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Bernhoft

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[54] **CONTROL MEANS FOR A PAIR OF FLUID MOTORS**

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[51] **Int. Cl.** **E02f 3/32**

[58] **Field of Search** 91/444, 448, 412, 411; 137/625.6, 625.63; 214/762, 763, 764

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Primary Examiner—Robert J. Spar

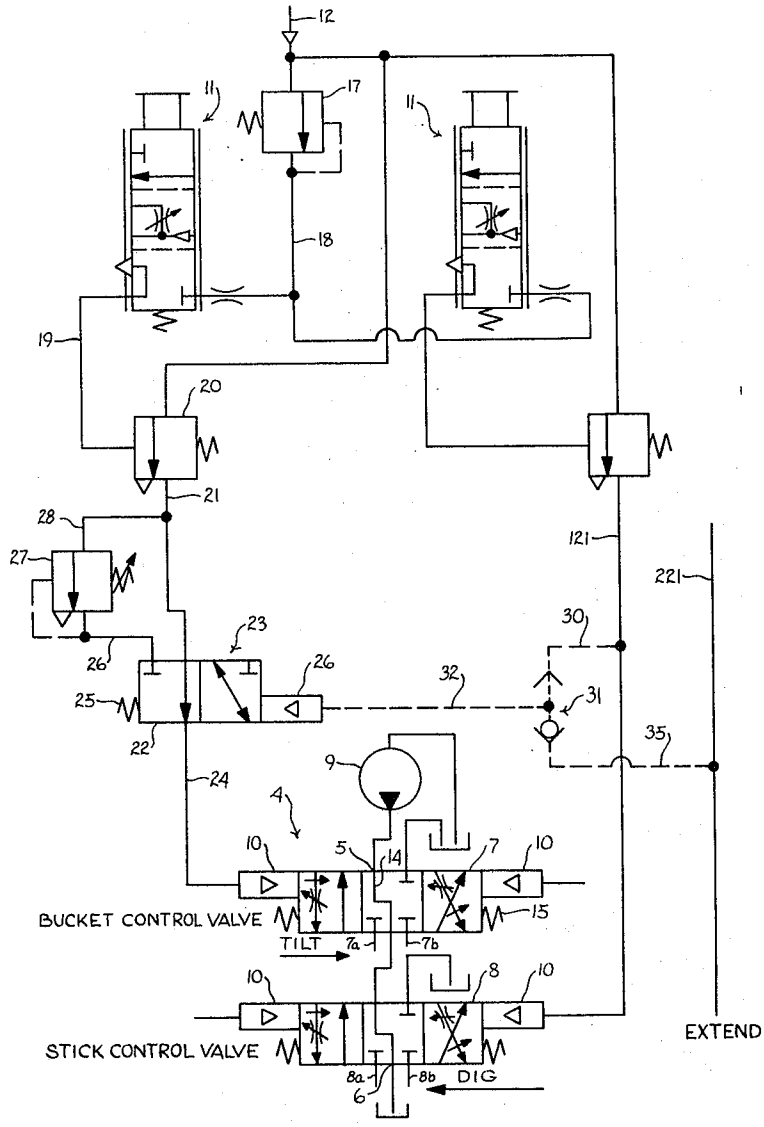
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[57] **ABSTRACT**

A fluid pressure system comprising a pair of pilot actuated control valves, one of which has an inlet for pump output fluid and passage means through which the other is supplied with said pump fluid. Actuation of the valve element in said one control valve to a full operating position inhibits flow of pump output fluid to the other control valve until said valve element is returned at least partway toward its neutral position, and such partial return thereof is automatically effected as a consequence of actuation of the pilot for said other control valve.

5 Claims, 2 Drawing Figures



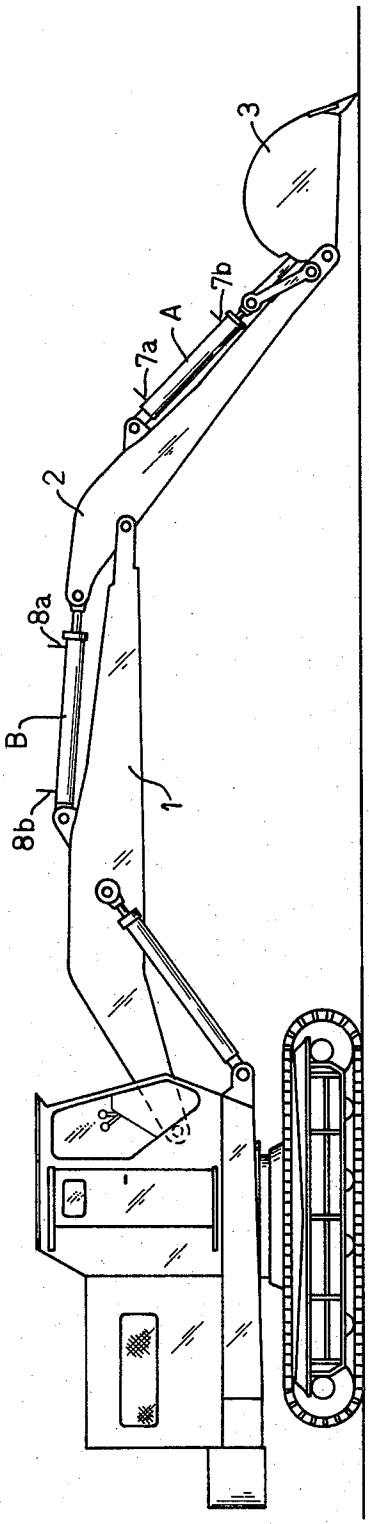


FIG. 1

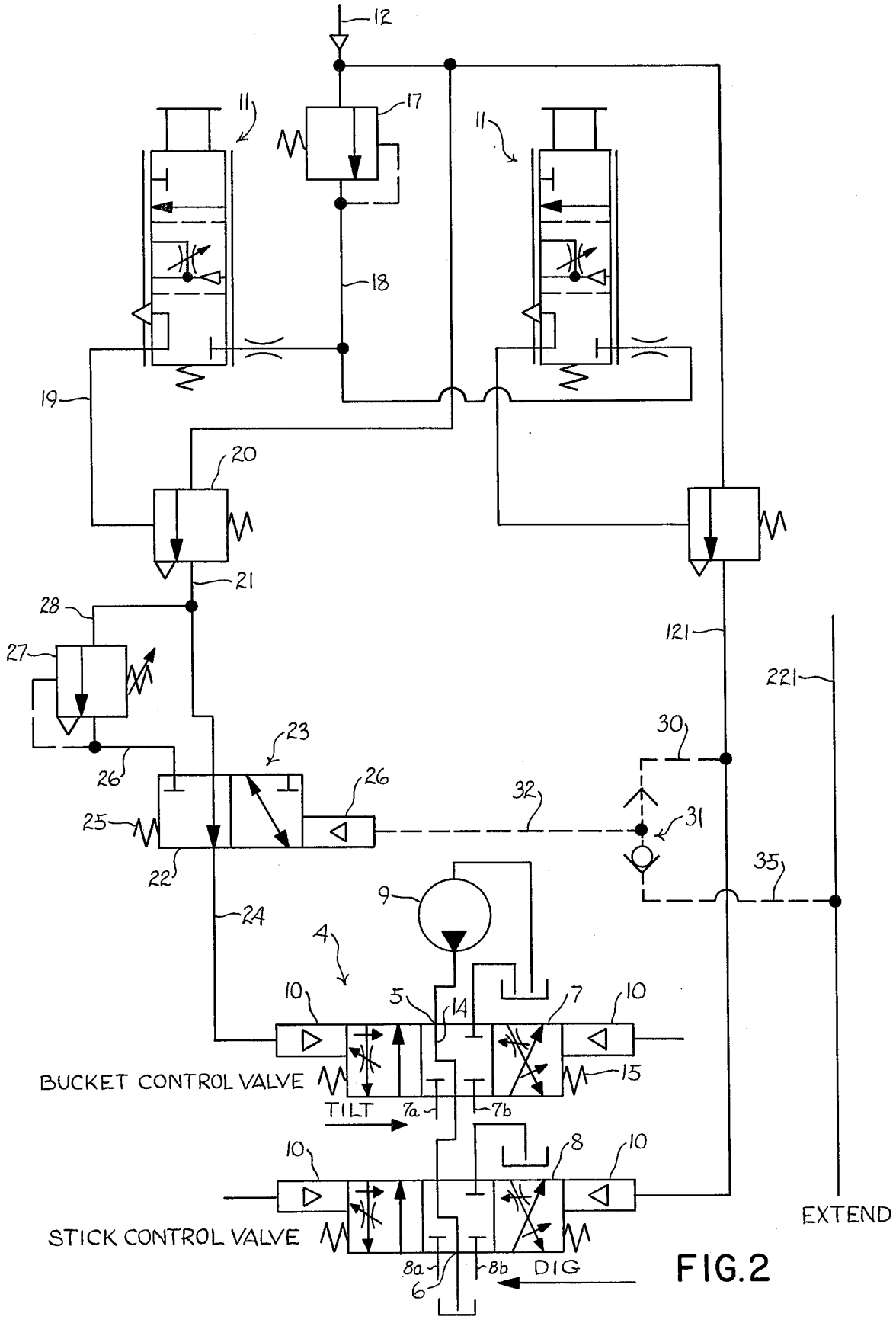

12
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23
26
25
22
24
32
31
30
121
221
35
9
4
10
5
14
7
10
BUCKET CONTROL VALVE
15
TILT
7a
7b
10
8
10
STICK CONTROL VALVE
8a
8b
DIG
6
EXTEND

FIG.2

CONTROL MEANS FOR A PAIR OF FLUID MOTORS

BACKGROUND OF THE INVENTION

This invention relates to fluid pressure systems in which a pair of liquid motors must at times be operated simultaneously, in consequence of actuation of pressure compensated control valves therefor.

As is well known, when two such pressure compensated control valves are connected together in a bank having a common inlet or supply passage for pump output fluid, that valve which is closer to the inlet has priority over the other. This is to say that if the valve element or spool of the first control valve is in a full operating position, all of the pump output fluid entering the inlet would flow to the fluid motor governed by said first valve, and none would be available for operation of the motor governed by the second control valve. In that case, only one of the fluid motors could be operated at a time.

A hydraulically operated backhoe is but one example of a mechanism having two fluid motors, in this case double acting hydraulic cylinders, which frequently must be operated concurrently in order to efficiently perform its digging function. A first pressure compensated valve can be one which controls the bucket cylinder, and the second pressure compensated valve can be one which controls the stick cylinder. If the bucket control valve is nearer the inlet and is actuated to a full operating position, all of the pump flow is directed into the bucket cylinder, and operation of the stick cylinder is impossible.

Inasmuch as all control valves have a maximum capacity, one solution to the aforementioned problem would be to supply a volume of pressure fluid to the inlet of the valve bank in excess of the capacity of the first valve section. In this way, sufficient fluid could be made available for simultaneous operation of both the bucket and stick cylinders. This solution, however, is subject to the objection that additional horsepower would be required, which additional horsepower would be wasted when only one of the cylinders was in operation.

Another solution to the problem involves practice of an expedient which has for long been quite common to operators of parallel and/or series-parallel control valves. This expedient required the operator to manually return the valve element of the first control valve partway toward its neutral position, in order to divert some of the incoming pump fluid to the motor governed by the second control valve. For simultaneous operation of the bucket and the stick cylinders of a backhoe, therefore, the operator had to acquire a certain degree of skill in the manual manipulation of the hand levers on their respective control valves and he frequently had to "hunt" for the proper positions of both valve elements, by continuously shifting their levers back and forth to obtain the desired rates of fluid flow to the motors governed by the control valves.

SUMMARY OF THE INVENTION

It is the purpose of the present invention to provide a fluid pressure system comprising a plural spool pilot operated control valve mechanism having a common pressure fluid supply passage for said spools, and wherein instrumentalities incorporated in the system

function automatically to effect partial retraction from a full operating position of the valve element of a first control valve nearest the inlet of the supply passage, as a consequence of actuation of the valve element of a second control valve downstream from the first in the direction of fluid flow through the supply passage, to thereby make pressure fluid available to the service passages governed by the second control valve.

More specifically it is an object of the invention to provide a control valve mechanism comprising a pair of pilot operated control valves, wherein actuation of the pilot to effect shifting of one control spool to an operating position automatically effects retraction of the control spool nearer the inlet of the mechanism from a full flow operating position thereof partway toward a neutral position to thus enable flow of inlet fluid to service passage means governed by the downstream valve spool.

With these observations and objectives in mind, the manner in which the invention achieves its purpose will be appreciated from the following description and the accompanying drawings, which exemplify the invention, it being understood that changes may be made in the specific apparatus disclosed herein without departing from the essentials of the invention set forth in the appended claims.

The accompanying drawings illustrate one complete example of an embodiment of the invention constructed according to the best mode so far devised for the practical application of the principles thereof, and in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagrammatic view of a material handling device, such as a backhoe embodying this invention, and

FIG. 2 is a graphic diagram of a fluid pressure system employed in carrying out the invention.

DETAILED DESCRIPTION

The invention is embodied in a material handling device, such as a backhoe illustrated in FIG. 1, and including a boom 1 to which an arm or stick 2 is pivoted for relative movement. In addition, a tool, such as a bucket 3, is pivoted to the arm 2 for relative pivotal movement. A hydraulic cylinder A is connected between the tool 3 and the stick 2 which upon extension of the hydraulic cylinder A causes clockwise pivotal movement of the bucket 3 relative to the arm 2. A similar cylinder B is connected between the arm 2 and the boom 1 which acts as a support so that extension of the hydraulic cylinder B causes the stick 2 to pivot in a clockwise direction relative to the boom 1.

Referring now more particularly to FIG. 2, it will be seen that the system comprises a control valve mechanism 4 having a pressure fluid inlet 5, an outlet 6, and first and second control valves 7 and 8 which can comprise two juxtaposed sections of a bank whose inlet 5 is supplied with pressure fluid from the output port of a pump 9. The first control valve 7 is that which is nearer the inlet 5 and can be considered as the upstream valve for controlling the cylinder A in FIG. 1. The second control valve 8 can thus be referred to as the second or downstream valve for controlling the cylinder B. The valve 7 is connected by hydraulic lines 7*a* and 7*b* to the opposite ends of hydraulic cylinder A and

valve 8 is connected by hydraulic lines 8*a* and 8*b* to the opposite ends of hydraulic cylinder B.

Each of the control valves has been shown as of the pressure compensated type having a control spool which is movable out of its neutral position indicated in the diagram to operating positions at opposite sides of neutral. Fluid pressure operated actuators **10**, one connected with each end of each spool, provides for shifting of the spools to one or the other of their respective operating positions at the dictate of pilot valves such as generally designated **11**. While each actuator **10** has its own pilot valve **11**, only two have been shown in the diagram, one for the actuator **10** at the left hand end of the upstream control valve **7**, and one for the actuator **10** at the right hand end of the downstream control valve **8**.

All of the pilot valves are connected with a common source of pilot fluid under pressure. For purposes of illustration the pilot fluid can comprise air under pressure brought in to the system through a duct **12**. The pilot valves **11** are of the type disclosed in detail in the copending application of Gerald W. Bernhoft and David A. Miller Ser. No. 195,581, filed Nov. 4, 1971 and entitled Control For Mobile Construction Machine now U.S. Pat. 3,773,084, granted Nov. 20, 1973. In fact, the pilot circuitry herein shown follows to a considerable extent that which is disclosed in said copending application.

Each pilot valve **11** has a plunger which is movable up and down is normally held in a closed upper position blocking flow of air under pressure from the air line **12** to the actuators **10**. Depression of the plunger of the pilot **11** for control valve **7** effects shifting of the spool thereof to a full operating position to the right of neutral by the actuator **10** at its left hand end; while depression of the plunger of the pilot **11** for control valve **8** effects shifting of its spool to a full operating position to the left of neutral by the actuator **10** at its right hand end.

With pressure compensated control valves like those graphically shown in the diagram, pressure fluid entering the inlet **5** from the pump **9** is able to flow substantially freely through a common supply passage such as indicated at **14** as long as the spools of both control valves remain in their neutral positions shown. Each one of the valves, when actuated separately to a full operating position at the dictate of its pilot **11**, is capable of directing substantially the entire output of the pump **9** to the hydraulic cylinder A or B governed thereby.

However, as is the case with series-parallel valves, if the spool of the first or upstream control valve **7** is in a full operating position, it inhibits flow of supply fluid to the second or downstream control valve **8**. As a result, the cylinder governed by the downstream control valve **8** cannot be operated until the spool of the upstream control valve **7** is returned to neutral, or at least partway toward neutral to a position metering flow to its associated cylinder and thereby allowing some of the pump output fluid entering the inlet **5** to flow to the downstream control valve **8** for operation of the cylinder governed thereby concurrently with the cylinder governed by the upstream control valve **7**.

As explained in the aforesaid copending application, however, it is possible by manual regulation of the position of the plunger of pilot valve **11** for control valve **7** to place it in any one of a number of undefined positions intermediate its closed and fully open positions, to effect reduction of the air pressure in the associated actuator **10** to a value at which the force it exerts on the spool of valve **7** balances the force of the return spring **15** thereon at some metering position of the spool between its neutral and full flow positions. In this way part of the pump fluid entering the inlet **5** can flow to the cylinder governed by control valve **7** and the remainder can be made to flow to the cylinder governed by control valve **8**.

According to this invention, the operator of apparatus, such as a backhoe, having the fluid pressure system herein illustrated, does not have to hunt for intermediate position the plunger of pilot **11** for valve **7** must occupy in order to enable concurrent operation of the cylinders governed by the control valves **7** and **8**. For example, one of these cylinders can be that which governs the tilting and dumping motions of the bucket under the control of the upstream valve **7**, and the other cylinder can be that which is governed by the downstream control valve **8** and effects the dig and extend motions of the stick upon which the bucket is mounted.

If it is assumed that the plunger is held in a fully depressed position in the pilot **11** for the upstream control valve **7**, so that the spool thereof will accordingly be in a full flow bucket tilt position at which all of the pump output fluid entering the inlet **5** flows to the bucket cylinder, the operator can automatically effect partial retraction of said spool and operation of the stick cylinder to cause digging motion of the stick concurrently with tilting motion of the bucket merely by actuation of the pilot **11** for the right hand actuator **10** of the downstream control valve **8**.

A full discussion of the pilot circuitry which follows, is necessary to an understanding of how this desired concurrent operation of the cylinders governed by both control valves is achieved without any repositioning of the plunger in the pilot for the bucket control valve **7**.

The pilot circuit for the actuator **10** at the left hand end of the bucket control valve **7** will be first described. Air under pressure of about 90 psi in line **12** enters a reducing valve **17** and flows therefrom to the inlet of pilot **11** via a duct **18** at a pressure of about 35 psi. An outlet duct **19** leads from the pilot valve and is connected with an amplifier **20** of a commercially available type manufactured by the Bellofram Corp. and known as its Model 362 relay.

The pressure in the duct **19** can be anywhere from 5 to 35 psi, depending upon the extent to which the plunger of the pilot valve **11** has been depressed. This pressure is controlled by bypassing incoming air to the atmosphere in an amount which decreases with downward motion of the pilot plunger until its fully open position is reached at the end of the plunger stroke.

Depending upon the pressure of the air entering the relay or amplifier **20**, the pressure of the air flowing into a duct **21** from the outlet of the relay will vary from about 15 to 90 psi. For the purposes of this invention the duct **21** can be considered as a fluid pressure supply line for the actuator **10** at the left hand end of the bucket control valve **7**.

If only that pilot valve governing bucket tilt is actuated to a full flow position, pilot fluid (air) in the supply duct **21** normally flows through the left hand section **22** of a two position three port valve instrumentality **23** to a duct **24** connecting with the valve actuator **10**, to subject the same to the full pressure of pilot fluid in duct

21. This, of course, effects shifting of the spool in the bucket control valve 7 to a full operating position to the right of neutral, against the force of its return spring 15.

The two position valve instrumentality 23 is biased to the position described above by a spring 25. It is also provided with a fluid pressure actuator 26 in the form of an air cylinder which, when connected with a source of air under pressure, effects shifting of said valve instrumentality to its other position to communicate the duct 24 with a duct 26 forming a branch of the supply duct 21.

An adjustable pressure regulating valve 27 in branch 28 of the supply duct is normally set to reduce the pressure of pilot fluid flowing to the actuator 10 through the valve instrumentality 23 to a value such as to allow the spring 15 to retract the spool of the bucket control valve 7 partway toward neutral, to a position at which the fluid pressure force exerted on the spool by the left hand actuator 10 balances the return force exerted on the spool by the spring 15.

By way of example, with a spring 15 of given strength, and with the pressure of pilot fluid in the supply duct 21 at a maximum value of about 90 psi, and assuming that the valve instrumentality 23 has been actuated to its position routing pilot fluid to the actuator duct 24 through the pressure regulating valve 27, the pressure of fluid then entering duct 24 will be about 52 psi. In other words, the opposing forces of spring pressure on one end of the bucket spool and of pilot actuator pressure on the other end of the spool will hold the spool in a metering position such as to make pump fluid available to the spool of the stick cylinder 8.

It should be noted that the pressure regulating valve 27 is of the self relieving type so as to dissipate any of the higher pressure air from the actuator 10 when the valve instrumentality 23 is shifted to its last described position.

It should also be understood that a duplicate of the pilot valve 11 and pilot circuitry described is provided for the actuator 10 at the right hand end of the bucket control valve 7, to govern "dump."

The valve instrumentality 23 will be shifted to its position routing pilot fluid through the pressure regulating valve 27 as a consequence of actuation of the pilot valve 11 for either actuator 10 of the stick control valve 8. The pilot circuitry for each actuator 10 of the stick control valve is the same as that described except that the pressure regulating valve 27 and fluid pressure actuated valve instrumentality 23 are eliminated therefrom.

For convenience, only that pilot valve 11 and pilot circuitry which controls the actuator 10 for the "dig" function of the stick control valve has been illustrated. Manual depression of the plunger of the pilot valve 11 for dig brings fluid (air) under pressure into the pilot supply duct 121. This duct leads to the actuator 10 at the right hand end of the stick control valve and it also has a branch 30 which leads through a shuttle valve 31 to a control duct 32 connecting with the fluid pressure actuator 26 for the two position valve instrumentality 23.

Accordingly, if the bucket control spool is in its full flow "tilt" position directing the entire pump output to the bucket cylinder at the time the plunger of the pilot valve 11 is depressed to effect actuation of the stick control valve for the dig function, the resulting pressurization of duct 121 with pilot fluid will effect actuation of the valve instrumentality 23 and disconnection of the actuator 10 for the bucket control valve from its supply duct 21, and pilot fluid will be routed to said actuator at reduced pressure through the regulator 27 and the two position valve instrumentality 23.

The spool of the bucket control valve 7 then assumes an intermediate or metering position at which part of the pump fluid entering the inlet 5 of the control valve mechanism is directed to the bucket cylinder and the remainder is directed to the stick cylinder. In this way, the bucket and stick cylinders can be operated simultaneously, to effect the desired digging action through the combined tilt and dig movement of the bucket and stick, respectively.

From this it will be seen that the adjustment of the pressure regulating valve 27 will determine how much pump output fluid will be diverted to the stick cylinder with a return spring 15 of given strength acting upon the spool of the upstream control valve 7.

The same retracting motion of the spool in the bucket control valve takes place upon depression of the plunger in the pilot valve (not shown) for the actuator 10 at the left hand end of the stick control valve. In that event, the actuator 26 for the two position valve instrumentality is again pressurized by pilot fluid (air) under pressure in the actuator supply duct 221 through a branch 35 connecting it with the actuator through the shuttle valve 31 and the duct 32.

From the foregoing description, together with the accompanying drawing, it will be readily apparent to those skilled in the art that this invention provides a fluid pressure system which automatically provides for partial retraction of the spool of a first pilot operated control valve from a full flow position, to enable simultaneous operation of two fluid motors, as a consequence of actuation of a pilot valve for a second control valve; and that adjustable instrumentalities incorporated in the system provide for such simultaneous operation of the fluid motors at optimum speeds without the necessity for repositioning of their pilot valves during such operation.

It will be further apparent that this invention is applicable to pilot operated control valve system regardless of whether the pilot valves and circuits governed thereby employ air or hydraulic fluid; and that the pilot valves themselves can be solenoid operated in some installations where remote control of the pilot valves is desired.

Those skilled in the art will appreciate that the invention can be embodied in forms other than as herein disclosed for purposes of illustration.

The invention is defined by the following claims:

1. In a material handling device including a pivotally mounted arm, a tool pivotally mounted on the arm, first and second fluid motor means for independently pivotally moving the arm and the tool, respectively, pump means for directing fluid to the first and second motor means, first valve means movable from a closed to an open position for directing fluid from said pump means to one of said first and second motor means, second valve means movable from a closed to an open position for directing fluid from said pump means to the other of said first and second motor means and manual actuator means for each of said first and second valve means; the improvement comprising: control means, including a separate source of fluid pressure and pressure operated means communicating with said separate source

for moving said first and second valve means between open and closed positions, operatively connected between said first and second valve means for moving said first valve means to a partially closed position in response to opening of said second valve means whereby said arm and said tool are pivoted simultaneously at a reduced speed.

2. In a material handling device including a pivotally mounted arm, a tool pivotally mounted on the arm, separate fluid motors for pivotally moving the arm and the tool, pump means providing a pressure fluid source for operation of said motors, a first control valve actuatable from a closed to an open position to direct pressure fluid from said source to one of said motors, a second control valve actuatable from a closed to a fully open position to direct pressure fluid from said source to the other motor and in which said first control valve in its fully open position precludes flow of pressure fluid from the source to said second control valve, the improvement which comprises:

A. manually operated actuator means for each of said first and second control valves for effecting such actuation thereof;

B. and control means connected with said first and second control valves and with the actuator means for said first control valve and operable whenever said first control valve is in its fully open position, and in consequence of valve opening operation of the actuator means for said second control valve, to effect movement of said first control valve to a partially closed position without necessitating manual adjustment of the actuator means for said first control valve, to thereby effect diversion of pressure fluid from the source to the motor governed by said second control valve for concurrent and independent pivotal motion of the arm and tool, said control means comprising a separate source of control pressure, and said manually operated actuator means including pressure responsive means for each of said first and second control valves communicating with said source of control pressure for moving said valves from said closed to open positions in response to pressure from said separate source.

3. A material handling device comprising, a support, an arm pivoted to said support, a tool pivoted to said arm, a first fluid motor operable to pivot said arm relative to said support, a second fluid motor operable to pivot said tool relative to said arm, pump means providing a pressure fluid source for operation of said motors, a first valve means movable between closed and open positions to control fluid flow from said source to said first motor, a second control valve means movable between closed and open positions to control fluid flow from said source to said second motor, a separate source of fluid pressure, pressure operated means communicating with said separate source for moving said control valve means between open and closed positions, control means operatively connected to said pressure operated means for moving said first valve means from said open towards said closed positions in response to movement of said second valve means from said closed to said open position for simultaneous and independent operation of said first and second motors.

4. A material handling device comprising, a support, an arm pivoted to said support, a tool pivoted to said arm, a first fluid motor operable to pivot said arm relative to said support, a second fluid motor operable to pivot said tool relative to said arm, pump means providing a pressure fluid source for operation of said motors, first and second valve means, said first valve means being movable between first and second positions to control fluid flow from said source to said first motor and to said second valve means, said second valve means being movable between first and second positions to control fluid flow from said source to said second fluid motor, said second valve means being substantially isolated from said pressure fluid source when said first valve means is in said second position, a separate source of fluid, a first pressure operated means operatively connected to said first valve means and a second pressure operated means operatively connected to said second valve means for moving each of said valve means between said first and second positions, first and second manually movable control valves disposed between said separate source and said first and second pressure operated means, respectively, and being operative to control delivery of pressure to said pressure operated means, and control means operatively connected between said first and second pressure operated means for moving said first valve means from said second towards said first position in response to pressure in said second pressure operated means for simultaneous delivery of fluid from said source to said first and second valve means for independent and simultaneous operation of said first and second fluid motors.

5. The combination of claim **4** in which said control means includes a pressure controlling valve connected to said first pressure operated means and to said separate source of pressure, said pressure controlling valve being operative in response to pressure in said second pressure operating means to reduce the pressure in said first pressure operating means for movement of said first valve means from said second towards said first position of the latter for communicating said second valve means with said first valve means for said simultaneous and independent pivotal movement of said arm and said tool.

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