This invention relates to a control system for hydraulic jacks of an earth mover or scraper. More particularly, this invention relates to a remote control system for hydraulic jacks which operate various material handling components of the earth mover.

Heretofore it has been the common practice in earth moving motor scraper controls to provide control valves at the operator's station and appropriate hoses to the hydraulic jacks employed to raise and lower the cutting edge, eject material and control the apron. Thus for the three usual functions of ejecting, apron control and raising and lowering of the bowl, as many as four different lines were required to pass from the operator station on the tractor to the trailing scraper.

The control system described herein improves upon prior systems in a number of aspects. This invention employs a single supply passage to series connected valves. Only one supply hose and one return hose pass between the tractor unit and trailer unit. Also a bypass passage with diverter valve is employed between the high pressure and low pressure sides of the system to reduce the work required by the pump and to reduce pump wear.

It is an object of this invention to provide an improved hydraulic control system for an earth mover wherein the control valves are located near the hydraulic jacks they control, are connected in series by a supply passage and only one supply hose and one return hose pass between the source of hydraulic fluid and the portion of the earth mover on which the jacks are employed.

It is a further object of this invention to provide a scraper control system which has simplified hydraulic circuits, has minimum fluid circulation power losses, has quick response to operator control, and which automatically unloads the pump when high pressure fluid is not required to actuate the jacks.

It is a further object of this invention to provide an electrically controlled system for remote hydraulic valves wherein a diverter valve is automatically controlled by the electric control system to unload the pump when hydraulic fluid is not required by the jacks.

It is a further object of this invention to provide an improved hydraulic control system for an earth mover wherein an electric over air control arrangement is employed to operate hydraulic valves located remote from the operator station.

These and other objects of this invention will be apparent when the following description is read in conjunction with the drawings in which:

FIG. 1 is a top view of an earth mover in which the present invention is utilized;
FIG. 2 is a side view of the earth mover illustrated in FIG. 1;
FIG. 3 is a schematic showing of the control system of this invention;
FIG. 4 is a section view of the bowl and apron control valves;
FIG. 5 is a section view of the bowl and apron control valves;
FIG. 6 is a section view of the diverter and relief valves.

Referring to FIGS. 1 and 2, the earth mover is made up of a front tractor unit 11 and a motorized trailer unit 16. The front tractor unit includes an engine 51 driving front wheels 15 and an operator station 12 at which a steering wheel 13 and operator seats 14 are located. The trailer unit 16 includes a yoke 17 which is pivotally connected to the front tractor unit by hitch means permitting horizontal swinging movement of a front tractor unit about a vertical axis and lateral oscillating movement of the front tractor relative to the yoke 17. Steering of the front tractor unit relative to the yoke 17 about a vertical pivot axis is accomplished by steering means 19. The trailer unit 16 also includes a bowl structure 18 pivotally connected to the yoke 17 on a transverse axis 21. The bowl structure 18 includes a transverse blade structure 20, side walls 24, 25 and rear driving wheels 27 driven by the rear engine 20. Material is ejected from the earth mover bowl structure by actuation of a hydraulic motor in the form of an ejector jack 31 to thereby pivot the bottom 28 about its pivot connection 29 with blade structure 30. The jack 31 is pivoted at its bottom end to a transverse frame member of bowl structure 18 and is pivoted at its top end to the pivoted bottom 28. The bowl structure 18 is raised and lowered by a pair of hydraulic motors in the form of bowl control jacks 32 which are pivotally connected at their lower rod ends to the forward end of side walls 24, 25, and are pivotally connected at their upper ends to the yoke 17. The apron 33 is pivotally connected to the side walls 24, 25 for pivotal movement about the axis of pin 34. The apron is pivoted by a hydraulic motor in the form of an apron control jack 36 pivoted at its lower end to the yoke and at its upper end to a lever 37 which carries a handle 38 having a sheave about which control cable 38 is reeved. Control valve assembly 41, containing the bowl control valve and the apron control valve, is mounted on the yoke in close proximity to the jacks 32, 36 controlled thereby. Ejector control valve assembly 42 is mounted on the bowl structure 18 in close proximity to the ejector jack 31.

The control valve assemblies 41, 42 are operated by an electric over air system, the electric control switches of which are mounted on a terminal block 46 at the operator's station 12 which includes a handle 47 permitting the operator to steady his hand during operation quickened by electrical elements or switches with his thumb or fingers. A diverter valve 48 is mounted on a hydraulic reservoir 49 carried by the tractor unit 11.

Referring to FIG. 3 showing the schematic showing of the electric over air over hydraulic control system, the engine 51 of the front tractor unit drives a hydraulic pump 53 and an air compressor 50 the latter of which supplies compressed air to an air storage tank 55. The hydraulic pump 53 draws fluid from the hydraulic reservoir 49 and supplies pressure fluid to the high pressure side of the system which includes a fluid supply passage 54 which passes through the bowl and apron control valve assembly 41 and to the ejector valve assembly 42. The low pressure side of the hydraulic system includes a return to reservoir passage 56 which connects valve assembly 42 to the reservoir 49 and a branch passage 57 connected to valve assembly 41. A bypass passage 58 is connected at one end to the reservoir 49 and at its other end to the supply passage 54 intermediate the pump 53 and the control valve assemblies 41, 42. A diverting valve 48 is interposed in the bypass passage 58 and the housing 59 therefor also houses a relief valve 61 which is hydraulically in parallel with the diverter valve 48.

The control valves of this control system are pilot operated by compressed air controlled by electrically operated air valves. An air conduit 64 supplies compressed air to a pneumatic actuator 66 employed to assist in op-
eration of the piston in the master cylinder 67 of the earth mover brake system. Upon pressing brake pedal 68, air is admitted to the actuator 66 which assists in moving the piston end of the master cylinder 67 to deliver high pressure brake fluid through conduits 72, 73 to the wheel cylinders 69, 71. An air conduit 63 extends to branch conduits 76, 77 connected to air valves 172, 186 at opposite ends of valve assembly 42. Branch conduits 158, 191, 192, 193 connect conduit 63 to air valves at opposite ends of the two spools of valve assembly 41. Air conduit 82 connects conduit 63 to an air valve 81 on diverter valve 48. The electrical control system for operating the electrically controlled air valves is connected to the earth mover electrical system through a switch 86. The electrical power source is illustrated as a battery 87.

Terminal block 46 which is mounted at the operator's station as illustrated in FIGS. 1 and 2, mounts three double throw, double pole switches 88, 89, 91 each of which is connected to the electrical source by supply lead 92.

Referring to FIGS. 3, 4, 5 and 6, the operation of the control system will now be explained. Hydraulic fluid supplied by pump 53 to supply conduit 54 passes through the open center bowl and apron control valves 96, 97, which together make up assembly 41. After passing through control valves 96, 97 the fluid continues to port 98 in the opposite wall of the valve housing 99, thence into the segment of passage 54 shown at the bottom of FIG. 4. When the operator wishes to raise the bowl structure 18, he pushes double pole switch 88 upwardly, as viewed in FIG. 3, to engage contacts 101, 102 thereby energizing air valves 103, 81 through flow of electricity thereto through leads 106, 107. Upon energizing of air control valve 103, air is supplied to a chamber, not shown, at the end of the bowl control spool 108 and the latter will be moved to the left, as viewed in FIG. 4, thereby supplying hydraulic pressure fluid to port 109 which is connected through a T connection 111 to hoses 112, 113 leading to the lower rod end of hydraulic jacks 32. When the double pole switch 88 is moved to a bowl raising position as just described, the air valve 81 admits air from conduit 82 to the chamber 116 at the end of a dumping valve spool 117 thereby moving the latter downwardly as viewed in FIG. 6 against the action of spring 118 to a position wherein land 119 blocks port 121 to prevent escape of supply fluid through conduit 58 to the return line of the spool 49 to which porting 123 is connected. Relief valve 61 is of the differential pressure type and is set at an appropriate pressure to guard the pump against excessive pressures. The diverter valve 48 and relief valve 61 are connected hydraulically in parallel between the reservoir 49 and the high pressure side of the system. When the rod ends of the jacks 32 are being supplied with pressure fluid, the opposite ends of the jacks are being exhausted to permit contraction and the exhausted fluid moves from the upper end of the jack through conduits 131, 132, to a T connection 133, thence through port 134 in valve housing 119 to the low pressure cavity 136 in the valve housing to which branch return passage 57 is connected.

When the double pole switch 88 is moved to its bowl lowering position, contacts 141, 142 are engaged and air control valves 143 and 81 are energized by current supplied through lead 144 and 146, respectively. The bowl structure 18 is thus lowered through expansion of the hydraulic jacks 32. Cavitation is prevented by anti-cavitation of valve 147, as illustrated in FIG. 4, should the pump 53 fail to supply fluid at a sufficient rate during lowering of the bowl structure.

When it is desired to raise the apron, double pole switch 89 is engaged to contacts 151, 152 thereby energizing air control valves 153, 81 through current flow through leads 154, 163 to effect supplying hydraulic fluid to jack 36 through hose 162 and to effect closing of the bypass passage 58. The apron is lowered upon the operator moving the double pole switch to the upper position, as shown in FIG. 3, wherein contact 164 is engaged thereby permitting compressed air to enter chamber 136 through air control valve 164 by current flow through lead 166. In the lowering position of valve spool 159, port 161 communicates with return to reservoir chamber 136 and the apron control valve 97 remains open through its center.

The ejector jack 31 is expanded to pivot the bowl bottom on the pivot connection 29 to an ejection position when double pole switch 91 is moved downwardly, as viewed in FIG. 3, to engage contacts 171, 182. Upon engaging contact 171, current is supplied to solenoid operated air control valve 172 through lead 173 thereby permitting compressed air to enter chamber 175 through air conduit 76. Pressurization of chamber 175 moves the ejector valve spool 174 to the left as viewed in FIG. 5, thereby causing land 176 to close port 177 and place supply port 178 in fluid supplying relation to ejector jack supply port 179 which is in fluid communication with ejector jack supply hose 181. Supply port 178 is connected to supply passage 54. When the switch 91 is moved to the eject position as beforementioned, contact 182 is also engaged causing current to flow through lead 183 to actuate air valve 81 which effects closing of the diverter valve 48.

When it is desired to contact the ejector jack 31, the double pole switch 91 is moved upwardly, as shown in FIG. 3, to contact terminal 184, thus supplying current to solenoid operated air control valve 186 through lead 187. When solenoid valve 186 is thus energized, the valve is conditioned to place the air supply conduit 77 in communication with air pressure chamber 188 thus causing the valve spool 174 which acts as a piston, to move to the right thereby placing the ejector jack supply port 179 in fluid communication with the return to reservoir chamber 189 which is in free fluid communication with return passage 56 which is illustrated as a hose.

From the foregoing description, it is seen that the electrically operated remote control system of this invention minimizes the hydraulic hose requirements for operating a plurality of hydraulic jacks. The structure shown within the broken lines 200 is mounted on the trailing unit 16 and the remaining portion of the control system is located on the tractor unit 11. Use of the vehicle compressed air system to actuate the valves permits an electric control system to be employed which has sufficiently low power requirements to be operated by a conventional earth mover electric supply means. By locating the hydraulic control valves near or adjacent to jacks which they control, the jacks will be subject to hydraulic pressure immediately upon actuation of the appropriate switches 88, 89, 91 thus giving fast response. The pump unloading means, in the form of bypass conduit 58 and diverter valve 48, unloads the pump 53 when pressure fluid is not required to actuate the jacks. This reduces pump wear as well as reducing power consumption. The relief valve 61 is brought into operation only when the pressure exceeds the safe operating value for actuators 32. When the diverter valve 48 is preferred since even when the diverter valve 48 is open, a low velocity flow will take place through such valves thereby reducing flow inertia. Thus upon actuation of a control switch, the response of the jack will be almost instantaneous. Further, by use of diverter valve 48 and relief valve 61 through expansion of the hydraulic jacks 32, cavitation is prevented from occurring in the bypass conduit 58.

Although a single embodiment of this electric over air over hydraulic control system for an earth mover has been illustrated and described, it is not intended to limit this invention, but rather it is intended that this invention shall include such other embodiments and modifications as are embraced by the appended claims.
Having now particularly described and ascertained the nature of our said invention and the manner in which it is to be performed, we declare that what we claim is:

1. A control system for a self-propelled earth mover including a bowl adjustable between excavating and transport positions by means including a first hydraulic motor and having means for ejecting material from said bowl including a second hydraulic motor; a hydraulic control valve for each of said motors; hose means connecting said control valves to said motors, respectively; a hydraulic fluid supply system on said earth mover including a pump and a hydraulic reservoir connected in fluid supplying relation to said pump; a hydraulic fluid supply passage connecting said control valves in series to said pump; a return to reservoir passage connecting said valves to said reservoir; a bypass passage between said reservoir and said supply passage on the upstream side of said control valves; a diverter valve in said bypass passage having open and closed positions, said diverter valve being remote from said control valves, remote control means for operating said control valves including manually operated elements remote from said control valves having neutral and motor actuating positions and means for automatically moving said diverter valve to a closed position when the operator moves one of said manual control elements to a motor actuating position, fluid supplied by said pump passing at low pressure to said reservoir through said bypass passage and through said fluid supply passage when said motors are not being actuated thereby insuring quick motor response upon movement of one said manually operated elements to a motor actuating position.

2. The structure set forth in claim 1 wherein said valves are of the open center type thereby permitting circulation of low pressure hydraulic fluid through said supply and return to reservoir passages when said diverters valve is in its open position.

3. The structure set forth in claim 1 wherein said control valves are mounted on said earth mover adjacent to their associated motors, respectively.

4. In combination with an earth mover having a tractor unit and a trailer unit drawn thereby through hitch means permitting relative pivotal movement of said units about a vertical axis, a bowl on said trailer unit, means for adjusting said bowl between excavating and transport positions including a first hydraulic motor on said trailer unit at the front of said bowl, means for ejecting material from said bowl including a second hydraulic motor at the rear of said bowl, a first open center control valve mounted on said trailer unit adjacent to said first motor and operatively connected to the latter, a second open center control valve mounted on said trailer unit adjacent to said second motor, said first and second valves having hold and motor actuating positions, a hydraulic fluid supply system on said earth mover including a pump and a hydraulic fluid supply passage connecting said control valves in series to said pump, a return to reservoir passage connecting said control valves to said reservoir, a bypass passage between said reservoir and said supply passage on the upstream side of said control valves, a diverter valve in said bypass passage having open and closed positions, said diverter valve being remote from said control valves, remote control means for operating said control valves including manually operated elements remote from said control valves having neutral and motor actuating positions and means for automatically moving said diverter valve to a closed position when the operator moves one of said manual control elements to a motor actuating position, fluid supplied by said pump passing at low pressure to said reservoir through said bypass passage and through said fluid supply passage when said motors are not being actuated thereby insuring quick motor response upon movement of one said manually operated elements to a motor actuating position.

5. The structure set forth in claim 4 wherein said remote control means is an electrically operated remote control system and said manually operated elements are switches.

6. The structure set forth in claim 4 wherein said control valves are pilot operated by fluid pressure controlled by said remote control means.

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