Sept. 20, 1971 W. J. LADO 3,605,561

ONE HANDLE SEQUENCE SELECTING VALVING FOR CROWD CYLINDERS

Filed Dec. 22, 1969 3 Sheets-Sheet 1

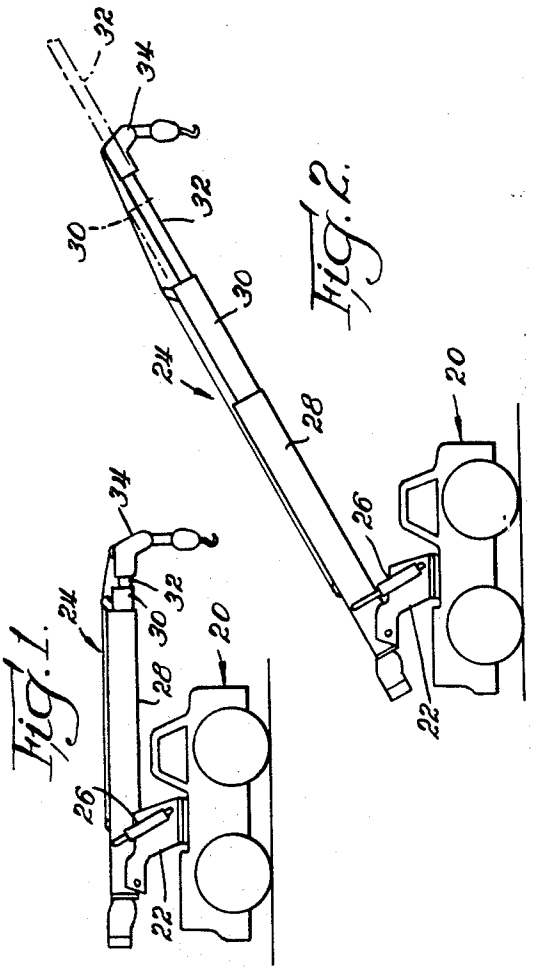


Fig. 2.

Fig. 1.

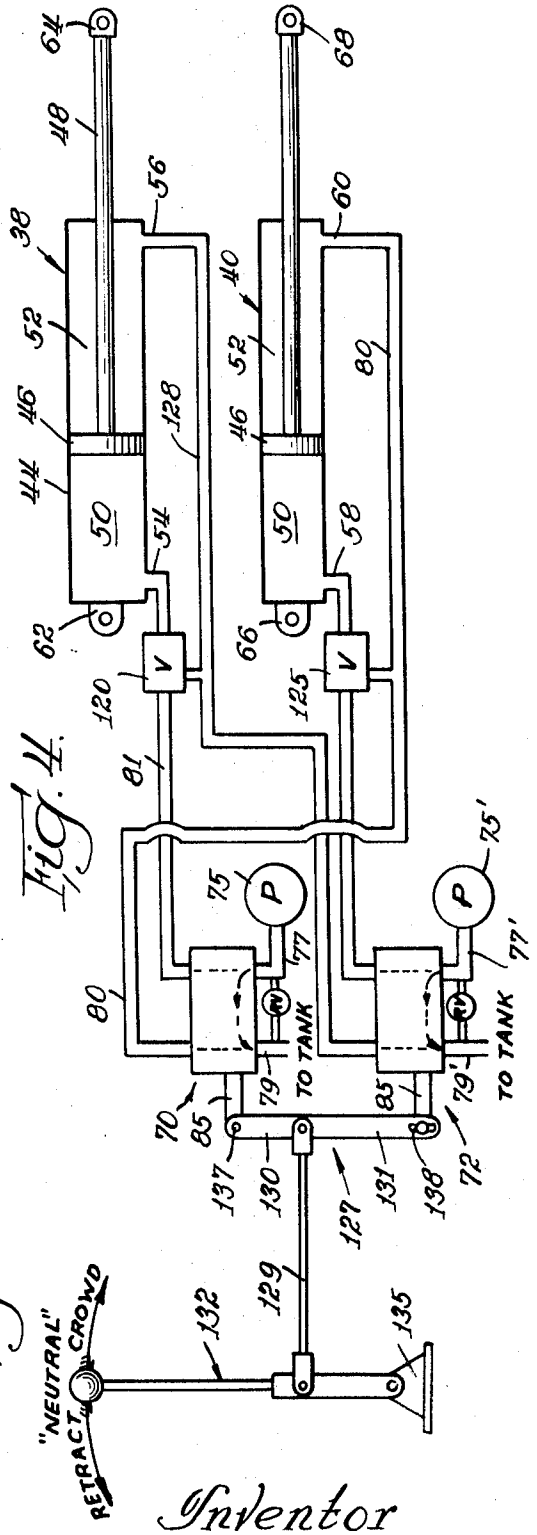


Fig. 4.

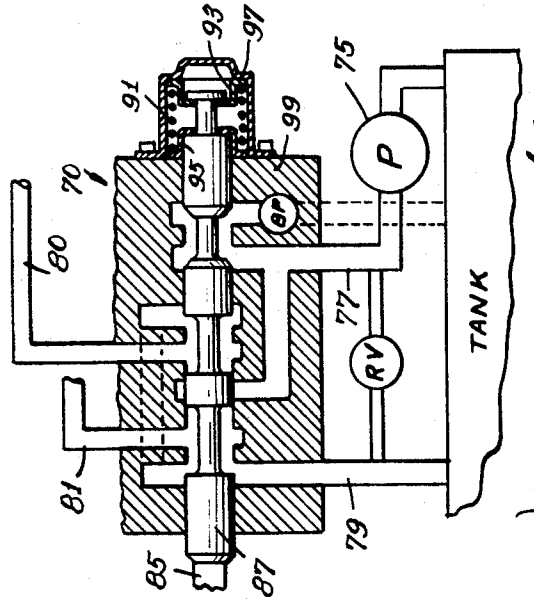


Fig. 3.

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ONE HANDLE SEQUENCE SELECTING VALVING FOR CROWD CYLINDERS

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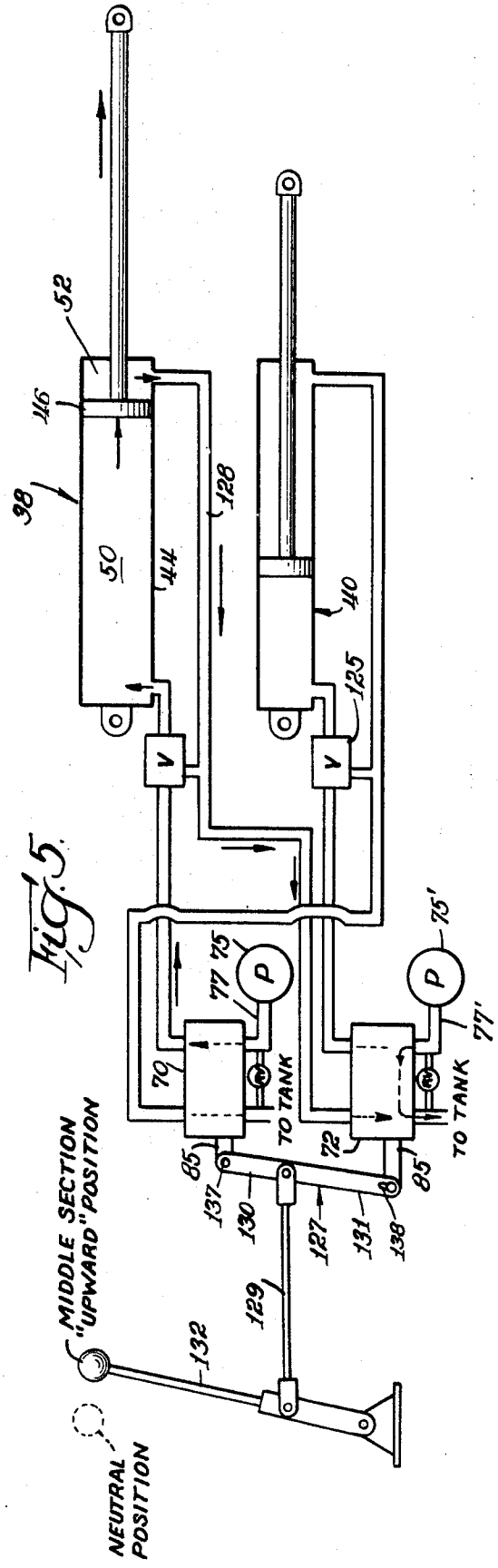


Fig. 5.

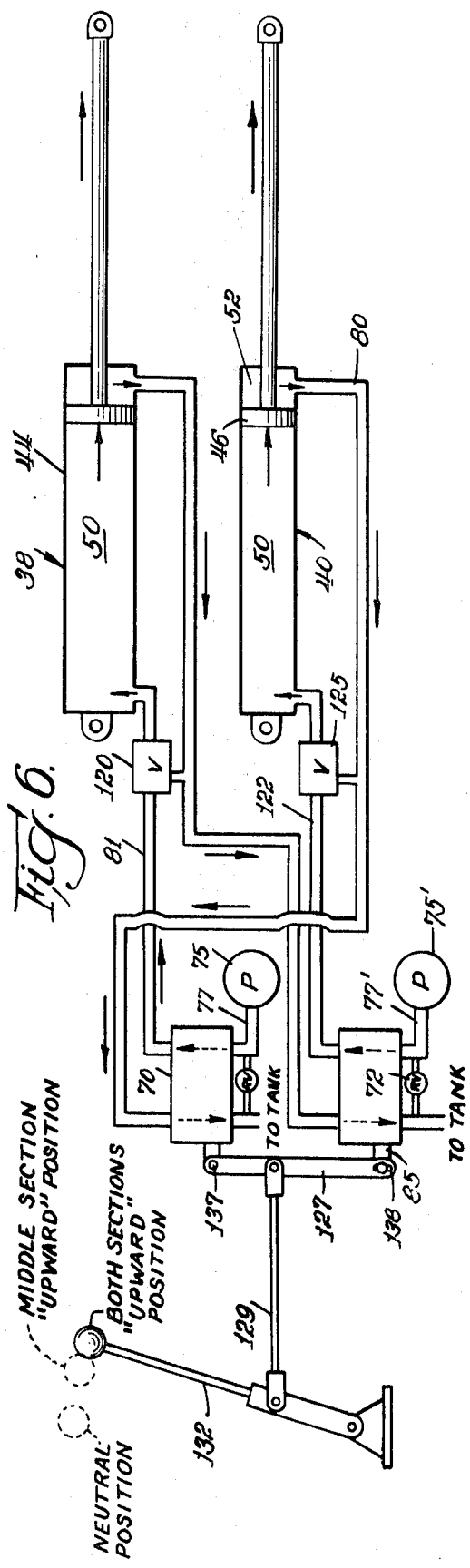


Fig. 6.

Sept. 20, 1971 W. J. LADO 3,605,561

ONE HANDLE SEQUENCE SELECTING VALVING FOR CROWD CYLINDERS

Filed Dec. 22, 1969 3 Sheets-Sheet 3

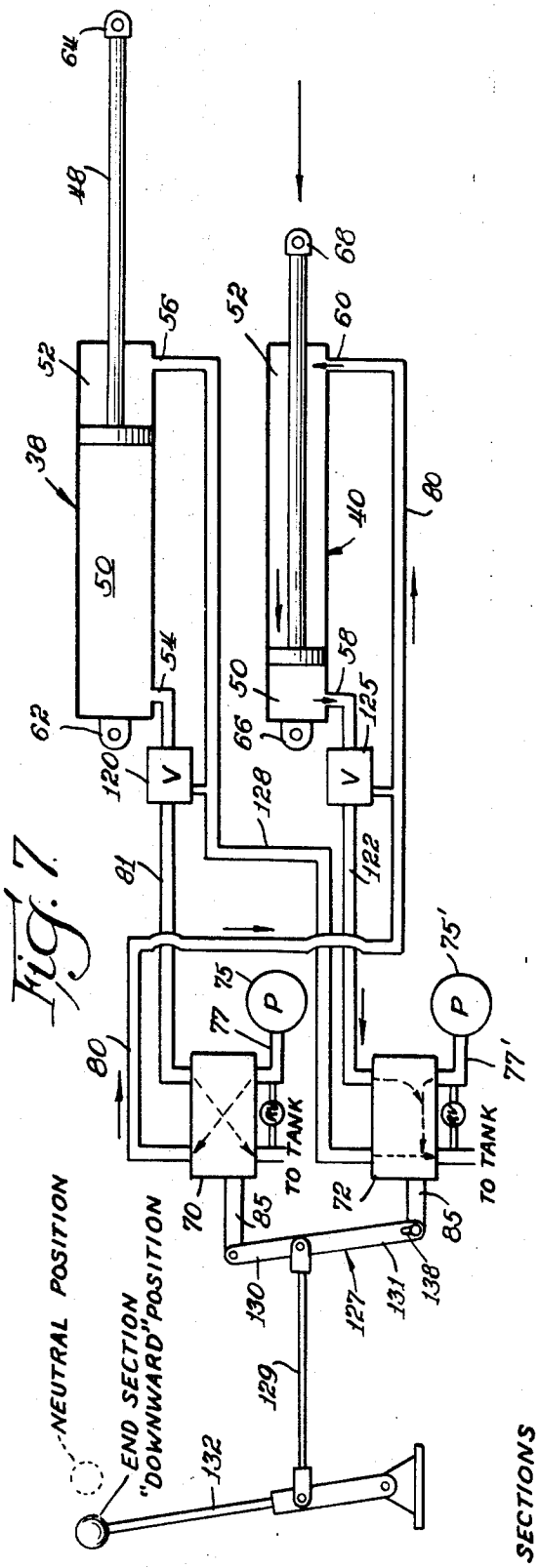


Fig. 7

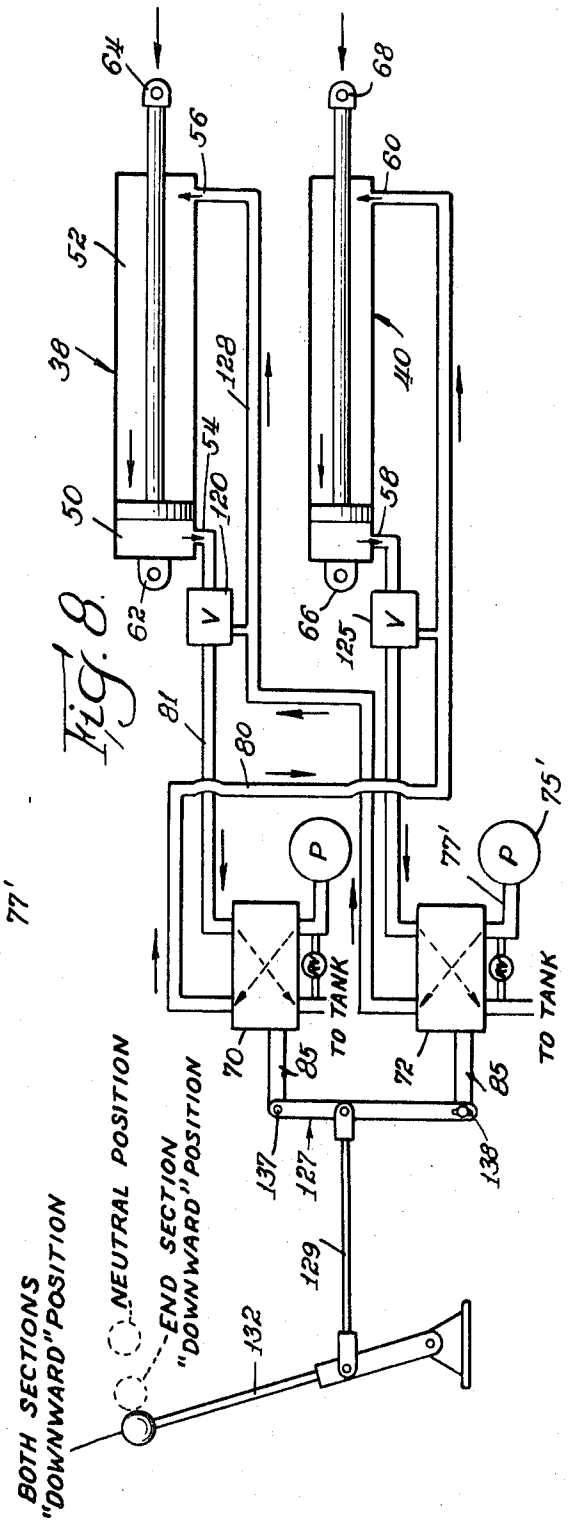


Fig. 8

United States Patent Office 3,605,561 Patented Sept. 20, 1971

3,605,561

ONE HANDLE SEQUENCE SELECTING VALVING FOR CROWD CYLINDERS

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Int. Cl. F15b 15/16
U.S. Cl. 91—413 6 Claims

ABSTRACT OF THE DISCLOSURE

In connection with a three part crane boom having a lighter forward telescopic boom section and a heavier rearward telescopic boom section controlled by separate crowd cylinders, the action is selectively controlled manually by a single handle connected to the valves by a preference linkage. Moving the handle to its limit in either direction will either extend or retract both cylinders simultaneously. Moving the handle half-way in the crowd direction will extend only the cylinder for the larger intermediate section. Moving the handle halfway in the retracting direction will retract only the smaller forward section. The preference linkage prevents the wrong sequencing, i.e., having the lighter forward boom section extended out from the heavier section first, or more than the heavier section is extended out from the still heavier base section.

BACKGROUND AND SUMMARY OF THE INVENTION

The invention, of which this disclosure is offered for public dissemination in the event that patent protection is available, relates to control of the telescopic action in crane booms having three or more parts.

In three part telescopic booms it is very undesirable, or even dangerous, to extend the forward section out of the intermediate section more than the intermediate section is extended out of the base section. The forward section is always of lighter construction than the intermediate section, which in turn is of lighter construction than the base section. The forward section is strong enough for the loads which it is expected to carry when the boom is fully extended, but not for loads to which it could easily be subjected when it alone is extended. This is especially true in connection with mobile cranes on which telescopic booms find their greatest use. These cranes are somewhat limited in their ability to withstand tipping forces, and hence are able to lift much heavier loads close to the wheels than far from the wheels. This factor provides an automatic safety element protecting the lighter forward section of the boom from being excessively loaded, provided that it is not extended out from the intermediate section more than the intermediate section is extended out from the base section.

Some crane experts believe it best that the forward section not be extended at all until the intermediate section is fully extended. This gives maximum protection to the forward, lighter section against being overloaded. Other crane experts believe it is best to provide simultaneous or paced extension, the extension of the forward section from the intermediate section keeping pace with the extension of the intermediate section from the base section. The theory here is that this provides adequate protection of the forward section against overloading, while rarely necessitating full extension of the intermediate section from the base section, thus minimizing canting-force problems. The load at the end of the boom tends to produce a canting-force of the intermediate section in the base section. When sections are well retracted one within the other, the canting-forces present no great

problem because the bearing points for resisting these canting-forces are separated by approximately the amount of the overlap of the two sections. As the sections are extended, however, these bearing points move closer together. At the same time, the leverage arm, represented by the extended length of the boom beyond the base section (which necessarily carries the bearing or support point about which the canting-forces act) is increased. Accordingly extremely high forces are exerted on the opposed bearing points resisting the canting action.

Even when the construction is sturdy enough so that there is no danger of breakage or collapse, there is at least increased friction while the sections move with respect to one another in the nearly fully extended position. At the same time, there tends to be a similar problem with respect to the cylinder and piston combination producing the telescopic action. The weight of these parts produces a sagging tendency with canting-forces between the cylinder and the piston-pistonrod assembly, and the bearing points for resisting this canting-force also move closer together as full extension is approached.

There have been various previous inventions and proposals for meeting the problems here discussed. The present applicant's prior patent, 3,300,060, disclosed a hydraulic control system for the two "crowd" cylinders accomplishing the boom extension which inevitably extended first the cylinder which acted on the intermediate section and inevitably retracted first the cylinder which acted on the forward section. In an application being collaterally filed by the same applicant, a hydraulic system is used which inevitably extends the two cylinders equally or retracts the two cylinders equally.

According to the present invention, a control system is provided which gives the operator a choice between equal action of the two cylinders during extension or retraction, or properly sequencing them during extension or retraction, while preventing the improper sequencing in either case. In spite of this option, the control by the operator is exerted through a single control handle.

The means for accomplishment is quite simple. A key feature is the use of a preference linkage between the single handle and two valves so that for both boom extension and boom retraction one valve has preference and will be the only one actuated if the handle is moved only to the halfway position. This preferred valve, instead of being connected in the usual way with its two cylinder ports (its two control ports) connected to opposite ends of one cylinder is connected to the rear end of one cylinder and to the forward end of the other cylinder. This might seem to present a problem in that heretofore the movement of such a valve in opening the pressure line to one end of the cylinder has also opened the return line from the other end of the cylinder. This problem is solved according to the present invention by using open-neutral valves so that both lines are open to discharge, i.e., to the reservoir, in the neutral position of the valve. Various dangers which this might seem to entail are avoided by placing in each "crowd" line (the line for each cylinder which leads to its rear or lower end) a pilot actuated check valve which prevents outflow from the cylinder except when predetermined positive pressure is supplied to the line leading to the upper or forward end of the same cylinder.

DESIGNATION OF THE FIGURES

FIG. 1 is a schematic elevational view of a mobile crane having hydraulically extendable and retractable boom sections shown in horizontal, completely retracted position.

FIG. 2 is a similar view with the boom slightly elevated and in partially extended condition.

FIG. 3 is a schematic illustration of a conventional self-centering control valve of a type which is useful with this invention.

FIGS. 4 through 7 are schematic diagrams showing the cylinders, hydraulic circuits, control valve linkage and manual control handle in accordance with a preferred embodiment of this invention.

FIG. 4 illustrates the condition of the valving when both valves are in open neutral condition.

FIG. 5 illustrates the condition and flow obtained when the control handle moves to the first "crowd" position.

FIG. 6 illustrates the condition obtained when the control handle is moved to the second "crowd" position.

FIG. 7 illustrates the condition and flows achieved when the control handle is positioned at its first "retract" position.

FIG. 8 represents the conditions and flows obtained when the control handle is positioned at its second "retract" position.

BACKGROUND DESCRIPTION

Mobile crane **20** includes boom supporting superstructure **22**, hydraulically extendable boom, generally **24**, and boom-elevating cylinder **26**. Boom **24** includes three sections, namely main section **28**, intermediate section **30** and end section **32**. Cable operated lifting mechanism, generally **34**, is fixed to the extreme end of end section **32**. Section **32** telescopes within middle section **30** and middle section **30** telescopes into main section **28**. Sections **30** and **28** must be successively stronger than end section **32** in order to support the maximum load, the distances or lever arms being successively longer.

Extension and retraction of telescoping section **30**, **32** is accomplished by means of hydraulic cylinder-piston units, respectively **38**, **40**, which are similar, although cylinder unit **38** is preferably of greater diameter than cylinder unit **40**. Each cylinder unit **38**, **40**, includes cylinder **44**, movable piston **46**, piston rod **48**, face chamber **50** and rod chamber **52**. Cylinder unit **38** includes face chamber conduit connection **54** and rod chamber conduit connection **56**. Cylinder unit **40** includes face chamber conduit connection **58** and rod chamber conduit connection **60**. Cylinder-end connector **62** and rod-end connector **64** illustrates fastening means by which cylinder **44** and rod **48** are respectively fixed to main boom section **28** and intermediate boom section **30**. Cylinder-end connector **66** and rod-end connector **68** schematically illustrate fastening means by which cylinder **44** and rod **48** of cylinder unit **40** are fastened to intermediate boom section **30** and end boom section **32**, respectively.

CONTROL VALVES

This invention departs from conventional practice especially in its hydraulic circuitry, which may be called criss-cross connection of the cylinders to the valves. The choice of valve and the preferable linkage for operating the valves are related to this hydraulic circuitry.

Valves **70**, **72** are both of the spring-centered 3-position, open neutral type, such as Vickers model CM2NO2, illustrated in FIG. 3. Hydraulic fluid under pressure is supplied by pump **75** or **75'** through pump lines **77** or **77'**. Return line **79** carries hydraulic fluid back to a tank or reservoir. Hydraulic conduits **80**, **81** are varyingly connected, depending on the position of spool **87**. In open neutral position of spool **87** shown in FIG. 3, the return line **79** is open to all the other conduits, so that in effect all four conduits are freely open to one another. Conduits **80**, **81** may be considered under substantially "0" pressure. The broken line connection at passage "BP" recognizes that this passage is connected to line **79** only if no other valve uses the pressure supply.

Control rod **85** is an extension of valve spool **87**. Spring **91** biases cups **93** and **95** against cover-stop **97** and body or stop **99** respectively. Thus movement of rod **85** toward the right hand side of FIG. 3 moves spool **87** and cup **95**, compressing spring **91** until cup **95** strikes cup **93**. This movement shifts spool **87** to the position which may be called forward flow. The lands of the spool will now be positioned to shut off passage "BP" and connect line **81** to pressure line **77** and **80** to return line **79**. Upon release of driving force at rod **85**, the spring **91** causes cup **95** and spool **87** to shift back to neutral, this movement ceasing when cup **95** strikes stop **99**.

When control rod **85** and spool **87** are shifted from neutral to the left, forcing cup **93** to compress spring **91** until the cups come into contact, and the spool is in the reverse flow condition, fluid under pressure at conduit **77** is then directed into conduit **80**, rather than conduit **81**, and fluid in conduit **81** is directed into return line **79**. Upon release of the force on rod **85** spring **91** returns cup **93**, and spool **87** back to the neutral position illustrated in FIG. 3, i.e., with cup **93** resting against stop **97**.

For simplicity of diagramming in FIGS. 4 to 8 the valve ports do not have the same positions as in FIG. 3.

HYDRAULIC "CIRCUITS"

As seen in FIG. 4 line **81** of valve **70** is the "crowd" line for cylinder unit **38**, being hydraulically connected (through a safety valve **120** such as a pilot actuated check valve), to main cylinder face chamber connection **54**. Line **122** of valve **72**, which corresponds to line **81** of valve **70** is the retract line for cylinder unit **38**, being hydraulically connected (through similar safety valve **125**). When pressured fluid is supplied through line **81** it extends cylinder unit **38** and intermediate boom section **30**. The return line for oil which must flow from connection **56** at the other end of the cylinder **44** as the piston moves toward it is line **128**. Instead of being connected to the same valve **70** according to standard practice, this line criss-crosses to valve **72**.

Similarly, the connections of cylinder unit **40** are criss-crossed. Its crowd line **122** (with a similar safety valve **125**) is connected to the right hand port of valve **72**, but its other line **80** is connected to the left-hand port of valve **70**.

PREFERENCE LINKAGE

Control rods **85** are pivotally secured to bridge **127**, a slot **128** or an extra link giving freedom of movement. Master control rod **129** is pivotally secured to bridge **127** at a point which is substantially closer to control rod **85** of valve **70** than to control rod **85** of valve **72**, so that portion **130** of bridge **127** is substantially shorter than portion **131**. Control handle **132**, pivotally mounted to support **135**, is pivotally connected to master control rod **129**. In the illustrated embodiment, the straight up and down position of handle **132** represents its open neutral position. Handle positions to the right of open neutral, as viewed in FIG. 3 are "crowd" control positions and, to the left are "retracting" control positions, (see FIG. 3). This linkage is a preference linkage causing handle **123** always to operate valve **70** first. Theoretically a preference linkage could have portions **130** and **131** equal if the springs of valve **72** were stiffer than the springs of valve **70**. Other preference means could be used, but manual control of cylinder position is desired, to be able to adjust the flow rate.

HYDRAULIC CIRCUIT OPERATION

The arrows drawn within the hydraulic system set forth in FIGS. 4 through 8 represent lines of flow within the system. The dotted lines drawn through valves **70**, **72** indicate passageways opening to a return line **79** which are available through valves **70**, **72** in the position indicated.

Pilot actuated check valves **120**, **125** derive their pilot pressures from rod chamber lines **128**, **80**, respectively and prevent flow out from face chambers **50** in the absence of a substantial threshold pressure in the corresponding rod-chamber hydraulic line, **128**, **80**. This is a

conventional safety feature, but serves a new purpose here. Specifically, it makes possible the use of open neutral valves, which in turn permit the criss-cross hydraulic connections.

The configuration illustrated in FIG. 4 represents the condition obtained when boom sections **30, 32** are half-way extended and control handle **132** is in the neutral position.

FIGS. 5 and 6 represent the conditions obtained when control handle **132** is moved in successive steps in the "crowd" direction, i.e., toward the right, as viewed in FIG. 5.

FIGS. 7 and 8 illustrate the conditions obtained when control handle **132** is moved in successive steps in the "retract" direction, i.e., toward the left of "neutral" as viewed in FIG. 3.

Control handle **132** will assume the "neutral" position, absent substantial urging in either direction, because of the biasing action of spring **91**. In this configuration hydraulic lines **81, 128, 122,** and **80** are open, through respective valves **70, 72** to a return line **79** which may be thought of as having the "0 pressure" of the reservoir. However pilot actuated check valves **120, 125** prevent flow of fluid through lines **81, 122,** respectively from face chambers **50,** and thus prevent retraction of cylinder rods **148,** and telescoping of sections **130, 132** within main section **128.** Fluid, under pressure from pumps **75, 75'** shunts through valves **70, 72** to return lines **79.** Thus, in the "neutral" condition, the status quo of sections **30, 32** is maintained by check valves **120, 125** and pressurized hydraulic fluid in lines **77** is merely recycled to the tank.

CROWDING

Movement of handle **132** in the "crowd" direction axially shifts master control rod **129** toward valves **70, 72.** Movement of master control rod **129** is transmitted to control rods **85** through bridge **127.** However, since movement in either direction of control rods **85** is resisted by identical biasing springs **91** and since master control rod **129** is pivotally connected to bridge **127** at a point such that portion **130** is substantially shorter than portion **131** of bridge **127,** control rod **85** at the end of short portion **130** will be the first to yield. This shifts spool **87** in valve **70** in the "crowd" direction, allowing hydraulic fluid in line **77,** under pressure from pump **75,** to pass through valve **70** as indicated in FIG. 5 into conduit **81** and thence into face chamber **50** of cylinder **44.** Valve **125** opens as a simple check valve to flow in this direction. Fluid forced out of rod chamber **52** by the movement of piston **46** in the extension direction passes by way of rod chamber conduit **128** through valve **72** (in open center condition) to return line **79.** No change occurs in the status of the other cylinder unit **40** since both of its lines **80** and **122** remain open to a return line **79.**

When rod **85** of valve **70** reaches the limit of its movement, continued movement of handle **132** must move control rod **85** of valve **72.** Hence the condition illustrated in FIG. 6 is obtained, and in this condition, both telescoping sections **30, 32** of the boom **24** are urged toward the extended condition. Valve **72** is now also positioned in the "crowd" configuration and fluid in line **77',** under pressure from pump **75',** passes to line **122** and readily passes through check valve **125** into face chamber **50** of cylinder unit **40.** Piston **46** of cylinder unit **40** is urged in the "extension" direction and fluid in rod chamber **52** of cylinder unit **40** passes through rod chamber conduit **80** which is now connected through valve **70** to return line **79** and the tank. Pump **75** for valve **72** may be smaller than pump **75** for valve **70,** in proportion to the cylinder cross-actions, so that the speed of extension of the lighter boom section will not be greater than the speed of extension of the heavier section. The piston rod of unit **38** can be larger in diameter so that the retracting speeds will be equal.

The operator wishing to extend boom **24** has the option of moving control handle **132** to the first position illustrated in FIG. 5 to extend only the heavier, middle section **30.** He also has the option of moving control handle **132** to the extreme "crowd" position illustrated in FIG. 6 in which both the heavier middle section **30** and the lighter end section **32** are extended. Release of handle **132** by the operator automatically causes the return of handle **132** to the neutral configuration illustrated in FIG. 4 because of the biasing action of springs **91.** However, the operator also has the option of manually returning handle **132** initially only half-way to the neutral configuration, i.e., to the position illustrated in FIG. 5, which automatically causes the lighter end section **32** to remain at the status quo, while the heavier middle section **30** continues to extend.

RETRACTING

"Retraction" control conditions are illustrated in FIGS. 7 and 8. Movement of handle **132** in the direction away from valves **70, 72** causes a corresponding shift in the position of master control rod **129.** Again, any movement of control rods **85** must be transmitted through bridge **127.** However, since bridge portion **130** is substantially smaller in length than bridge portion **131,** the difference in leverage causes springs **91** at valve **70** to yield first so that the configuration illustrated in FIG. 7 is first obtained. In this configuration, spool **87** is shifted to the "retract" condition so that fluid in line **70,** under pressure from pump **75,** passes through valve **70** to line **80** and thence into rod chamber **52** of cylinder unit **40** which tends to cause the retraction of the lighter boom section **32.** However, pilot actuated valve **125** would prevent this, except that pressure in line **80** actuates pilot check valve **125** permitting fluid from face chamber **50** of cylinder unit **40** to pass by way of hydraulic line **122** through valve **72** to the tank. Since, under these conditions, line **128** is open to return line **79** through valve **72,** there is inadequate pressure to the pilot connection of check valve **120** to permit change in the status of heavier, middle cylinder unit **38.**

Continued movement of control handle **132** in the "retract" direction again shifts master control rod **129** correspondingly. When valve **70** has reached the limit of its movement control rod **129** forces control rod **85** of cylinder **72** outwardly, i.e., to the left as indicated in FIG. 8, bringing valve **72** into the "retract" configuration also. Since this leads to no change in the connections to end section cylinder unit **40,** the discussion of those conditions will not be repeated. However, this does lead to a change in the flow through valve **72.** Hydraulic fluid in line **77',** under pressure from pump **75',** passes through valve **72** into rod chamber line **128,** thence into rod chamber **52** of cylinder unit **38.** Generation of pressure in line **128** actuates pilot valve **120** permitting fluid from face chamber **50** of cylinder unit **38** to return by way of hydraulic conduit **81** through valve **70** to the tank.

Again, release of handle **132** by the operator results in automatic return of handle **132** to the "neutral" position illustrated in FIG. 4 because of the biasing action of springs **91** at valves **70,** and **72.** Again, however, the operator can elect to return handle **132** by bringing it first only to the configuration shown in FIG. 7 at which point the retraction of the middle section is halted and retraction of the lighter end section is continued.

As to both crowding and retracting handle **132** may be moved all of the way at once, in which case the sequence is so rapid that the beginning of movement of the middle and end sections is apparently simultaneous.

ACHIEVEMENT

Using the novel arrangement described hereinbefore, the operator has the option, using only one handle, of extending or retracting the telescoping boom sections, one at a time or both at once, but is prevented from

the dangerous operation of extending the light section first or retracting it last.

I claim:

1. In a crane having a three-part telescoping boom, said boom comprising a heavier rearward telescoping section and a lighter forward telescoping section, each of said sections controlled by separate respective crowd cylinders, the improvement comprising:

manual control means for extending and retracting said sections, said control means having a single operator controllable handle, said handle having a neutral position and being movable to a first crowd position and a second crowd position on one side of said neutral position; and to a first retract position and a second retract position on the opposite side of said neutral position;

and valve means controllable by said control handle for selectively extending said heavier section when said handle is in the first crowd position, for simultaneously extending both sections when the handle is in the second crowd position, for selectively retracting said smaller section when said handle is in the first retract position, and for simultaneously retracting both sections when said handle is in the second retract position, said control means and valve means being incapable of selectively retracting the heavier section.

2. The improvement of claim 1 in which said valve means comprises two separate self-centering valves, each operable by its respective control rod, and in which said control means includes preference linkage means for connecting said handle to each of said respective rods, and means, responsive to the movement of said handle, for moving one of said rods when said handle is in one of said first positions, and for moving the other of said rods when the handle is in the second of said operating positions.

3. The improvement of claim 1 in which said valve means comprises two separate valves, each operable by its respective control rod, and in which said control means includes preference linkage means for connecting said handle to each of said respective rods, and means, responsive to the movement of said handle, for moving one of said rods when said handle is in one of said first positions, and for moving the other of said rods when the handle is in the second of said operating positions, said preference linkage including bridge means pivotally joined at each end to said rods;

respective bias means for urging respective valve means to said open middle neutral position;

connecting rod means for connecting said handle and said bridge means at some point between said attachment of said rods to said bridge, the point of attachment and the relative strength of the bias means having been pre-selected for activation of one valve means upon movement of said handle to either of said first positions, and for activation of both valve means upon movement of said handle to either of said second operating positions.

4. A crane having a boom with base section and intermediate and forward telescopic sections of successively reduced sturdiness, a cylinder unit for each telescopic section for extending and retracting it upon supplying hydraulic fluid respectively through crowd and retraction lines, and a pair of spring-centered reversing valves each having three positions for controlling the supply of hydraulic fluid through said lines, characterized by

a single member operator-controlled for controlling both valves, means responsive to said single member for giving preference to a preferred one of said valves whereby the nonpreferred valve will remain in neutral position except upon further actuation of the single member while the preferred valve is in actuated position;

said lines having criss-cross connections to the valves, with a crowd line for extending the intermediate section and a retraction line for retracting the end section being connected respectively to the two cylinder ports of the preferred valve, and the crowd lines for the end section and the retraction line for the intermediate section being correspondingly connected to the non-preferred valve; and

said valves being of open neutral type and each supplied with hydraulic fluid from a separate pump.

5. A boom according to claim 4 in which the output capacities of the pumps have substantially the same relationship as the cross-sectional areas of the cylinder units, to provide substantially equal speed of extension of the sections when the single means is fully operated in the crowd direction.

6. In a crane having a three part telescoping boom, said boom comprising a heavier rearward telescoping section and a lighter forward telescoping section, each of said sections controlled by separate respective crowd cylinders, the improvement comprising:

manual control means for extending and retracting said sections, said control means having a single operator controllable handle, said handle having a neutral position and being movable to a first crowd position and a second crowd position on one side of said neutral position; and to a first retract position and a second retract position on the opposite side of said neutral position;

and valve means controllable by said control handle for connecting two pumps for selectively extending said heavier section when said handle is in the first crowd position, for simultaneously extending both sections when the handle is in the second crowd position for selectively retracting said smaller section when said handle is in the first retract position, and for simultaneously retracting both sections when said handle is in the second retract position, said control means and valve means being incapable of selectively retracting the heavier section; and

the output capacities of the pumps having substantially the same relationship as the effective cross-sectional areas of the cylinder units, to provide substantially equal speed of extension of the sections when the single means is fully operated in the crowd direction.

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EDGAR W. GEOGHEGAN, Primary Examiner

U.S. Cl. X.R.

91—411A; 137—636, 625.69, 596