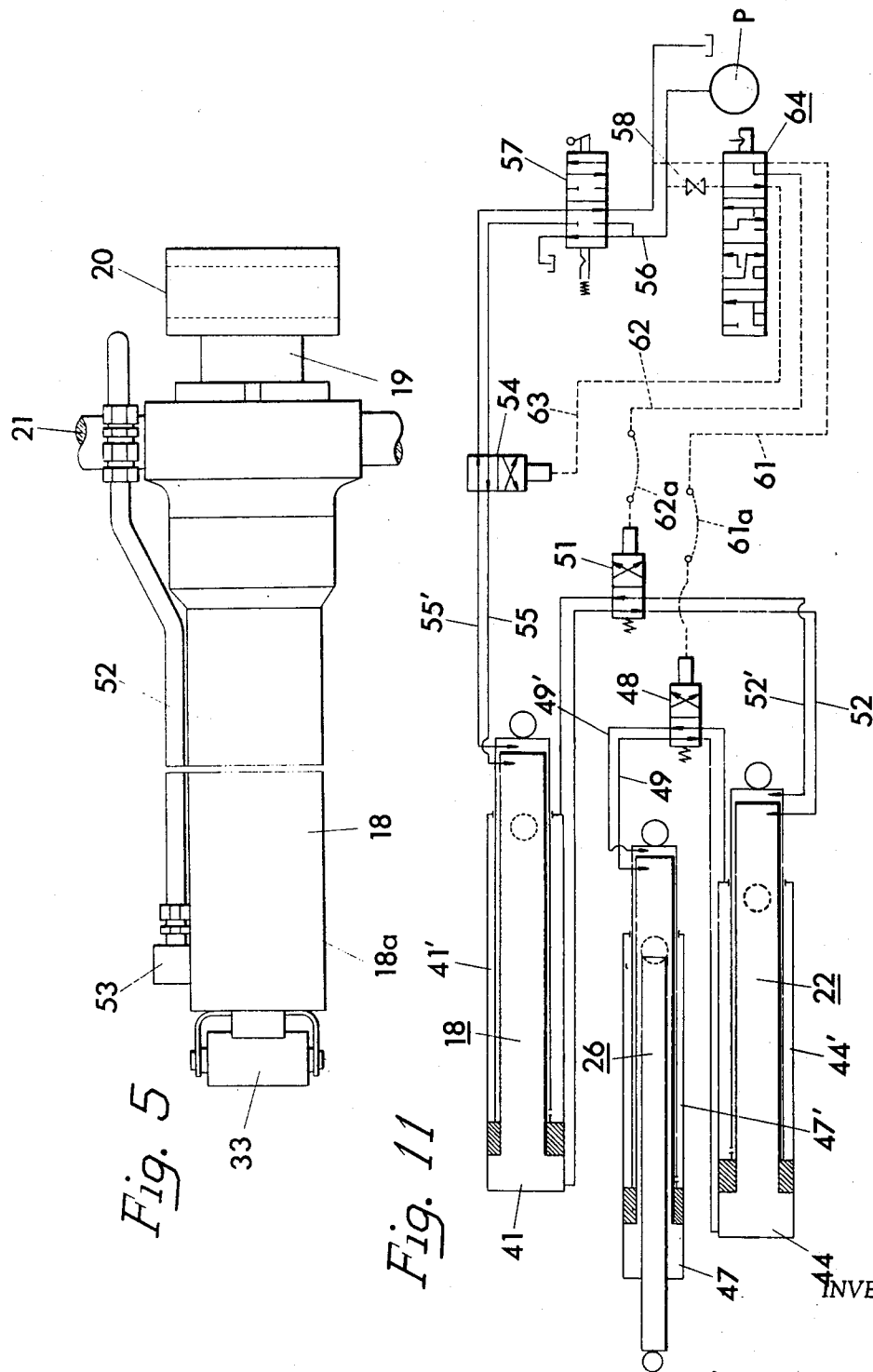


Fig. 5

Fig. 11

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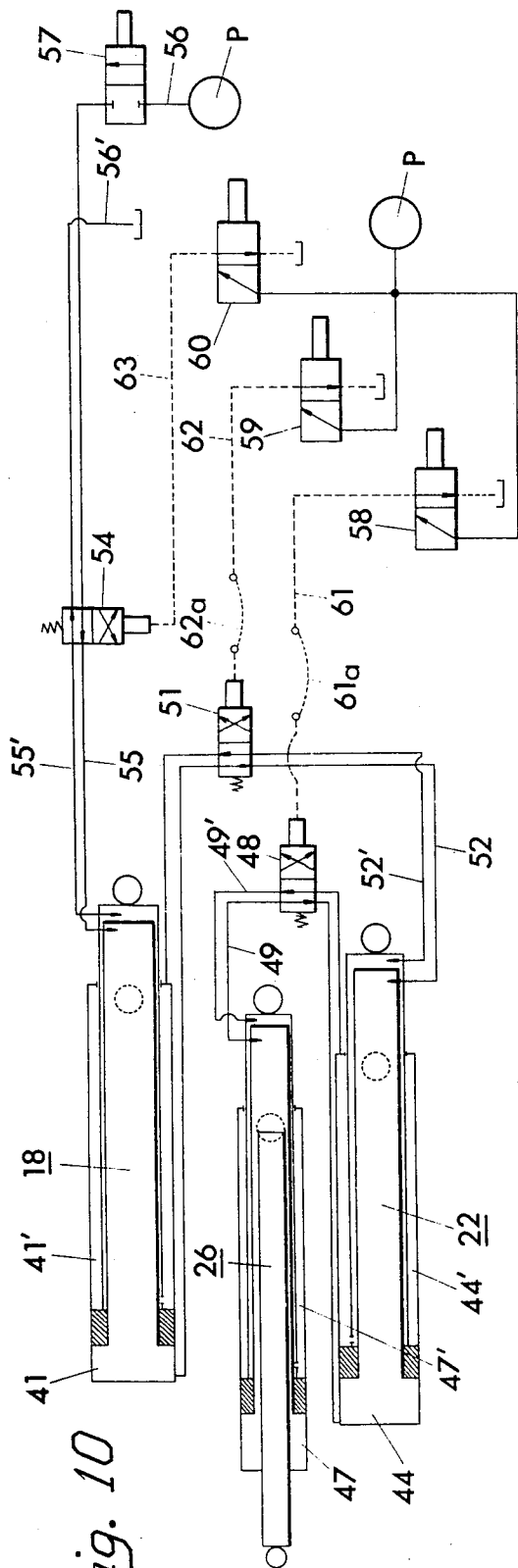


Fig. 10

Fig. 7

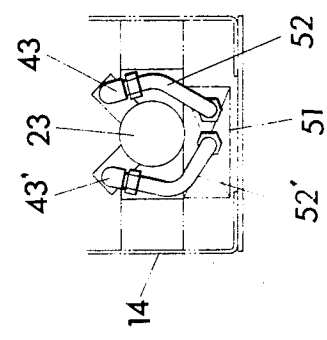
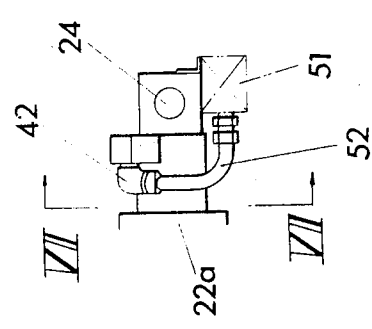


Fig. 6



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EXTENSION MEANS OF A MULTISTAGE EXTENSIBLE BOOM

The present invention relates to an extension means of a multistage extensible boom which has more than three extensible boom members telescopically connected with each other.

Heretofore, the three-stage extensible boom, as shown in FIG. 1, having an outer boom member 1, an intermediate boom member 2 telescopically fitted therein and an inner boom member 3 telescopically fitted into said intermediate boom member 2 has been moved into the extended position or the retracted position by the oil pressure fed to the hydraulic cylinders 4 and 5, the former 4 being arranged between the outer boom member 1 and the intermediate boom member 2, and the latter 5 being arranged between the intermediate boom member 2 and the inner boom member 3. The oil pressure in such a three-stage extensible boom is fed to the hydraulic cylinder 4 through the pressure circuits 6 and 7, while it is fed to the hydraulic cylinder 5 moving according to the extending or retracting motion of the intermediate boom member 2 through the hoses 10 and 11 each arranged so as to be wound up around each of winding rolls 8 and 9. The feed control of oil pressure to respective cylinders 4 and 5 in such structure must be effected by individually or simultaneously connecting the ends of hoses 10 and 11 to the oil pressure circuits 6 and 7.

Furthermore, in the extension means having such a construction that both the oil pressure supply circuits 6 and 7 and the hoses 10 and 11 are serially connected to the changeover valve 12 so as to simultaneously control the plurality of hydraulic cylinders 4 and 5, a drawback has been often encountered such that the regular extension sequence of respective boom members is hardly obtained. Otherwise, in the extension means where a plurality of valves (not shown) are separately connected to the pressure supply circuit connected to the hydraulic cylinder 4 and to another pressure circuit consisting of a plurality of hoses 10 and 11 so as to independently control the plurality of cylinders 4 and 5, the increment in the number of pressure supply circuits, and in the whole length thereof is essential, which is disadvantageous in the economic aspect.

The present invention is made in order to overcome the above drawback and disadvantage of the conventional extension means.

Accordingly, an object of the present invention is to provide a boom extension means for a multistage extensible boom having more than three boom members telescopically extensibly connected to each other and a plurality of hydraulic cylinders arranged through respective boom members and extending longitudinally from a base portion of the multistage extensible boom to a top portion thereof opposite to the base portion, which comprises a compressed oil chamber provided on an extending side of a respective hydraulic cylinder and a compressed oil chamber provided on a retracting side thereof; both of the oil chambers being in serial communication with each other; one of the hydraulic cylinders which positions the extension means at the side closer to a base portion of the boom being connected to an oil pressure supply and discharge circuit; and a plurality of changeover valves controllable by an oil pressure or solenoid and each connected to oil pressure supply and discharge circuits each connecting the preceding hydraulic cylinder with the succeeding hydraulic cylinder.

Another object of the present invention is to provide an extension means for a multistage extension boom, wherein control circuits each connected to each of said changeover valves controllable by the oil pressure or solenoid, are connected to a unitary changeover valve or a single switching means so that respective changeover valves are selectively turned from one position to the other by operating the unitary changeover valve or switching means, thereby controlling the working fluid.

In the accompanying drawings, FIG. 1 is a diagrammatical longitudinal view showing an oil pressure feed circuit of a known three-stage extensible boom;

FIG. 2 is a diagrammatical longitudinal view of a five-stage extensible boom showing a preferred embodiment of the present invention;

FIG. 3 is an enlarged partial longitudinal sectional side view of the substantial part of the extensible boom of FIG. 2;

FIG. 4 is a cross-sectional view taken along the line IV—IV of FIG. 3;

FIG. 5 is a plan view of a first hydraulic cylinder;

FIG. 6 is a side elevation view of a base portion of a second hydraulic cylinder;

FIG. 7 is a view taken along the line VII—VII of FIG. 6;

FIG. 8 is a side elevation view of a base portion of a third hydraulic cylinder;

FIG. 9 is a view taken along the line IX—IX of FIG. 8;

FIG. 10 is a diagrammatical view showing an oil pressure supply circuit arrangement; and

FIG. 11 is a diagrammatical view showing an oil pressure supply circuit arrangement in a boom extension means of another embodiment of the present invention.

At the outset, the first embodiment of the present invention will be described with reference to the accompanying drawings.

In FIGS. 2 through 10, reference numerals 13, 14, 15, 16 and 17 are respectively first, second, third, fourth and fifth boom members having a cylindrical shape and telescopically interconnected to each other so as to afford a sliding motion. The third cylindrical boom member 15 has an internal partitioning wall 15a extending in the longitudinal direction thereof and dividing the internal space into an upper space and a lower space. Numeral 18 is a first hydraulic cylinder arranged within the upper space of the third boom member 15 and extending longitudinally extending through the first and second boom members 13 and 14. The first hydraulic cylinder 18 is connected to the first and second boom members 13 and 14 with the aid of a piston rod 19 secured at its one end to the base portion of first boom member 13 by a pivot 20 and an outer cylinder 18a secured, at the side nearer to the base portion of boom, to the base portion of second boom member 14 by a pivot 21.

Numeral 22 is a second hydraulic cylinder longitudinally extending through the second and third boom members 14 and 15 and connected to both of the boom members 14 and 15 with the aid of a piston rod 23 secured at its one end to the base portion of second boom member 14 by a pivot 24 and an outer cylinder 23a secured, at the side nearer to the base portion of boom, to the base portion of the third boom member 15 by a pivot 25.

Numeral 26 is a third hydraulic cylinder extending longitudinally through the third, fourth and fifth boom members. The hydraulic cylinder 26 is a double-acting three-stage hydraulic cylinder which includes a piston rod 27 extending toward the base portion of the outer cylinder 26a and projecting outwardly thereof, and a plunger piston 29 extending toward the top portion of the outer cylinder 26a and projecting outwardly thereof and being loosely fitted into the tubular piston rod 27 through a piston 28. This hydraulic cylinder 26 is connected to respective boom members 15, 16, and 17 with the aid of the piston rod 27 secured by a pivot 30 to the third boom member 15, the outer cylinder 26a secured by a pivot 31 to the fourth boom member 16 and the plunger piston 29 secured by a pivot 32 to the fifth boom member 17. Numeral 33 is a roller which bears against the top portion of first hydraulic cylinder 18; 34 is a roller which bears against the top portion of second hydraulic cylinder 22; 35 is a roller which supports the outer cylinder 26a of third hydraulic cylinder 26; 36 is a roller which carries the top portion of the outer cylinder 26a, and numerals 37, 38 and 39 are buckling prevention members which support the plunger piston 29.

An oil pressure supply circuit through which the working pressure is applied to the first, second and third hydraulic cylinders 18, 22 and 26 will be described, referring to FIGS. 3 through 10. Numerals 40 and 40' are oil pressure supply ports provided at the base portion of piston rod 19 of the first hydraulic cylinder 18. One port 40 is communicated through

the inside of hollow piston rod 19 with a compressed oil chamber 41 located on an extending side of the first hydraulic cylinder 18, while the other port 40' is communicated through a tube 42 with a compressed oil chamber 41' located on a retracting side of the first hydraulic cylinder 18. Numerals 43 and 43' are oil pressure supply ports provided at the base portion of the piston rod 23 of the second hydraulic cylinder 22. One port 43 is communicated through the hollow piston rod 23 with a compressed oil chamber 44 located on an extending side of the second hydraulic cylinder 22, and the other port 43' is communicated through a tube 45 with a compressed oil chamber 44' located on a retracting side of said second hydraulic cylinder 22. Numerals 46 and 46' are oil pressure supply ports provided at the base portion of the piston rod 27 of the third hydraulic cylinder 26. One port 46 is communicated through the piston rod 27 with a compressed oil chamber 47 located on an extending side of the third hydraulic cylinder 26, while the other port 46' is communicated with a compressed oil chamber 47' located on a retracting side of the third hydraulic cylinder 26, through an oil channel 27a formed between the double cylinders of piston rod 27.

The oil supply to these ports 40, 40', 43, 43' and 46, 46' of respective hydraulic cylinders 18, 22 and 26 will be described hereinafter.

The ports 46 and 46' of the third hydraulic cylinder 26 are connected to a port 50 adjoining to the compressed oil chamber 44 located on an extending side and to a port 50' adjoining to the compressed oil chamber 44' located on a retracting side through working-pressure supply paths or circuits 49 and 49' to which is interconnected a two-way and two-position changeover valve 48. Either port 50 or 50' is provided at the side of outer cylinder 22a. The ports 43 and 43' of the second hydraulic cylinder 22 are connected to a port 53 adjoining the compressed oil chamber 41 located on an extending side of the first hydraulic cylinder 18 and to a port 53' adjoining to the compressed oil chamber 41' located on a retracting side thereof (either of ports 53 or 53' is provided at the side of outer cylinder 18a) through oil pressure supply and discharge paths or circuits 52 and 52' to which a two-way and two-position changeover valve 51 is interconnected. The ports 40 and 40' of the first hydraulic cylinder 18 are connected to an oil pressure supply circuit 56 and a tank circuit 56' through oil pressure supply and discharge circuits 55 and 55' to which a two-way and two-position changeover valve 54 is interconnected. Numeral 57 is a switching valve which is incorporated into the oil pressure supply and discharge circuit connected to the pressure source.

In such oil pressure circuit arrangement, either of the oil pressure circuits 49 and 49' is fixedly arranged between the outer cylinder 22a of second hydraulic cylinder 22 and the piston rod 27 of the third hydraulic cylinder which moves as a whole with the third boom member 15 at the time of the extending or retracting motion of boom. Either of circuits 52 and 52' is fixedly arranged between the outer cylinder 18a of the first hydraulic cylinder 18 and the piston rod 23 of the second hydraulic cylinder 22 which moves as a whole with the second boom member 14 at the time of the extending or retracting motion of boom. Accordingly, there is no requirement for providing a hose for these parts.

Control circuits for controlling respective changeover valves 48, 51 and 54 by the oil pressure are shown in FIG. 10, wherein numeral 58 is a control valve for changeover valve 48; 59 is a control valve for changeover valve 51; and 60 is a control valve for changeover valve 54. Control circuits 61, 62 and 63 are connected between control valves 58, 59 and 60 and changeover valves 48, 51 and 54, respectively, so that the respective changeover valves 48, 51 and 54 are turned from one position to the other by manually operating respective control valves 58, 51 and 60 to feed the oil pressure to respective changeover valves, thereby controlling the working pressure to be applied to the respective hydraulic cylinders 18, 22 and 26. 61a is a pulley for winding up a hose interconnected to the circuit 61 for supplying the working pressure to the chan-

geover valve 48 and moving with the third boom member 15 at the time of the extending or retracting motion of boom. Similarly, 62a is a pulley for winding a hose interconnected to the circuit 62 for supplying the working pressure to the changeover valve 51 and moving with the second boom member 14 at the time of the extending or retracting motion of boom.

The thus-constructed five-stage extensible boom is operated as follows.

AS is best shown in FIG. 10, respective hydraulic cylinders 26, 22 and 18 are maintained in their retracted positions, when the control valves 58, 59 and 60 are set so as to communicate with the tank circuits and the switching valve 57 remains closed. The respective hydraulic cylinders 18, 22 and 26 are actuated in succession to their extending positions in the following manner:

I. When only the control valve 59 is operated to the position to communicate with the oil pressure circuit, and the switch valve 57 is opened, the changeover valve 51 is turned to the other position, e.g., the crossed position, and the oil pressure is fed to the first hydraulic cylinder at its compressed oil chamber 41 located on its extending side through the oil pressure supply circuit 55. The oil pressure is applied from the compressed oil chamber 41 located on the extending side to the compressed oil chamber 44 located on the retracting side of the second hydraulic cylinder 22 through the changeover valve 51 turned to the other position and the pressure supply circuit 52'. The oil pressure is further applied therefrom to the compressed oil chamber 47' on the retracting side of the third hydraulic cylinder 26 through the pressure path 49'. Accordingly, the first hydraulic cylinder 18 is actuated to the extending position, while the second and third hydraulic cylinders are kept in their retracted positions.

II. If the control valve 58 is set so as to communicate with the pressure supply circuit and the switch valve 57 is opened, the changeover valve is turned to the other position. Thus, the oil pressure is supplied to the compressed oil chamber 44 on the extending side of the second hydraulic cylinder 22 from the pressure source through the pressure circuit 55, the compressed oil chamber 41 on the extending side of the second hydraulic cylinder 18 and the pressure supply circuit 52, and further supplied to the compressed oil chamber 47' on the retracting side of the third hydraulic cylinder 26 through the other position of the changeover valve 48 and the pressure supply circuit 49'. Accordingly, the first and second hydraulic cylinders 18 and 22 are actuated to the extending positions, while the third hydraulic cylinder 26 remains retracted.

III. If the switch valve 57 is opened as all of the control valves 58, 59 and 60 are kept in the position communicating with the tank circuit, the oil pressure is supplied to respective hydraulic cylinders 18, 22 and 26 at their compressed oil chambers 41, 44 and 47 on the extending sides thereof, thereby actuating all of hydraulic cylinders 18, 22 and 26 to the extending positions.

IV. If the control valve 60 is operated to communicate with the pressure supply circuit and the switch valve 57 is opened, the oil pressure is supplied to the compressed oil chambers 41', 44' and 47' on the retracting side of respective hydraulic cylinders 18, 22 and 26, thereby returning all of hydraulic cylinders 18, 22 and 26 to the retracted positions as shown in FIG. 10.

It will be clearly understood from the above description that respective hydraulic cylinders 18, 22 and 26 are actuated to their extending or retracting positions by selectively operating respective control valves 58, 59 and 60, so that desired boom members are operated in desired sequence.

FIG. 11 shows another embodiment of the present invention, in which the control valves 58, 59 and 60 of the first embodiment are associated into a unitary changeover valve 64. The unitary changeover valve 64 has four operative positions I, II, III and IV; in detail, three positions to cause any one of control valves 58, 59 and 60 to communicate with the pres-

sure supply circuit, while causing the other two to communicate with the tank circuit, and one position to simultaneously cause all the control valves to communicate with the tank circuit. By selectively operating the unitary changeover valve 64 to a desired operative position, the oil pressure will be supplied to any desired circuit 61, 62 or 63 while the other circuit(s) 61, 62 or 63 communicate with the tank circuit. In this embodiment, respective hydraulic cylinders are actuated in succession to the extending or retracting position to be determined according to the selected operation of the unitary changeover valve to any of operative positions I, II, III and IV. The extension means in this embodiment provides simplicity and ease in the operation of the control valve and accuracy in actuation of the extensible boom, eliminating the problem of separately operating each of the control valves to the operative position.

In this embodiment, the changeover valves 48, 51 and 54 are interconnected to respective pressure supply circuits 49, 49'; 52, 52' and 55, 55', so that respective valves 48, 51 and 54 are operated under remote control by the oil pressure. If rubber hoses are used as pressure supply circuits, a regulating valve 58 must be connected because the working pressure in this device is high. As an alternative, these changeover valves may be replaced by solenoid valves (not shown) which are operated under remote control through electric circuits. In the latter case, the pressure circuits 61, 62 and 63 in the first or second embodiment must be electric circuits, and the control valves 58, 59 and 60 or the unitary changeover valve 64 must be proper switch(es).

The changeover valve 54 connected to the oil pressure supply and discharge circuits connected to the first hydraulic cylinder 18 may be omitted. In this case, the valve 57 must be substituted by a four-way three-changeover valve.

The thus-constructed extension means of the multistage extensible boom according to the present invention is operated to actuate respective extensible boom members to the extending position or retracting position, as described hereinabove. It is advantageous that the extension means of multistage extensible boom can control respective hydraulic cylinders so as to actuate respective boom members of extensible boom successively and in regular sequence to the extending or retracting position, so that respective boom members can be extended to the maximum thereby imparting the maximum lifting capacity to the extensible boom.

The extension means of the extensible boom of the present invention is advantageously simple in its structure and manufactured at low cost, even if the control circuits having changeover valves controllable by the control valves or solenoid are electric circuits or are of the oil pressure control type, since the structure of pressure circuits becomes compact, compared to the conventional one where extension means are incorporated into respective pressure supply circuits extending to hydraulic cylinders and a pressure supply circuit is provided at each of hydraulic cylinders moving at the time of extending or retracting motion of boom.

What is claimed is:

1. In an extension means of a multistage extensible boom having more than three boom members telescopically extensibly connected to each other and a plurality of hydraulic cylinders associated with respective boom members and extending longitudinally from a base portion of said multistage extensible boom to a top portion thereof spaced longitudinally from the base portion, which comprises a compressed oil chamber provided on an extending side of a respective hydraulic cylinder and a compressed oil chamber provided on a retracting side thereof; both of said oil chambers being in serial communication with each other; one of said hydraulic cylinders positioned closest to the base portion of said boom being connected to an oil pressure supply and discharge circuit; and a plurality of changeover valves controllable by one of oil pressure and solenoids and each connected to said oil pressure supply and discharge circuits and each connecting a preceding said hydraulic cylinder with a succeeding said hydraulic cylinder.

2. In an extension means of a multistage extensible boom having more than three boom members telescopically extensibly connected to each other and a plurality of hydraulic cylinders associated with respective boom members and extending longitudinally from a base portion of said multistage extensible boom to a top portion thereof spaced longitudinally from the base portion, which comprises a compressed oil chamber provided on an extending side of a respective hydraulic cylinder and a compressed oil chamber provided on a retracting side thereof; both of said oil chambers being in serial communication with each other; one of said hydraulic cylinders positioned closest to the base portion of said boom being connected to an oil pressure supply and discharge circuit; a plurality of changeover valves controllable by one of an oil pressure and solenoids and each connected to working-pressure supply and exhaust circuits connecting a preceding hydraulic cylinder with a succeeding hydraulic cylinder; control circuits connected to each of said changeover valves controllable by one of oil pressure and solenoids; and a unitary changeover valve or switching means connected to each of said control circuits; said unitary changeover valve or switching means being arranged for selectively operating each of said changeover valves to a desired position.

3. An extension means of a multistage extensible boom as claimed in claim 1, wherein one of said changeover valves controllable by one of oil pressure and solenoids is also connected to said oil pressure supply and discharge circuit connected to one of hydraulic cylinders positioned closest to the base portion of said boom.

4. An extension means of a multistage extensible boom as claimed in claim 2, wherein one of said changeover valve controllable by one of oil pressure and solenoids is also connected to said oil pressure supply and discharge circuit connected to one of hydraulic cylinders positioned closest to the base portion of said boom.

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