United States Patent

[11] 3,578,787

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[54] **CONTROL SYSTEM**
5 Claims, 7 Drawing Figs.

[52] **U.S. Cl.** **212/59,**
212/55, 212/44, 212/31, 214/138, 254/150,
254/186, 254/185
[51] **Int. Cl.** **B66c 23/06**
[50] **Field of Search** 254/184,
185, 186, 150, 145; 212/55, 54, 31; 91/461

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ABSTRACT: A control system for a convertible pullshovel-crane wherein a plurality of hydraulic cylinders and/or hydraulic motors are actuated by a combination of air cylinders and hydraulic valves. In one embodiment, booster means for some of the hydraulic cylinders are provided with interlocks to prevent booster operation under certain conditions. In another embodiment, a plurality of hoist drums are controlled by the hydraulic motors, with the drums having both friction brakes as well as friction clutches to provide flexibility of cable control. Various bypasses and interconnections in the pneumatic circuit permit varying or fixing certain drum speeds.

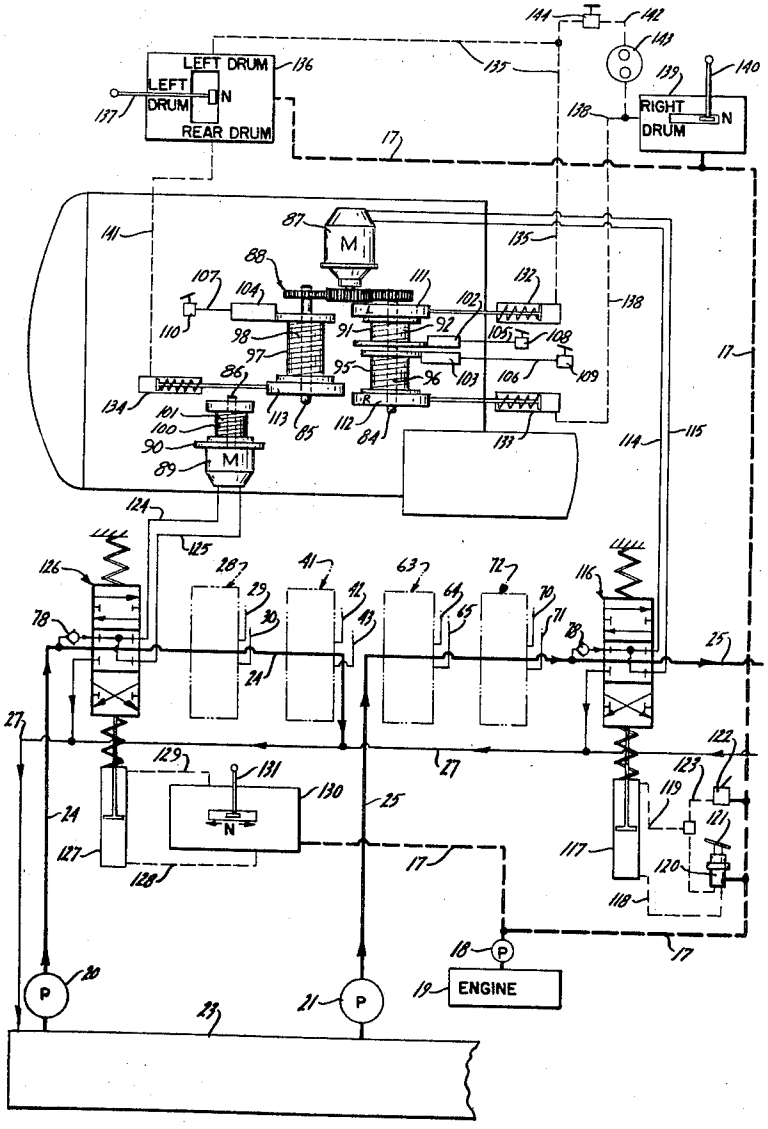
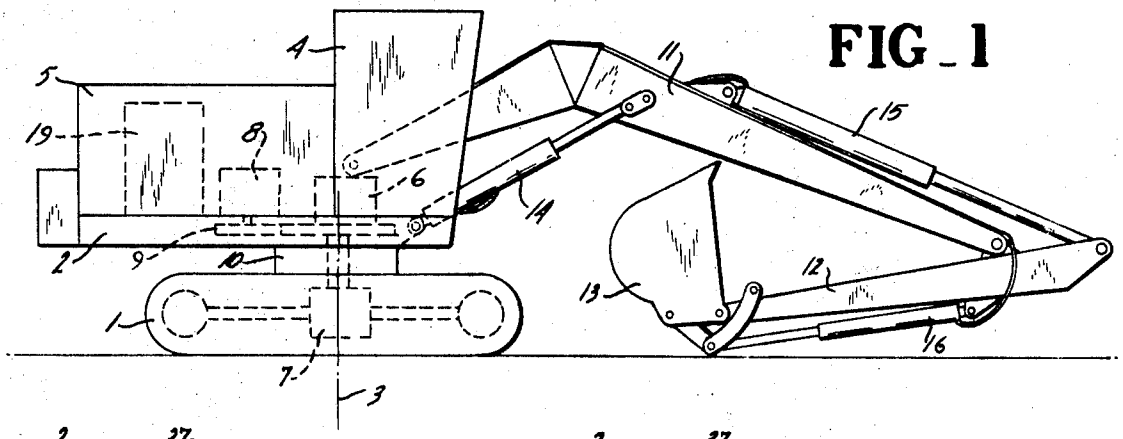


FIG_1



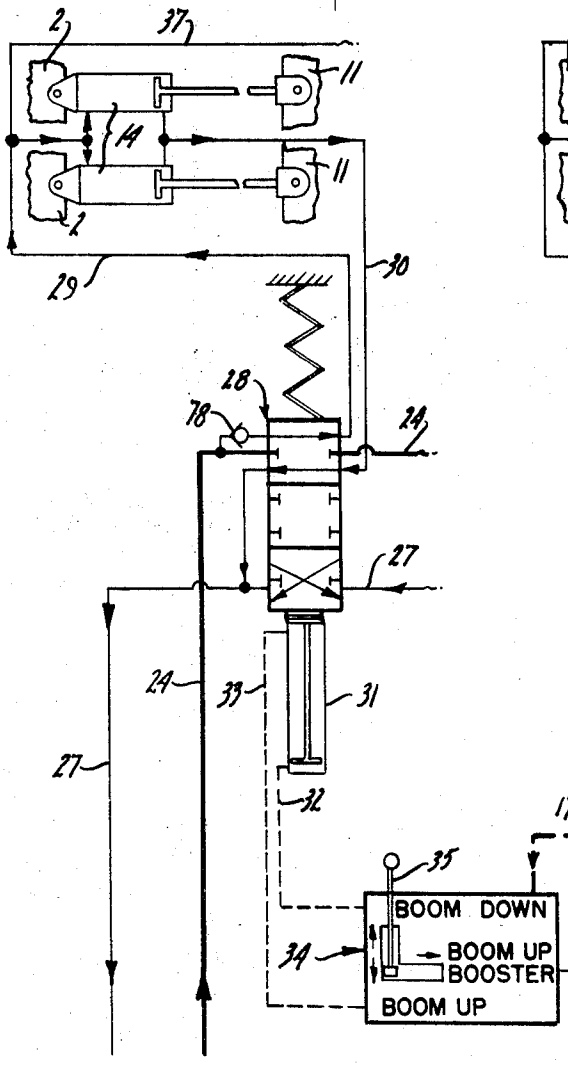


FIG_3

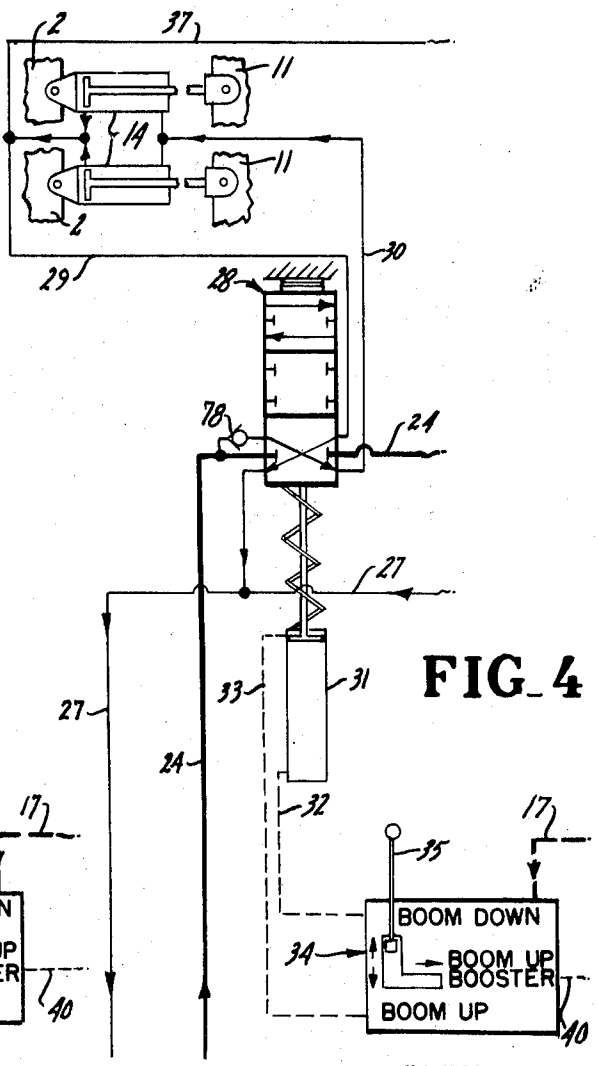


FIG_4

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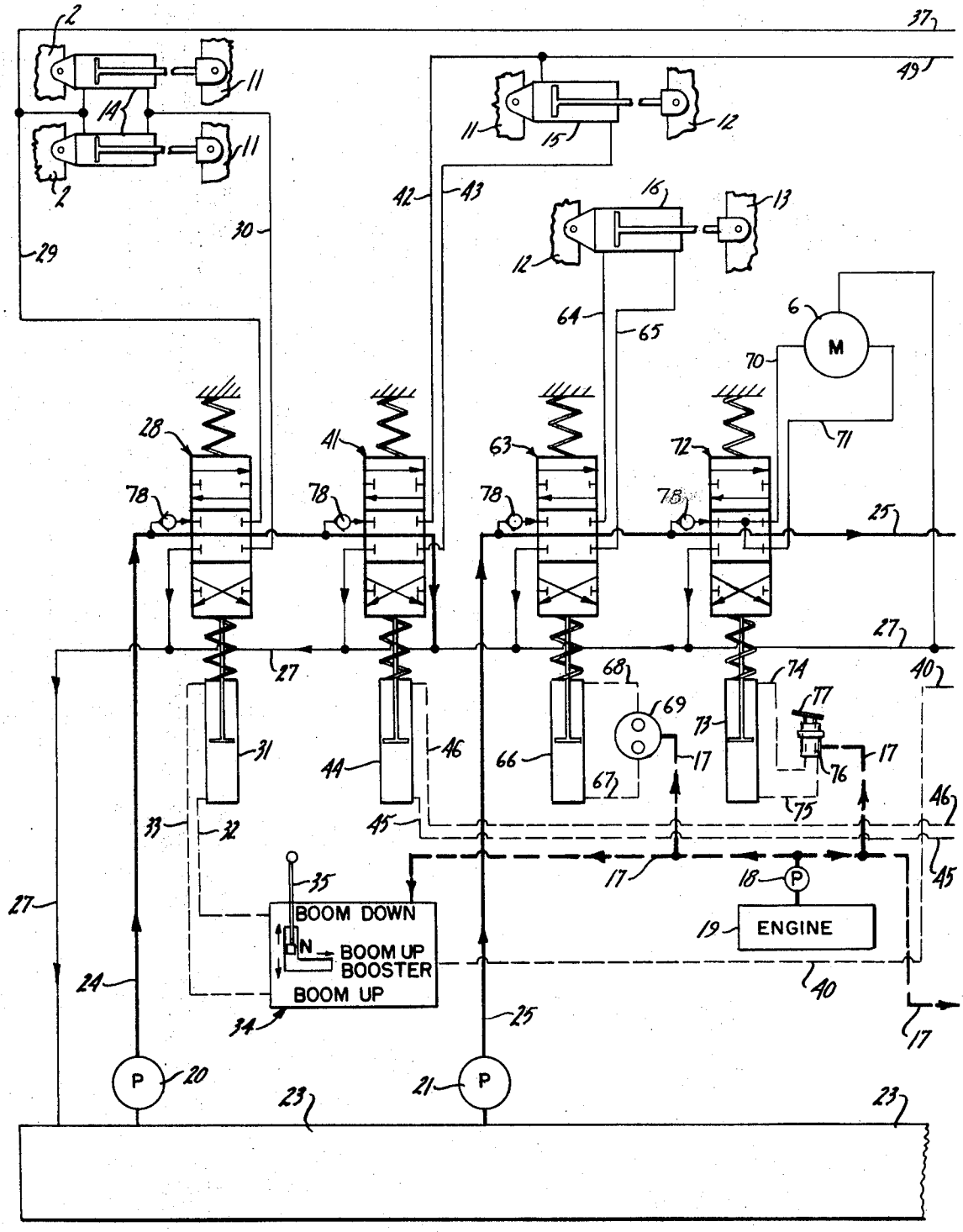


FIG. 2A

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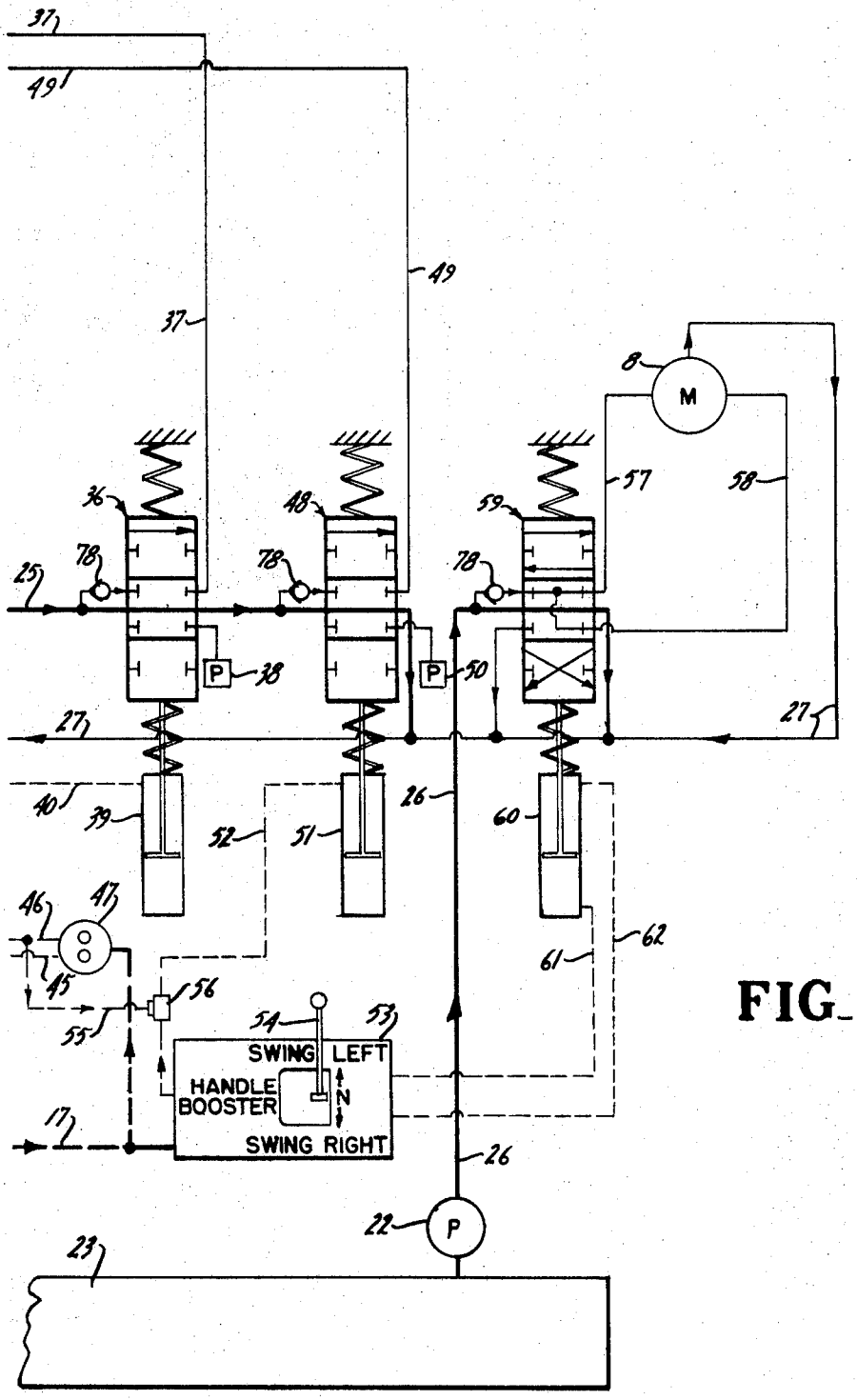
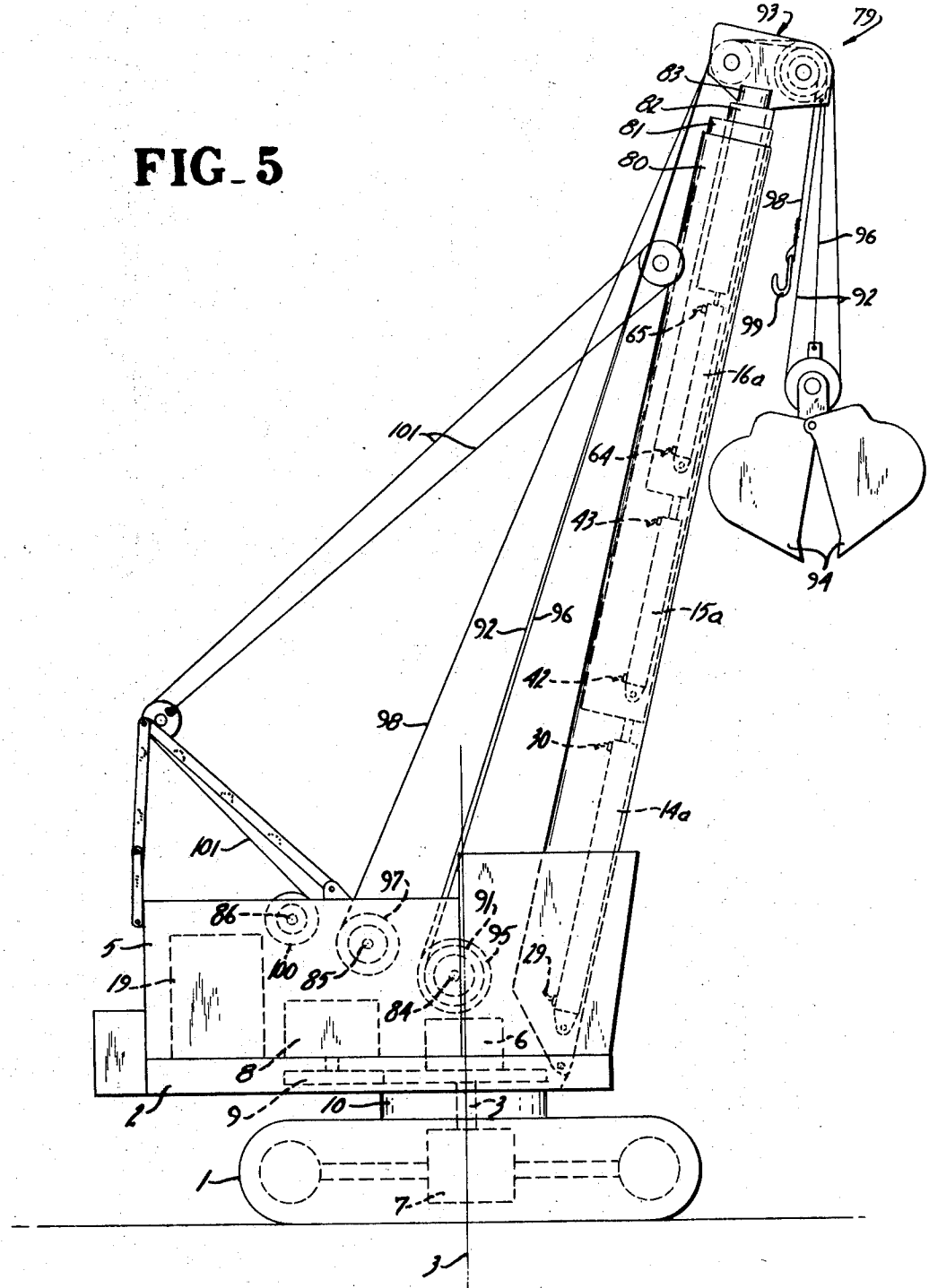


FIG. 2B

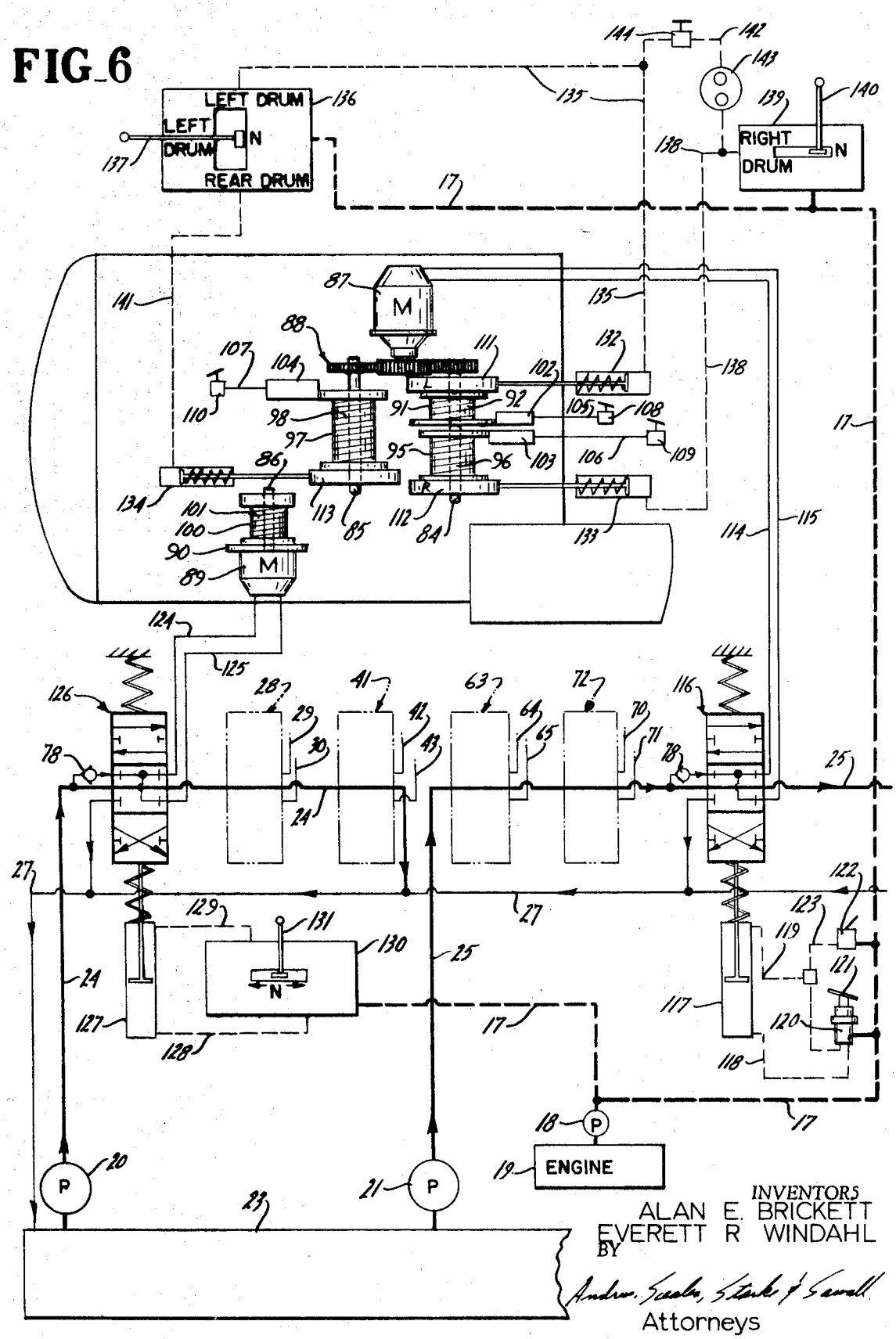
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FIG. 5



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FIG_6



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CONTROL SYSTEM

This invention relates to a control system, and more particularly to a control system for a convertible pullshovel-crane which is mounted on a caterpillar-type vehicle, rubber-tired vehicle, or the like.

The control system of the invention utilizes a plurality of valves which in turn actuate the operating cylinders and motors of the device. The circuitry involves a number of unique features, which alone and in combination provide a very flexible system of operation.

It is contemplated that the basic device to which the control system is attached may be convertible from a pullshovel to a crane, or vice versa. Likewise, the control system may be easily converted to operate the device, no matter which form the latter takes.

The accompanying drawings illustrate the best mode presently contemplated by the inventors for carrying out the invention.

In the drawings:

FIG. 1 is a schematic side elevation of a pullshovel embodying one aspect of the invention;

FIG. 2A is the left portion of a hydraulic and pneumatic circuit diagram for the embodiment utilized in FIG. 1;

FIG. 2B is the right portion of the hydraulic and pneumatic circuit diagram for the embodiment utilized in FIG. 1;

FIG. 3 is a fragmentary portion of the diagram shown in FIG. 2A, with the boom cylinder valve in the boom-raising position;

FIG. 4 is a view similar to FIG. 3 with the boom cylinder valve in the boom-lowering position;

FIG. 5 is a schematic side elevation of a crane embodying another aspect of the invention; and

FIG. 6 is a hydraulic and pneumatic circuit diagram for the embodiment utilized in FIG. 5, and showing additions to FIG. 2A.

As shown in FIG. 1 of the drawings, the control system is adapted for use with a basic machine comprising a vehicle mounted on caterpillar treads 1 and which includes a platform 2 pivotable or swingable about an upright axis 3. Platform 2 supports an operator's cab 4 as well as a rear end enclosure 5 for equipment or the like.

Suitable means are provided to drive caterpillar treads 1 forward and backward, and to swing platform 2 about axis 3. For this purpose, a hydraulic travel motor 6 is connected as by a suitable drive connection 7 to treads 1. Similarly, a hydraulic swing motor 8 is connected by a suitable drive 9 to the platform support 10 which is suitably mounted for rotation about axis 3.

Suitable framework, not shown, is also mounted on platform 2 supporting various operating elements.

PULLSHOVEL EMBODIMENT

In the pullshovel embodiment, FIGS. 1—4, the framework supports a boom 11 having a handle 12 pivoted thereon, with a dipper 13 pivoted to the end of handle 12. A boom cylinder 14, handle cylinder 15 and dipper cylinder 16 are mounted to their respective elements in the usual well-known manner. As shown, two boom cylinders 14 are utilized, although this may not be essential.

Control of cylinders 14, 15 and 16 is effected by the control system and circuit shown in FIGS. 2A, 2B, 3 and 4. In the present embodiment, the circuit is dual; that is, it includes a pneumatic circuit (shown in dash lines) which acts as the primary control for the secondary hydraulic circuit (shown in full lines), which in turn controls cylinders 14, 15 and 16.

Air for the pneumatic circuit is supplied through air lines 17 leading from an air pump 18 which is operated by an engine 19 which is the primary source of power for the device.

Likewise, a plurality of oil pumps 20, 21 and 22 are provided and which are connected to a source of oil in a tank or sump 23. Each pump is connected in an hydraulic fluid supply line 24, 25 and 26, respectively which extends from the pump

outlet through the system, as will be described, and back via a common return line 27 to sump 23.

For purposes of controlling boom cylinders 14 to thereby raise or lower boom 11, a four-way three-position hydraulic metering spool valve 28 is disposed in line 24. Valve 28 is connected via lines 29 and 30 to opposite ends of cylinders 14. Control of valve 28 is provided by a double acting air cylinder 31 whose piston is connected to the spool of valve 28 to move the latter between neutral and other positions. The opposite ends of cylinder 31 are connected via pneumatic lines 32, 33 to a handle-operated boom control air valve 34, which in turn is supplied with air from air pump 18 through main air line 17.

As shown, the lever 35 of valve 34 is manually movable in an L configuration and is shown in neutral position in FIG. 2A. When lever 35 is to the left and moved up from neutral, air valve 34 will cause the spool of hydraulic valve 28 to gradually move up and connect boom cylinders 14 to fluid so that boom 11 is lowered, as in FIG. 4. Likewise, when lever 35 is to the left and moved down from neutral, boom 11 will be raised, as in FIG. 3. When lever 35 is to the left and in its neutral position, the spool of valve 28 will be in its central or neutral position and hydraulic fluid in line 24 will merely flow through the valve.

It is usually desired to increase the speed of raising of boom 11 and of a full dipper 13 compared with the desired speed of lowering the boom and dipper. For this purpose, cylinders 14 are provided with pistons which have an effective area on the "boom-raising" side which is substantially greater (such as twice) than the area on the "boom-lowering" side.

In addition, hydraulic boom booster means are provided. In the present embodiment, a four-way two-position hydraulic metering spool valve 36 is disposed in line 25 and is connected through a single hydraulic line 37 to the "boom-raising" side of cylinders 14. The other hydraulic line from a discharge port in valve 36 is blocked against fluid flow, as by a plug 38. Control of valve 36 is provided by a double-acting air cylinder 39 whose piston is connected to the spool of valve 36 to move the latter between neutral and other positions. The upper end of cylinder 39 is connected via a single pneumatic line 40 to boom control air valve 34. When lever 35 is in the down or boom-raising position, it can be moved gradually to the right, which gradually actuates air cylinder 39 and valve 36. This provides additional hydraulic fluid and boost to boom cylinders 14.

Since boosting is only desirable when boom 11 is being raised, the L-shaped configuration of permitted movement of lever 35 provides a mechanical interlock which prevents operation of the booster unless lever 35 is in the lower "boom-raising" position.

For purposes of controlling handle cylinder 15 for digging and the like, a second four-way three-position hydraulic metering spool valve 41 is disposed in line 24 between valve 28 and sump 23. Valve 41 is substantially similar to valve 28 and is connected via lines 42, 43 to opposite ends of cylinder 15. Control of valve 41 is provided by a double-acting air cylinder 44 whose piston is connected to the spool of valve 41 to move the latter between neutral and other positions. The opposite ends of cylinder 44 are connected via pneumatic lines 45, 46 to a normally closed manually operable on-off two-button poppet valve 47 which in turn is supplied with air from air pump 18 through main air line 17. When the left or right button of poppet valve 47 is actuated, the piston of air cylinder 44 will move the spool of valve 41 to its full up or down position respectively to actuate dipper handle 12 up or down respectively.

Once again, downward pivoting of handle 12 is desirably faster than upward pivoting. Thus cylinder 15 is provided with a piston having an effective area on the "handling lowering" side which is substantially greater (such as twice) than the area on the "handle raising" side.

Furthermore, as with the boom, booster means are provided. As best seen in FIG. 2B, a four-way two-position hydraulic metering spool valve 48 is disposed in line 25

between valve 36 and sump 23. Valve 48 is connected through a single hydraulic line 49 to the "handle lowering" or "dig" side of cylinder 15. The other hydraulic line from a discharge port in valve 48 is blocked against fluid flow, as by a plug 50. Control of valve 48 is provided by a double-acting air cylinder 51 whose piston is connected to the spool of valve 48 to move the latter between neutral and other positions. The upper end of cylinder 51 is connected via a single pneumatic line 52 to a handle control air valve 53 which is supplied with air through line 17.

As shown, the manually operable lever 54 of valve 53 is movable in a D configuration. When lever 54 is in a central position as shown in FIG. 2B, the booster system is in neutral. When lever 54 is moved gradually to the left from neutral, air cylinder 51 and hydraulic spool valve 48 will be gradually actuated to provide additional hydraulic fluid to cylinder 15 to boost the action of the handle, in a downward or digging direction.

Interlock means are provided to prevent actuation of booster valve 48 unless handle cylinder valve 41 is in operation to lower handle 12. For this purpose, a pneumatic signal line 55 is connected between line 52 and line 46 downstream from poppet valve 47. A normally closed relay valve 56 is disposed at the junction of signal line 55 and line 52. Thus when booster valve 53 is actuated, air flowing through pneumatic line 52 is blocked, from passing to cylinder 51 by valve 56. However, poppet valve 47 is connected to relay valve 56 by line 55 in such a way that when valve 47 is actuated, a signal passes thru line 55 to open relay valve 56. Actuation of lever 54 leftward then also causes air to actuate air cylinder 51 and handle booster valve 48. This occurs only if poppet valve 47 has been actuated.

In many instances during operation, it is desireable to swing or pivot platform 2 about axis 3. For this purpose, hydraulic swing motor 8 is utilized. Motor 8 is of any suitable type and is connected through lines 57, 58 to a suitable four-way three-position swing motor hydraulic metering spool valve 59, which is somewhat similar to valves 28 and 41, and which is disposed in line 26. Control of valve 59 is provided by a double-acting air cylinder 60 whose piston is connected to the spool of valve 59, to move the latter between neutral and other positions. The opposite ends of cylinder 60 are connected via pneumatic lines 61, 62 to handle control air valve 53.

The D configuration of movement of valve lever 54 permits the latter to be moved gradually up and down from neutral position to supply air to cylinder 60 and thereby drive motor 8 in either direction. The D provides that the unit can be swung while the handle booster valve 48 is being operated.

For purposes of controlling dipper cylinder 16 for digging, another four-way three-position hydraulic metering spool valve 63 is utilized. In this instance, valve 63 is disposed in line 25 between pump 21 and hydraulic boom booster valve 36. Valve 63 is connected via lines 64, 65 to the opposite ends of dipper cylinder 16. Control of valve 63 is provided by a double-acting air cylinder 66 whose piston is connected to the spool of valve 63 to move the latter between neutral and other positions. The opposite ends of cylinder 66 are connected via pneumatic lines 67, 68 to a normally closed manually operable on-off two-button poppet valve 69 which in turn is supplied with air from air pump 18 through main air line 17. When the left or right button of poppet valve 69 is actuated, the piston of air cylinder 66 will move the spool of valve 63 to its full up or down position respectively to pivot dipper 13 one way or the other.

Dipper cylinder 16 is shown having a piston with an effective area on one side which is substantially greater (such as twice) than the area on the other side.

In many instances, it is desireable during operation to move the vehicle on treads 1. For this purpose, travel motor 6 is utilized. Motor 6 is of any suitable type and is connected through lines 70, 71 to a suitable four-way three-position travel motor hydraulic metering spool valve 72, which is similar to swing motor valve 59, and which is disposed in line 26 between dipper cylinder valve 63 and boom booster valve 36. Control of valve 72 is provided by a double-acting air cylinder 73 whose piston is connected to the spool of valve 72 to move the latter between neutral and other positions. The opposite ends of cylinder 73 are connected via pneumatic lines 74, 75 to a suitable metering valve 76 which is supplied with air from main line 17 and which is actuated for metered airflow in either direction by a foot pedal 77. Thus, speed of movement of the vehicle in either direction is under substantial control at all times.

It is to be noted that boom cylinder valve 28 is in series in hydraulic line 24 with handle cylinder valve 41, with the latter valve being positioned downstream of the former valve from pump 20. Likewise, dipper cylinder valve 63, travel motor valve 72, boom booster valve 36 and handle booster valve 48 are all in series in hydraulic line 25 and positioned downstream from pump 21 in respective order given. Thus, with this arrangement, no valve in any one line can operate its respective cylinder or motor unless all valves upstream therefrom in the same line are in neutral. That is, when any valve in a line is in fully open operating position, all valves downstream therefrom will not be supplied with hydraulic fluid and therefore cannot operate their respective cylinders or motors. As an example, when boom cylinder valve 28 is in full open position to move cylinder 14, handle cylinder valve 41 cannot supply fluid to cylinder 15, even if poppet valve 47 is moved to actuate air cylinder 44 and the spool for valve 41. Likewise, boosting of handle 12 cannot take place if boosting of boom 11 is occurring, if travel motor 6 is operating or if dipper 13 is being moved. And so on. Also, if boosting of boom 11 is taking place, travel motor 6 and dipper 13 must be in neutral to allow flow of fluid to valve 36. If valve 63 or 72 are fully actuated, valves 36 and 48 will no longer receive operating fluid.

In order to insure sufficient hydraulic line pressure for proper operation of the bank of four-way valves 28, 41, 63 and 72 and the bank of four-way valves 36 and 48, as well as valve 59, a suitable check 78 is positioned at the inlet to each valve. Also, all the spools of the seven above-mentioned valves are spring loaded in both directions to assist the valve in automatically returning to neutral position. In addition, suitable valves, not shown, may be utilized in the hydraulic lines wherever necessary to substantially reduce the effects of any shocks on the system or to control the speed of cylinders or motors.

In the pneumatic system, poppet valves 47 and 69, control valves 34 and 53, as well as metering valve 76 should be provided with the usual air bleed means, not shown, for air discharge from their respective working lines. Furthermore, poppet valves 47 and 69 may in some instances by replaced by metering valves similar to valve 76 where more gradual control and operation is desired.

All of the manual controls for the system may be placed on the vehicle in any suitable location, such as in the operator's cab 4.

CRAWLER-CRANE EMBODIMENT

In some instances, it may be desireable to convert the vehicle from a pullshovel unit to a crane-type unit. See FIG. 5. In such case, the basic vehicle would remain generally the same. That is, the treads 1, platform 2, upright axis 3, cab 4, enclosure 5, travel motor 6 with its drive 7 and operating connections, swing motor 8 with its drive 9 and most operating connections, and the platform support 10 would remain substantially intact. However, boom 11, handle 12 and dipper 13 and their respective cylinders 14, 15 16 of FIG. 1 would be removed from the vehicle framework and replaced with the crane elements shown in FIG. 5.

In this second embodiment, a crane boom 79 would be secured to the framework. Although boom 79 could be of single unitary construction, that shown is of the telescoping type with a lower fixed section 80 and three movable telescoping sections 81, 82 83. Each section is provided with extensible

operating cylinders 14*a*, 15*a* and 16*a*, which correspond to and replace the cylinders 14, 15, 16 in the pullshovel embodiment. Cylinders 14*a*, 15*a*, and 16*a* are connected via hydraulic lines 29–30, 42–43, and 64–65 to valves 28, 41 and 63 which are operated in generally the same manner as previously described. See FIGS. 5 and 6.

The lifting and other operations of the crane device are accomplished by the use of drum-wound cables. For this purpose, three drum shafts 84, 85 and 86 are provided. Front shaft 84 and what will be called rear shaft 85 are driven by a single hydraulic motor 87 through a suitable drive 88, while boom hoist shaft 86 is disposed rearwardly of shaft 85 and is driven by its own hydraulic motor 89 through a suitable drive 90.

A left drum 91 is mounted on front shaft 84 and has a cable 92 thereon which passes over a jib 93 at the top of boom 79 and down to any suitable desired element such as a bucket or clam 94 for raising or lowering the latter. A right drum 95 is also mounted on shaft 84, separate from drum 91, and has a cable 96 thereon which also passes over jib 93 and down to clam 94 for opening and closing the latter. A single drum 97 is mounted on rear shaft 85 and also is provided with a cable 98 which passes over jib 93. The end of cable 98 may be used in any way desired, and is shown as having a hook 99 for lifting and lowering large beams or any other desired object. A single drum 100 is fixedly mounted on boom hoist shaft 86 and has a cable 101 thereon which is secured to boom 79 for pivotally hoisting and lowering the latter.

As best shown in FIG. 6, drums 91 95 and 97 are provided with suitable normally disengaged independently operable friction-type brakes 102, 103 and 104 respectively, for purposes to be described. Each brake 102, 103, 104 is connected via suitable mechanical or other type lines 105, 106, 107 respectively, to brake pedals 108, 109, 110 respectively mounted near the operator in cab 4.

In addition, drums 91, 95 and 97 are provided with independently operably friction-type clutches 111, 112, 113 respectively which operate independently of said friction brakes to connect or disconnect each drum from its respective shaft for purposes to be described.

Drum 100 could also be provided with a friction brake and a friction clutch, not shown.

Referring to FIG. 6, hydraulic motor 87 drives drum shafts 84 and 85 to thereby turn drums 91, 95 and 97 when they are suitably clutched to their respective shafts. Motor 87 is driven via its connection through hydraulic lines 114, 115 to a four-way three-position hydraulic metering spool valve 116 which is similar to travel motor valve 72. In the conversion from a pullshovel to a crane, valve 116 may be added to the right valve bank shown in FIG. 2B so that it is downstream from valve 72 in hydraulic line 25. Valve 116 is controlled by a double-acting air cylinder 117 whose piston is connected to the spool of valve 116 to move the latter between neutral and other positions. The opposite ends of cylinder 117 are connected via pneumatic lines 118, 119 to a suitable metering valve 120 which is supplied with air from main line 17 and which is actuated for metered airflow in either direction by a foot pedal 121. Pedal 121 thus provides a speed and direction control for drums 91, 95 and 97. A suitable hand control may be substituted for pedal 121 without departing from the spirit of the invention.

In some instances it may be desirable to provide a full speed raising action of any or all of drums 91, 95 and 97 without the need for foot pedal action. For this purpose, drum motor speed lockup means are provided which comprises an on-off poppet valve 122 which is supplied with air from main line 17 and which is connected through a line 123 to line 119. Thus, when poppet valve 122 is actuated, foot pedal operated valve 120 is bypassed and the hydraulic metering valve 116 is opened full in the hoisting direction.

Hydraulic motor 89 drives hoist drum shaft 86 to thereby turn boom hoist drum 100. Motor 89 is driven via its connection through hydraulic lines 124, 125 to another four-way three-position hydraulic metering spool valve 126 which is similar to valve 116. In the conversion from a pullshovel to a crane, valve 126 may be added to the left valve bank shown in FIG. 2A, so that it is upstream from valve 28 and in series therewith in line 24. Valve 126 is controlled by a double-acting air cylinder 127 whose piston is connected to the spool of valve 126 to move the latter between neutral and other positions. The opposite ends of cylinder 127 are connected via pneumatic lines 128, 129 to a suitable hand-controlled metering valve 130, which is supplied with air from main line 17 and which is actuated via lever 131 to provide speed and direction control for boom hoist drum 100.

The control of friction clutches 111, 112, 113 will now be described. Each clutch is provided with an air cylinder 132, 133 and 134 respectively, with the piston of each cylinder moving to actuate the respective clutch. Cylinder 132 operates clutch 111 to clutch or declutch left drum 91 on front shaft 84. For this purpose, cylinder 132 is connected via pneumatic line 135 to a drum control metering valve 136 which is supplied with air from main line 17 and which has a manually operable lever 137. Likewise cylinder 133 operates clutch 112 to clutch or declutch right drum 95 on front shaft 84; and is connected via a pneumatic line 138 to a second drum control metering air valve 139 with a manually operable lever 140. Furthermore, cylinder 134 operates clutch 113 to clutch or declutch rear drum 97 on rear shaft 85; and is connected via a pneumatic line 141 to air valve 136. As shown lever 137 moves from a central neutral position in either direction to selectively operate left clutch 111 or rear clutch 113.

A connector line 142 extends between lines 135 and 138, and includes an on-off poppet valve 143 therein. Poppet valve 143 may be utilized to operate left drum 91 simultaneously with right drum 95 when valve lever 137 is in neutral and rear drum 97 is not operating. Furthermore, an adjustable drag regulator 144 may be inserted in line 142 to permit varying the air pressure in air cylinder 132 which in turn varies the clutching action of left clutch 111 relative to right clutch 112. This, thus, varies the cable pull of left drum 91 relative to right drum 95.

While valve 136 is shown as providing separate operation of left drum 91 and rear drum 97, the valve could be similar to valve 53 described previously, and wherein simultaneous operation of both drums 91 and 97 is provided for. Furthermore, a separate valve for independent operation of rear drum 97 may be utilized.

While drums 91 and 95 and their shafts and controls have been designated "left" and "right" respectively, they could be reversed in position without departing from the spirit of the invention.

Air cylinders 132, 133 and 134 are spring loaded toward released or declutching position in any suitable manner. Since the control valves 136 and 139 for the clutch cylinders are of the metering type, the cylinders do not necessarily always provide a full clutching action. Thus, clutch slipping occurs whenever full drum speed is not desired. The combined availability of friction drum brakes 102, 103, 104 with the externally operated friction clutches 111, 112, 113 for drums 91, 95 and 97 respectively provide extreme flexibility of operation. For example, control levers 137, 140 will stay in whatever position they are set at, thus providing a permanent engaging of the clutch controlled thereby. When one or more drums are permanently clutched in, foot pedal 121 and/or valve 130 may be moved between positions to turn the respective drum. At all times, whether drum is rotating or stopped, the particular clutches will remain engaged and will prevent drifting. If at any time, with one or more drums turning or stationary, it is desired to lower one or more loads faster than would be possible with the clutch drive, the particular drum clutch or clutches can be disengaged, the respective drum friction brake or brakes engaged, and the load permitted to fall by gravity at a fast rate with the friction brake providing the control.

Thus, if it is desired to drop clam **94** very fast while cable hook **99** is either stationary or moving upward or downward, right and left clutches **111** and **112** can be disengaged and simultaneously friction brakes **102** and **103** engaged to an extent to permit clam **94** with its two cables **92, 96** to fall as fast as desired.

The control system of the invention is especially valuable for purposes of convertability between different types of units. While the basic system described herein utilizes two hydraulic valve banks, additional banks may be used. In addition, the number of operating valves in each bank may be easily changed while retaining the basic functions. For example, if the pullshovel embodiment were changed to a crane embodiment with either a telescoping boom of fewer telescoping sections, or a nontelescoping boom, one or more of hydraulic spool valves **28, 41** and **63** could merely be disconnected from the circuit.

We claim:

1. In a device of the class described having a boom, means for raising and lowering the boom, a front and a rear shaft with corresponding front and rear drums mounted thereon with said drums having cables wound thereon which extend over the boom for performing desired functions, and having hydraulic motor means connected for driving both said shafts in either direction; a control system comprising, in combination:

a. hydraulic drum valve means connected to said motor means to operate the latter, a double-acting cylinder having its piston connected to said drum valve means to move the latter between its various operating positions,

pneumatic circuit means including a manually operated pneumatic metering valve connected between a source of air and both sides of said double-acting cylinder to operate said drum valve means, said metering valve controlling the speed of said motor means from a maximum to a lesser speed,

c. and lockup means provided in said circuit to bypass said metering valve to provide maximum speed of said motor means when said metering valve is set for less than maximum speed.

2. The control system of claim **14** wherein said lockup means comprises an on-off type valve connected between said source of air and one side of the connection between said metering valve and said drum valve means.

3. In a device of the class described having a boom, means for raising and lowering the boom, a front and a rear shaft with hydraulic motor means connected for driving said shafts in either direction, a left and a right drum mounted on said front shaft, a rear drum mounted on said rear shaft, said drums having cables wound thereon which extend over the boom for performing desired functions; a control system comprising, in combination:

a. a left, right and rear friction clutch on each said respective drum for clutching and declutching each drum to its respective shaft,

b. manually operably clutch control means for operating each said clutch independently of the other, said clutch control means comprising:

1. a first manually operable pneumatic valve connected to a supply of air and connected to both said left clutch and said rear clutch to actuate said left and rear clutches, said first valve having a "left," "rear" and "neutral" position,

2. a second manually operable pneumatic valve connected between said air supply and said right clutch to actuate the latter, said second valve having a "right" and a "neutral" position,

c. and valve control means connecting said first and second valves for permitting clutching of both said left and right clutches simultaneously while said first valve is in "rear" or "neutral" position.

4. The control system of claim **3** wherein said valve control means comprises:

a. a pneumatic line between:

1. the connection from said first valve and said left clutch, and

2. the connection from said second valve and said right clutch,

b. and a manually operable on-off valve in said line.

5. The control system of claim **4** which includes adjustable drag regulating means in said pneumatic line to vary the pressure of air in the line so that the cable pull of said left drum relative to said right drum may be varied.

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,578,787 Dated May 18, 1971

Inventor(s) Alan E. Brickett

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

Column 1, line 52, after "2" insert ---for---

Column 3, line 75, cancel "26" and substitute therefor ---25---

Column 4, line 51, cancel "by" (first occurrence) and substitute therefor ---be---

Column 7, line 31, before "pneumatic" insert ---(b)---

Column 7, line 41, cancel "14" and substitute therefor ---1---

Column 8, line 14, cancel "operably" and substitute therefor ---operable---

Signed and sealed this 28th day of December 1971.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Acting Commissioner of Patents

FORM PO-1050 (10-69)

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