

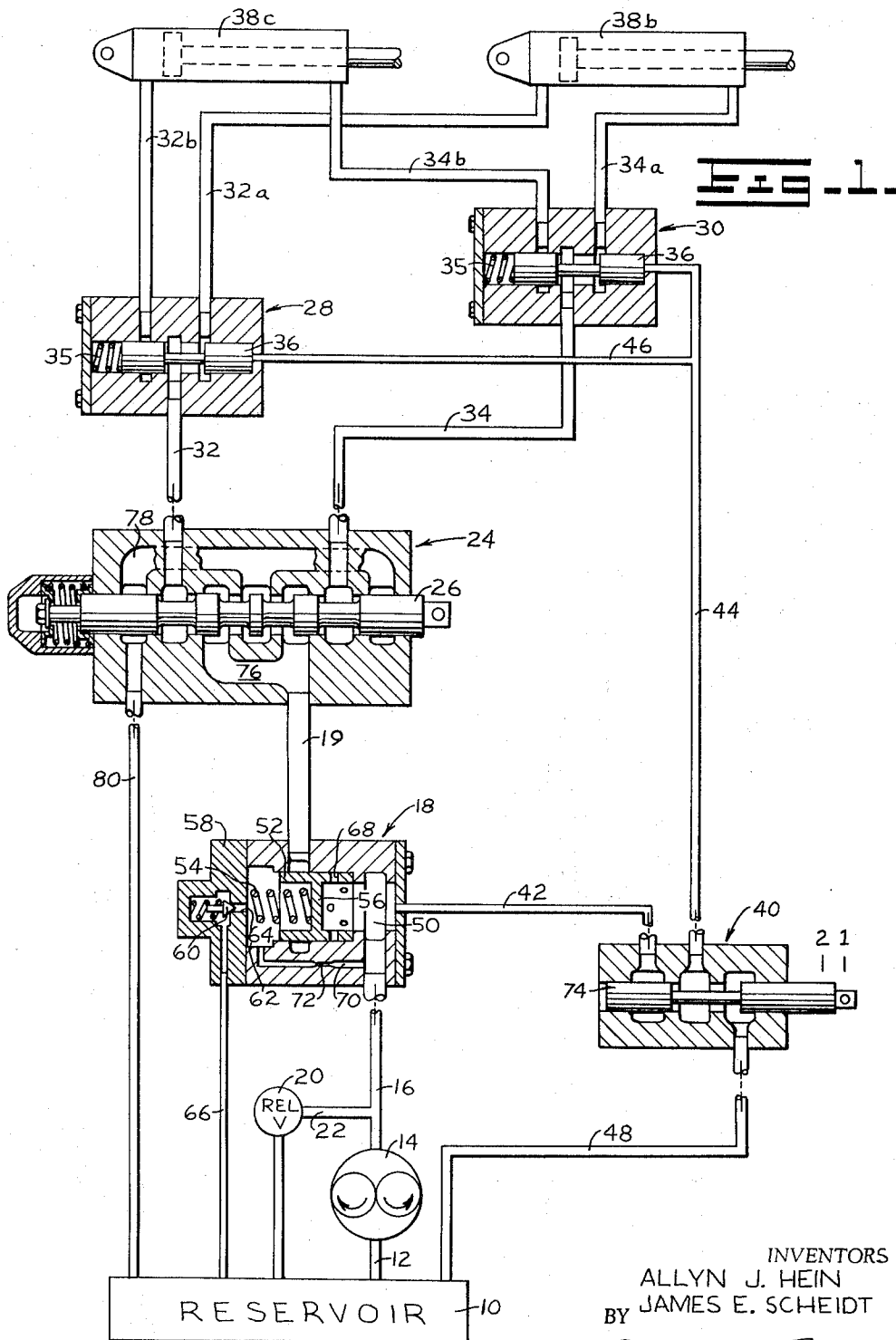
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A. J. HEIN ETAL
HYDRAULIC CIRCUIT

3,304,633

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3 Sheets-Sheet 1



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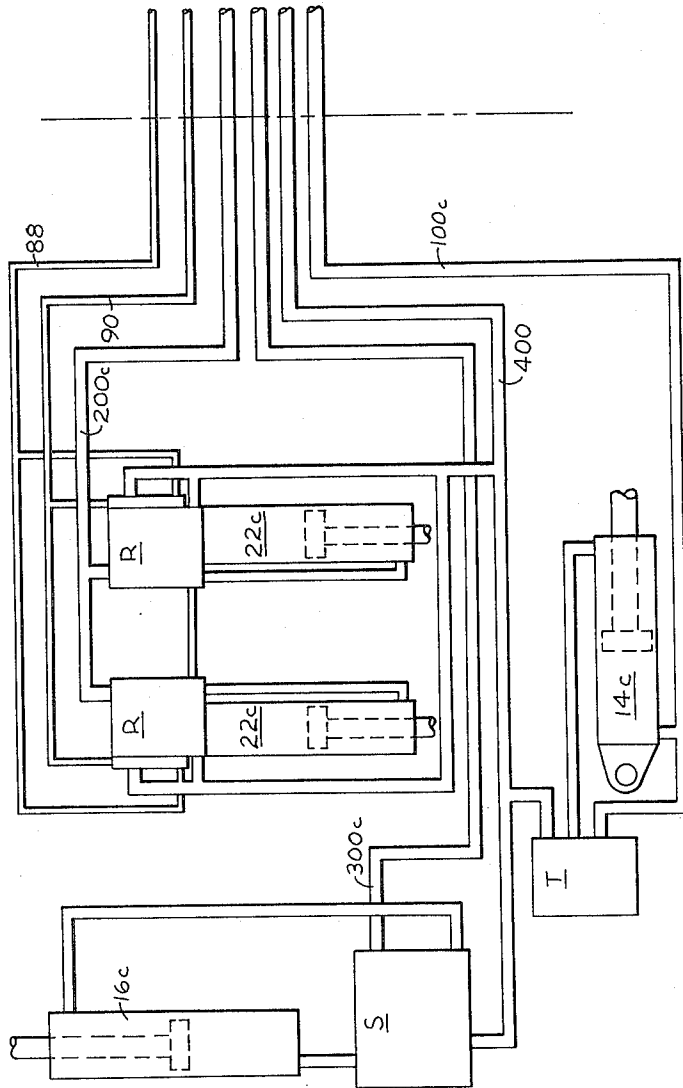
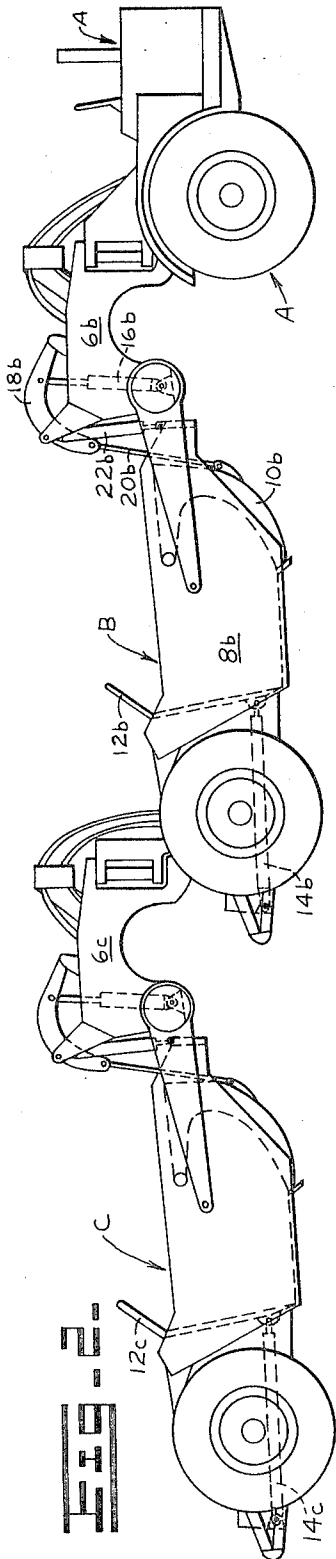


FIG. 4

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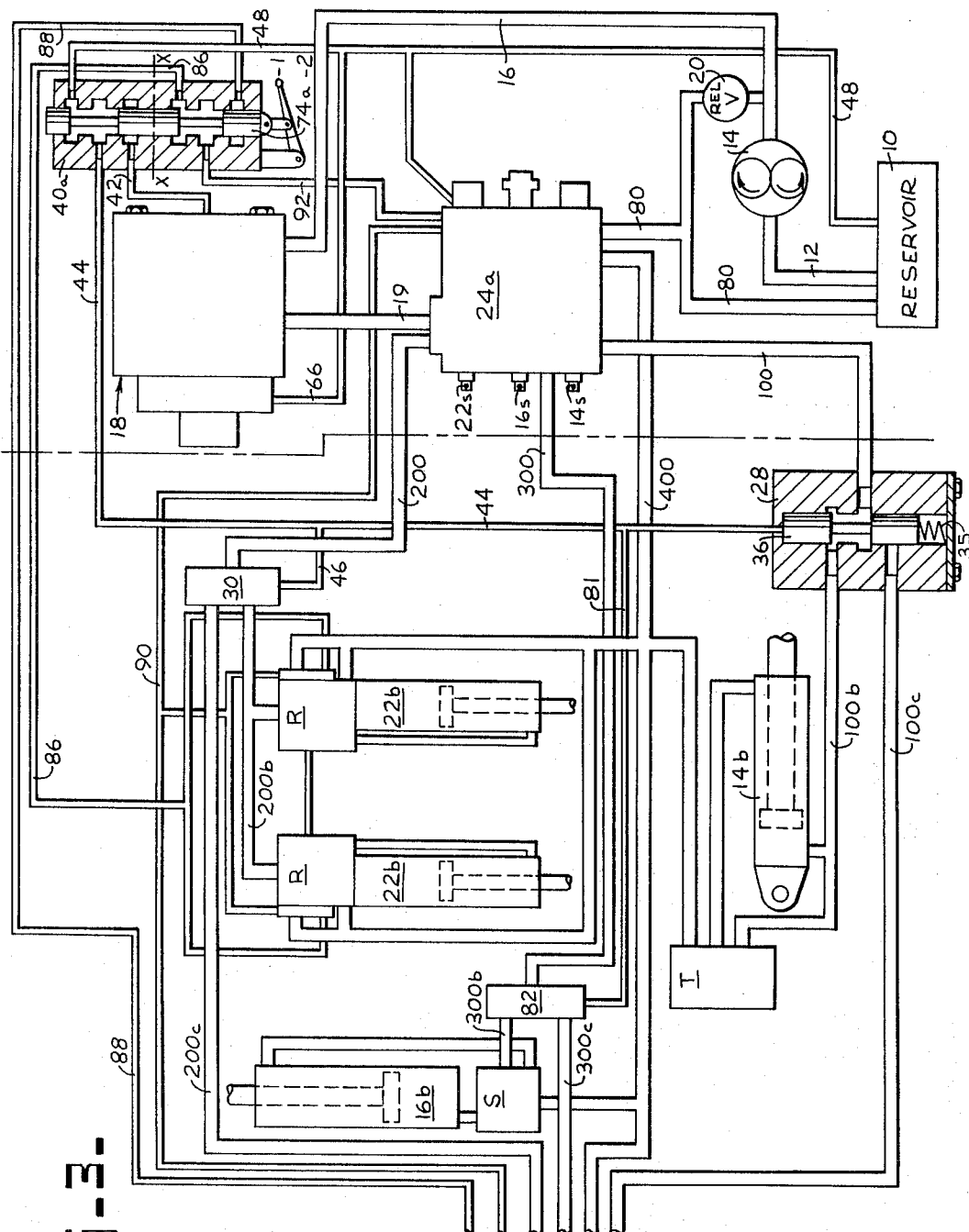


FIG. 3

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3,304,633

HYDRAULIC CIRCUIT

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9 Claims. (Cl. 37—129)

This invention relates to a hydraulic circuit and more particularly to a hydraulic circuit including at least two hydraulic motors which are associated with control mechanisms that are operable to effect actuation of either one of such motors in any desired sequence.

Independent selective operation of a plurality of hydraulic motors is usually achieved by providing an electrical control circuit which operates to condition hydraulic controls in accordance with a selected operational sequence or with a sequence desired by an operator. The main objections to incorporating an electrical control circuit for conditioning the various hydraulic control elements of a hydraulic circuit are ones of cost and dependability. Certain types of machinery, for example earthmoving machinery, is subject to many adverse climatic and environmental conditions such as dirt, moisture, oil and shock forces of great magnitude, which cause frequent break down of electrical controls rendering the earthmoving machinery inoperable to perform its intended function. Thus, in the interests of economy and dependability this invention provides a simple and yet rugged hydraulic pilot pressure circuit which incorporates a novel valve associating the elements of the hydraulic circuit in a new and improved manner.

Incorporation of the novel hydraulic circuit of this invention is shown, in certain of the hereinafter described figures, as applied to earth moving machinery and more particularly to earth moving scrapers. In machinery of this type a plurality of hydraulic motors are utilized in order to effect loading and unloading of earth between selected points. Current practice involves arranging the earth scrapers in tandem relation and effecting alternate operation, in any desired sequence, of each scraper by the operator in order to fulfill the loading and unloading functions.

Accordingly, it is an object of this invention to provide a new and improved hydraulic circuit for effecting independent selective operation of at least two hydraulic motors.

Another object of this invention is to provide a novel pressure responsive hydraulic control valve which determines which one of two hydraulic motors will operate.

Another, and more specific object of this invention, is to provide a novel hydraulic control valve which is selectively operable to establish communication between a source of pressure fluid and actuating mechanisms on each of two tandemly arranged pieces of earth moving apparatus and which is effective to provide a source of pilot pressure fluid to condition either one of such tandem units for operation.

Other objects of the invention and features of novelty will be apparent from the following description taken in connection with the accompanying drawings in which:

FIGURE 1 is a schematic view of the hydraulic circuit constructed in accordance with the principles of this invention showing certain of the control valves diagrammatically;

FIG. 2 is a side elevation of the tandemly arranged earthmoving apparatus which incorporates the novel hydraulic circuit of this invention;

FIGS. 3 and 4, considered together, constitute a schematic representation of the hydraulic circuit associated with the hydraulic system of tandemly arranged earthmoving scrapers.

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The hydraulic circuit shown in FIG. 1 includes a reservoir 10 from which fluid therefrom is communicated to a pump 14 by a conduit 12. The pump pressurizes and discharges fluid to a conduit 16 and a restrictor valve 18. A predetermined value of maximum pump discharge pressure is maintained by a suitable relief valve 20 in a return conduit 22 which communicates with the discharge conduit 16 and the reservoir 10. Pressure fluid from the restrictor valve 18 is communicated by a conduit 19 to a control valve 24 having a spring centered spool 26 which, depending upon the position of the spool, directs the pressure fluid to switch valves 28 or 30 by conduits 32 and 34, respectively.

Each switch valve includes a spring 35 biasing a spool 36 which operates to permit pressure fluid in the conduits 32 or 34 to be communicated to the hydraulic motors 38b or 38c depending upon the position of spools 36. Conduits 32a and 32b are in communication, respectively, with the head-end of the hydraulic motor 38b and the head-end of the hydraulic motor 38c whereas the switch valve 30 communicates pressure fluid to the motors 38b and 38c by conduits 34a and 34b communicating pressure fluid to the rod-end of the motors 38b and 38c.

In order to achieve the objective of alternate independent selective operation of either of the hydraulic motors 38b or 38c, this invention includes a pilot pressure circuit which is operable to simultaneously shift the spools 36 against the bias of the springs 35. The pilot pressure circuit comprises a manually operable two-position spool valve 40, which by means of a conduit 42, communicates with the restrictor valve 18. A conduit 44 and a branch conduit 46 communicate pressure fluid to the switch valves 30 and 28, respectively, in order to effect shifting of the spools 36. A conduit 48 connects the valve 40 to the reservoir 10.

The hydraulic circuit thus far described is operable, by positioning the spool of valve 40 in either one of the positions indicated by the numerals 1 and 2 to condition the valves 28 and 30 so that extension or retraction of either one of the hydraulic motors 38b or 38c is effected.

The restrictor valve 18 includes a cavity 50 in communication with the pump discharge conduit 16 within which is reciprocally mounted a spool 52 spring biased to the right by a spring 54. The opposite ends of the spool 52 are bored to define a transverse wall 56 engageable with the spring 54. A relief valve 60, in a cap 58, provides communication for the cavity 62, located between the transverse wall 56 and the valve cap 58, with the reservoir 10 by means of a passageway 64 and a conduit 66. The tubular wall of the spool 52 (to the right of the wall 56) has a plurality of holes 68 formed therein which permit flow of pressure fluid from the cavity 50 to the conduit 19 thus communicating pressure fluid to the control valve 24.

A portion of the pressure fluid in the cavity 50 flows through a passageway 70 which establishes communication between the cavity 50 and the cavity 62. The passageway 70 includes an orifice 72 which, when the valve 60 is opened, reduces the value of pressure in the cavity 62 thereby providing a pressure difference on the opposite side of the spool 52, with the higher value of pressure in the cavity 50, in order to assist in the shifting of the spool 52 to the left against the bias of the spring 54.

The conduit 42 communicates pressure fluid from the cavity 50 to the manually operable spool valve 40 to supply pressure fluid, depending upon the position of the spool 74, to actuate the spools 36 of the switch valves 28 and 30. As shown, the spool 74 is in the position indicated by the numeral 1 blocking communication of the conduit 44 with the conduit 42 and the conduit 44 is vented to the reservoir 10 by means of the conduit 48. Thus, the spools 36 of the switch valves 28 and

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30 are biased to the right by the springs 35. Movement of the spool 74 to the position indicated by the numeral 2 blocks communication between the conduit 44 and the conduit 48 and establishes communication between the conduit 42 and the conduit 44 so that pressure fluid is communicated to the switch valves 28 and 30 shifting the spools 36 to the left against the bias of the springs 35.

Pressure fluid, communicated from the valve 18 to the valve 24 by the conduit 19, flows to an inlet manifold 76 which, depending upon the adjusted position of the spool 26, supplies pressure fluid to the conduit 32 or the conduit 34. In the position shown, the conduits 32 and 34 are blocked from communicating with the inlet manifold 76. The valve 24 also includes a discharge manifold 78 communicating with the reservoir 10 by a conduit 80 in order to return fluid from the conduits 32 or 34 to the reservoir 10.

Assuming that it is desired to actuate the motor 38b, the spool 74 of valve 40 is adjusted to the illustrated position blocking communication of the conduit 42 with the conduit 44. The valves 28 and 30 also have the spools 36 located in the illustrated position. Pressure fluid from the pump pressurizes the cavity 50 and flows through the passageway 70 also pressurizing the cavity 62. As the pressure rises in the cavity 62 to about 125 p.s.i., the relief valve 60 opens allowing pressure fluid to flow through the passageway 64 and to the conduit 66 returning the fluid to the reservoir 10. This, of course, reduces the pressure in cavity 62 to such a value that the pressure in the cavity 50 is sufficient to shift the spool 52 to the left against the bias of the spring 64 thereby establishing communication between the cavity 50 and the conduit 19. Shifting the spool 26 of control valve 24 to the right establishes communication between the now pressurized inlet manifold 76 and the conduit 32 permitting pressure fluid to be discharged to the switch valve 28. The pressure fluid is communicated to the head-end of the motor 38b by the conduit 32a. Fluid from the rod-end of the motor 38b is discharged through the conduit 34a, through the conduit 34, to the discharge manifold 78 and the conduit 80 returning the fluid to the tank or reservoir 10. In the event it is desired to retract the piston of motor 38b, it is merely necessary to shift the spool 26 of the valve 24 to the left establishing communication between the inlet manifold 76 and the conduit 34 allowing pressure fluid to flow through the conduit 34a and to the rod-end of the motor 38b. At the same time the fluid in the head-end of the motor 38b flows through the conduit 32a, through the switch valve 28, through the conduit 32, to the manifold 78 returning the fluid to the reservoir 10 by the conduit 80.

When it is desired to effect actuation of the motor 38c, the spool 74 of the valve 40 is shifted to the position indicated by the numeral 2 establishing communication between the conduit 42 and the conduit 44, so that the pressure fluid shifts the spools 36 to the left against the bias of the springs 35. Shifting the spool 26 to the right establishes communication between the inlet manifold 76 and the conduit 32, and since the spool 36 is shifted to the left, the conduit 32 is in communication with the conduit 32b communicating pressure fluid to the head-end of the motor 38c, thus effecting extension thereof. Fluid from the rod-end of the motor 38c is discharged to the conduit 34b, and the conduit 34, which is now in communication therewith, to the discharge manifold 78, and to the tank or reservoir 10 by the conduit 80. Retraction of the motor 38c is accomplished by moving the spool 26 to the left permitting pressure fluid from the inlet manifold 76 to flow through the conduit 34, through the conduit 34b, and to the rod-end of the motor 34c. Fluid in the head-end of the motor 34c is discharged through the conduit 34b, through the conduit 32, through the discharge manifold 78 and through the conduit 80 returning the fluid to the reservoir 10.

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The hydraulic circuit shown in FIGS. 3 and 4 incorporates the basic concept shown in FIG. 1 and described above with minor alterations dictated by its application to earth moving apparatus. In addition, as will be hereinafter pointed out, certain hydraulic control devices are incorporated in the illustrated circuit which are the subject of two applications and a patent assigned to the assignee of the present invention.

The earth moving apparatus incorporating this invention is shown in FIG. 2 and comprises a conventional tractor A to which is pivotally connected a draft beam 6b of a two-wheeled scraper B which in turn supports a similar two-wheeled scraper C by another similar draft beam 6c. As is known to those skilled in the art, the scrapers B and C are designed to load and unload earth while moving along the ground. Since each scraper is identical in construction, the particular mechanisms which allow the scrapers to load and unload material will be described with reference to the scraper B. As shown, scraper B includes a large bowl 8b that is mounted for pivotal movement in a vertical plane about the axle supporting the illustrated wheels. An apron 10b, pivotally mounted to the side walls of the bowl 8b, opens and closes an open forward end of the bowl. An ejector 12b located interiorly of the bowl 8b is reciprocated toward the forward wall of the bowl by a jack 14b. It is apparent, therefore, that when the bowl 8b is loaded and the apron 10b is pivoted upwardly movement of the ejector 12b toward the forward end of the bowl 8b discharges the contents of the bowl. In order to raise and lower the apron 10b, a hydraulic jack 16b (shown in dotted outline) has the upper end of its piston rod pivotally connected to an arcuate link 18b which is in turn connected to the apron 10b by the rod 20b. Accordingly, extension of the hydraulic jack 16b raises the apron 10b. Raising and lowering of the forward portion of the bowl 8b is accomplished by a pair of transversely adjacent jacks 22b interconnected to the draft beam 6b and the forward end of the bowl 8b.

Since each of the scraper bodies B and C incorporate jack mechanisms which perform the same function, for example, corresponding jacks 14b and 14c whose extension and retraction effect reciprocable movement of the ejector plates 12b and 12c, respectively, the control valve assembly 24 of FIG. 1 is designated by the numeral 24a in FIG. 3 and it includes three spools 22s, 16s, and 14s, each of which controls actuation of the jacks on each scraper that perform the same function.

The jacks 14b and 14c are provided with speed change valves T operating in such a manner so that pressure fluid acting on the head-end of the jacks is augmented by the fluid discharged from the rod-end in order to increase the speed at which the ejector plates 12b and 12c are moved toward the front wall of the bowl. The manner in which the valves T are constructed to perform this function is set forth in U.S. application Serial No. 182,154, filed March 15, 1962, and entitled "Hydraulic Circuit for Actuation of an Earth Moving Scraper Ejector," now U.S. Patent No. 3,138,884. The apron jacks 16b and 16c are associated with check relief valves S whose construction and manner of operation are set forth in U.S. application Serial No. 154,790, filed November 24, 1961, and entitled "Hydraulic Circuit for Tractor Drawn Scraper or the Like," now U.S. Patent No. 3,115,716. The pairs of bowl jacks 22b and 22c are also associated with check relief valves designated by the letter R and are the subject of U.S. Patent No. 3,068,596, issued December 18, 1962. These valves R, S, and T do not affect the mode of operation of the hydraulic circuit of the present invention; therefore, detailed description thereof in this application is not necessary.

The selector valve 40a shown in FIG. 3 combines the functions of the valve 40 shown in FIG. 1 with that part of the valve fulfilling such functions being located

above the reference plane X—X and the portion of the valve 40a below the reference plane X—X functions to effect operation of the check relief valves R associated with the jacks 22b and 22c. The conduit 44 in the circuit shown in FIG. 3 also communicates with the switch valve 28 and with the switch valve 30 by the branch conduit 46. In addition, another branch conduit 81 delivers pressure fluid to an additional switch valve 82 which is operative to supply pressure fluid to the jacks 16b or 16c. Fluid supplied to the control valve assembly 24a is communicated to the switch valves 28, 30 and 82 by conduits 100, 200, and 300, respectively. The control valve assembly 24a includes an inlet manifold and a discharge manifold which is connectable with the conduits 100, 200, and 300 depending upon which of the spools 14s, 16s and 22s are actuated and, of course, whether they are actuated to the left or the right. A common fluid return manifold 400 communicates with all of the jacks on each scraper and with the control valve assembly 24a so that the pressure fluid is returned to the reservoir 10 by the discharge manifold in the valve 24a and the conduit 80 which communicates with the reservoir 10.

In operation assuming that it is desired to actuate the jacks on the scraper B, the operator positions the spool 74a of the valve 40a in the position indicated by the numeral 1 thereby blocking fluid communication between the conduit 42 and the conduit 48 which is in communication with the reservoir 10. At the same time communication between the conduit 44 and the conduit 48 is established and the springs 35 associated with each one of the switch valves 28, 30 and 82 to locate the spools 36 so that the conduits 100, 200, and 300 are in fluid communication with the conduits 100b, 200b, and 300b. Actuation of the jack 14b takes place when the operator manually shifts the spool 14s to the right, connecting the conduit 100 with the inlet manifold of the control valve assembly 24a thereby permitting pressure fluid to flow through the conduit 100, through the switch valve 28, through the conduit 100b, and to the head-end of the jack 14b causing extension thereof. In a similar manner, extension of the jacks 16b and 22b is effected by shifting the spools 16s and 22s to the right permitting the pressure fluid in the inlet manifold of the control valve assembly 24a to flow through the conduits 300 and 200 to the switch valves 82 and 30 whose spools are positioned to allow the pressure fluid to flow through the conduits 300b and 200b, respectively.

When it is desired to actuate the jacks on scraper C, the spool 74a is positioned at the location indicated by the numeral 2 thereby establishing communication between the conduit 42 and the conduit 44 and blocking the return conduit 48. The conduit 44 communicates the pressure fluid to the switch valve 28 and to the branch conduits 46 and 81 biasing the spools therein to establish communication between the conduits 100 and 100c, the conduits 200 and 200c, and the conduits 300 and 300c. Manual actuation of the spools 14s, 16s and 22s communicates pressure fluid to the jacks 14c, 16c and 22c causing their actuation in the same manner as described above in connection with the jacks on the scraper B.

Control pressure fluid, for the check relief valve R associated with the sets of jacks 22b and 22c, is supplied by the conduits 86 and 88 and conduits 90 and 92 return this fluid to the reservoir 10. The particular manner and purpose with which such control pressure is effective to cause actuation of the valves R is set forth in the above referenced U.S. Patent No. 3,068,596.

From the foregoing description it will be evident that the hydraulic circuit of the present invention provides a very simple and dependable structure for effecting selective operation of hydraulic motors. The relationship of the valves 18 and 40 automatically conditions the pilot pressure circuit for operation so that selection of which

motor is to be actuated is accomplished by merely shifting the spool 74.

What is claimed is:

1. A hydraulic control circuit for selectively individually operating at least two hydraulic motors comprising: a hydraulic circuit for actuating said motors, selectively operable control means for effecting actuation of said motors in a desired sequence, means for supplying fluid under pressure to said circuit, switch valve means being operable to effect operation of either one of said motors, a hydraulic pilot pressure circuit for actuating said switch valve means to permit pressure fluid energization of one of said motors, and control valve means in communication with said motor actuating hydraulic circuit and said pilot pressure circuit for rendering said pilot pressure circuit ineffective to operate said switch valve means in order to permit pressure fluid energization of the other of said motors.

2. A hydraulic control circuit as defined in claim 1 wherein at least one of the motors is located on each of two earthmoving scrapers connected in tandem and drawn by a single tractor and the selectively operable control means is located on said tractor.

3. A hydraulic control circuit for selectively individually operating tandemly arranged bowl-type scrapers each of which include bowl lifting jacks, an apron jack, and an ejector jack, the improvement comprising: a hydraulic circuit for actuating said jacks, selectively operable control means for effecting actuation of said jacks in a desired sequence, means for supplying fluid under pressure to said circuit, switch valve means having a pressure fluid input in communication with said selectively operable control means and pressure fluid outputs in communication with said jacks for directing pressure fluid to either of said outputs, a hydraulic pilot pressure circuit for actuating said switch valve means to establish communication between said input and one of said outputs to permit actuation of the jacks on one of said scrapers, and control valve means in communication with said jack actuating hydraulic circuit and said pilot pressure circuit for rendering said pilot pressure circuit ineffective to actuate said switch valve means so that communication between said input and the other of said outputs is established thus permitting actuation of the jack on the other of said scrapers.

4. A hydraulic control circuit for selectively individually operating tandemly arranged bowl-type road scrapers each of which include bowl lifting jacks, an apron jack, and an ejector plate jack, the improvements comprising: a hydraulic circuit for actuating said jacks, selectively operable control means for effecting actuation of said jacks in a desired sequence, switch valve means being operable to effect operation of the jacks on either scraper, a hydraulic pilot pressure circuit for actuating said switch valve means to permit pressure fluid energization of the jacks on one of the scrapers and control valve means for rendering said pilot pressure circuit ineffective to operate said switch valve means in order to permit pressure fluid energization of the jacks on the other scraper.

5. A hydraulic control circuit for effecting operation of at least two hydraulic motors comprising: means for supplying pressure fluid to each of the motors, selectively operable valve means in said supplying means for rendering either of the motors inoperative, a chambered control valve means in said supplying means, said control valve means being effective on an increase in pressure in the chamber thereof to actuate said selectively operable means and thus render one of the motors ineffective and the other motor effective.

6. A hydraulic control circuit for effecting operation of at least two hydraulic motors comprising: means for supplying pressure fluid to each of said motors, selectively operable valve means in said supplying means for disestablishing communication of said supplying means

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with either of said motors, a chambered control valve means in said supplying means, a pressure fluid pilot circuit deriving pressure fluid from said control valve for operating said selectively operable valve means, means in said pilot circuit for reducing the value of pressure imposed on said selectively operable valve means, and means for venting said pilot circuit to a zone of reduced pressure in order to render the pressure in said pilot circuit ineffective to operate said selectively operable valve means and thereby condition said supplying means to permit operation of one of said motors.

7. A hydraulic control mechanism for effecting operation of at least two pressure fluid responsive actuators comprising: a control valve operative on an increase in pressure for supplying pressure fluid to said actuators, a switch valve deriving different values of fluid pressure from said control valve, said switch valve including an input conduit communicable with the pressure fluid output of said control valve and further including output conduits in communication with each of the actuators, and a selectively operable valve for increasing or decreasing the value of fluid pressure communicated to said switch valve in order to cause communication of either of said output conduits with said input conduit of said switch valve to thereby effect actuation of either of the actuators.

8. The combination of claim 7 wherein said switch valve includes a reciprocable spool being spring biased in one position and pressure fluid biased in another position so that the mentioned relationship between the input and the output is effected.

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9. A hydraulic control mechanism for effecting operation of hydraulic jacks comprising: a control valve operative on an increase in pressure for supplying pressure fluid to said jacks, switch valves communicable with said control valve, each of said switch valves including an input conduit connectable with the pressure fluid output of said control valve and further including output conduits in communication with the jacks on each scraper, a selectively operable valve for increasing or decreasing the value of fluid pressure communicated to said switch valves in order to cause communication of either of said output conduits with said input conduit of said switch valves to thereby effect actuation of said jacks, and means associated with said control valve for reducing the value of pressure communicated to said switch valves and maintain said control valve open to supply pressure fluid to said jacks.

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