

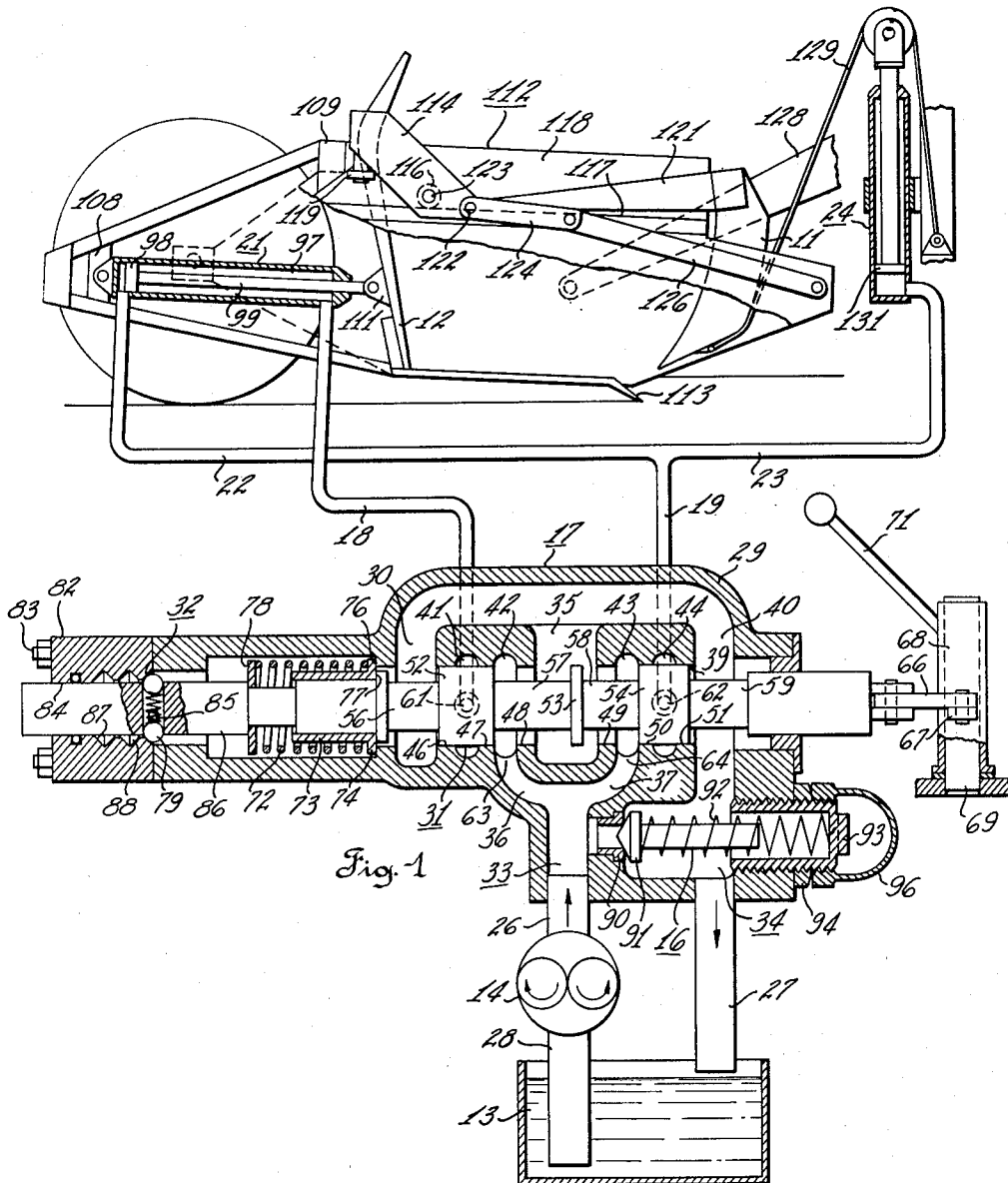
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R. M. ANDERSON
HYDRAULIC CONTROL SYSTEM

2,946,144

Filed May 28, 1957

5 Sheets-Sheet 1



Inventor
Reynold M. Anderson
By Henry J. Marcinick
Attorney

July 26, 1960

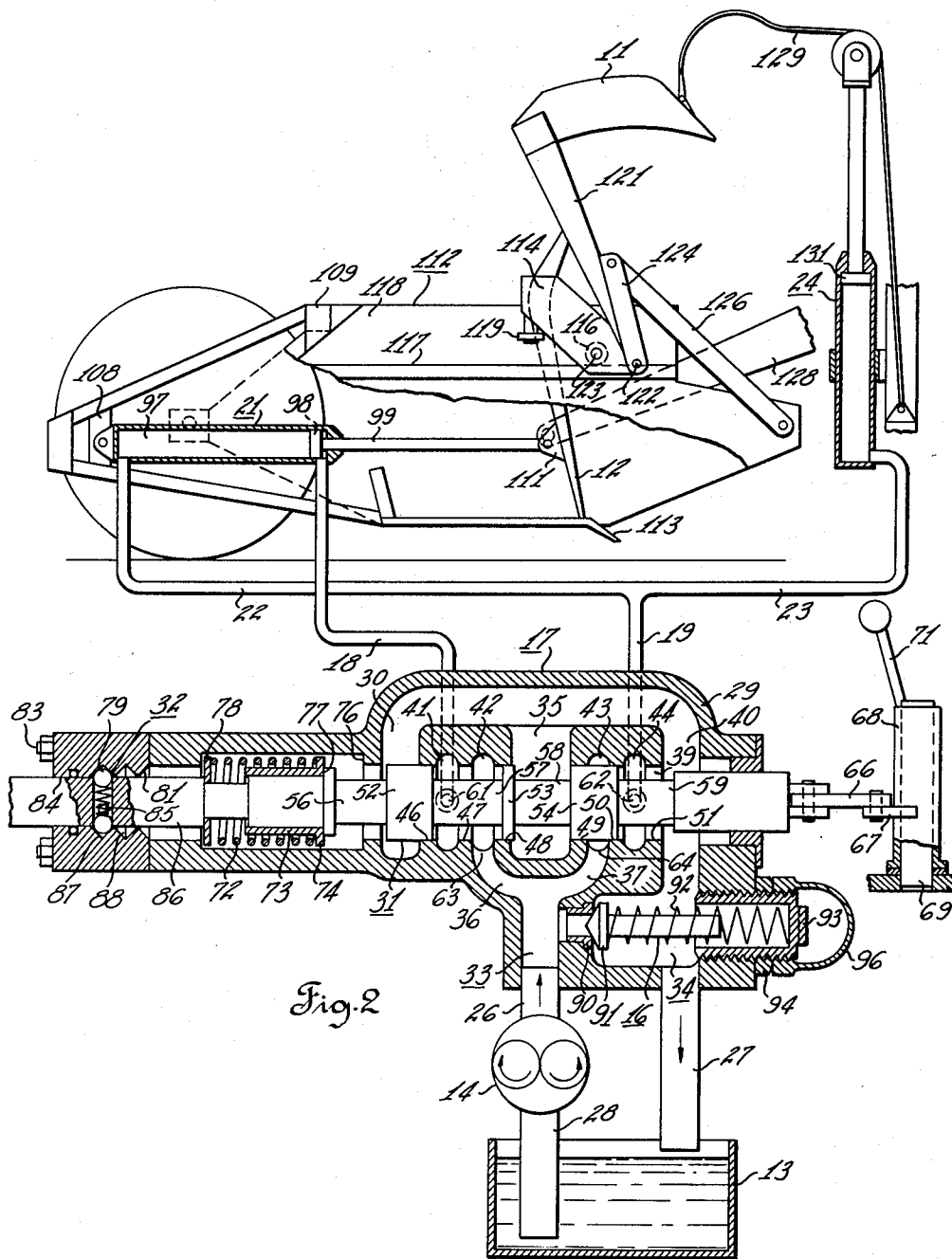
R. M. ANDERSON

2,946,144

HYDRAULIC CONTROL SYSTEM

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5 Sheets-Sheet 2



Inventor
 Reynold M. Anderson
 by Henry J. Maronick
 Attorney

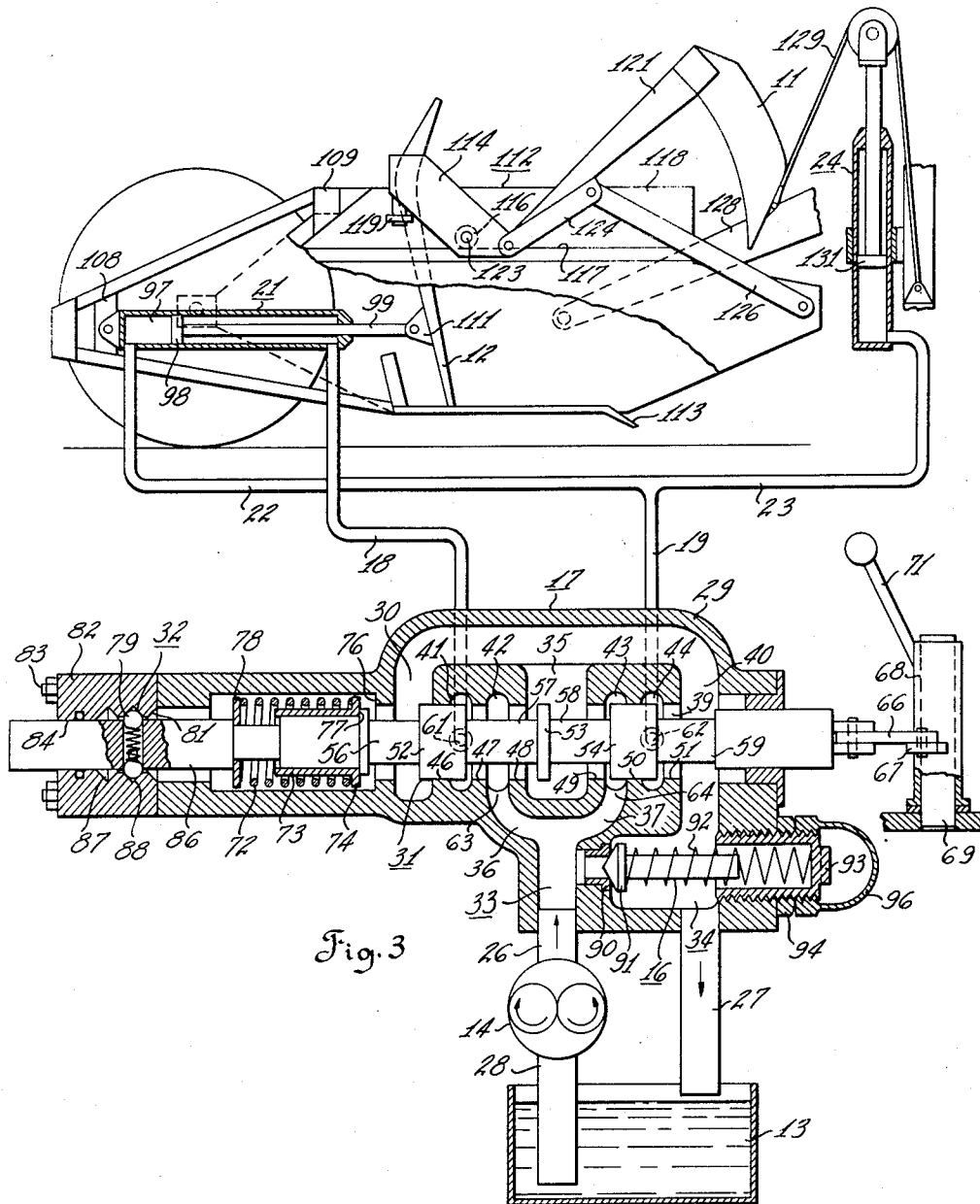
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R. M. ANDERSON
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5 Sheets-Sheet 3



Inventor
Reynold M. Anderson
by *Henry J. Macintosh*
Attorney

July 26, 1960

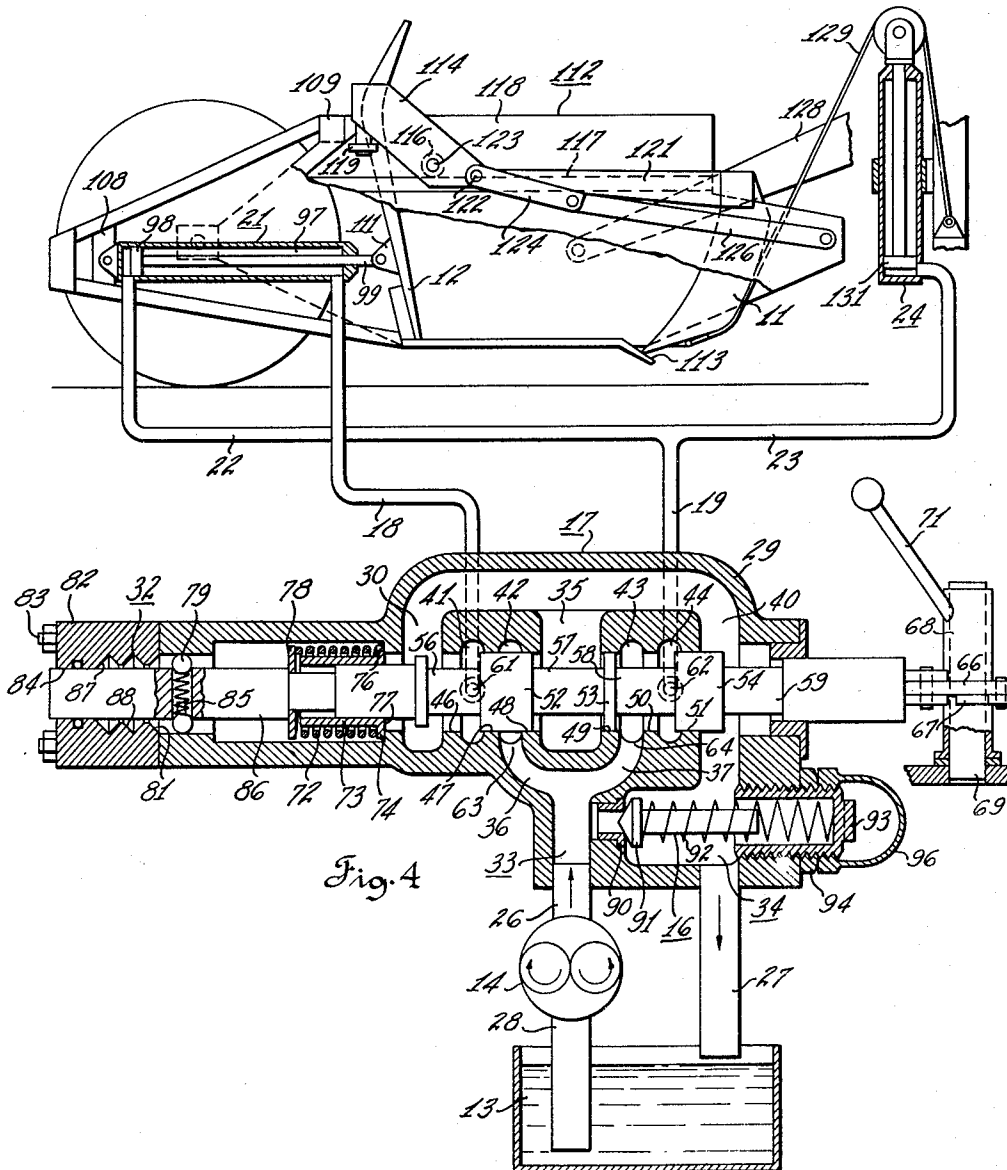
R. M. ANDERSON

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5 Sheets-Sheet 4



Inventor
Reynold M. Anderson
By Henry J. Mancus
Attorney

July 26, 1960

R. M. ANDERSON
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5 Sheets-Sheet 5

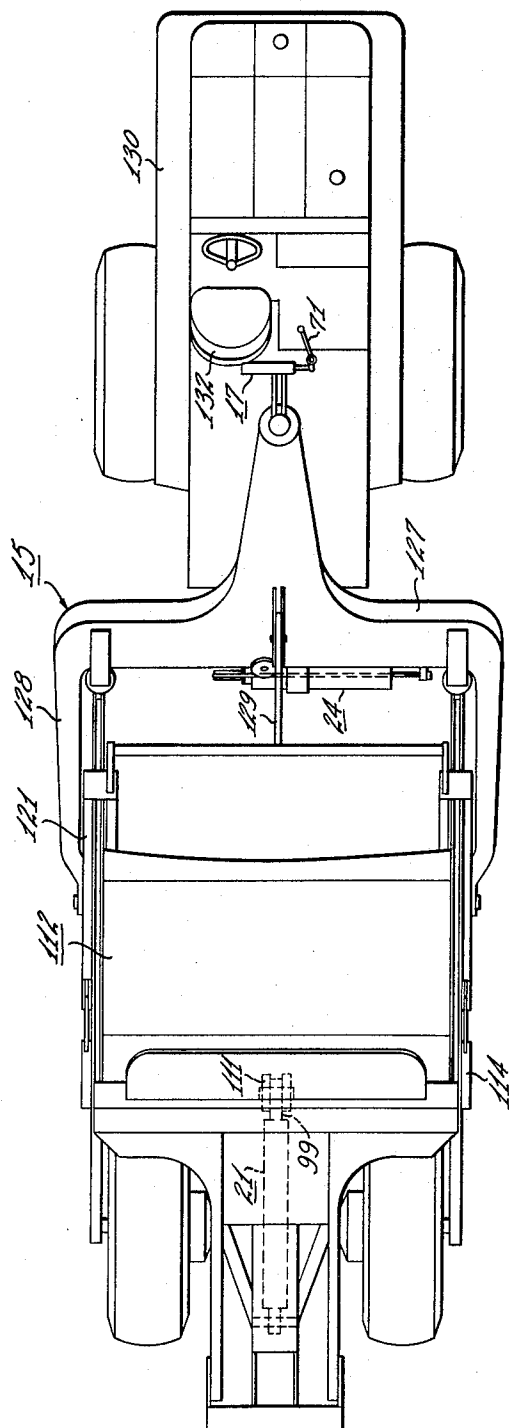


Fig. 5

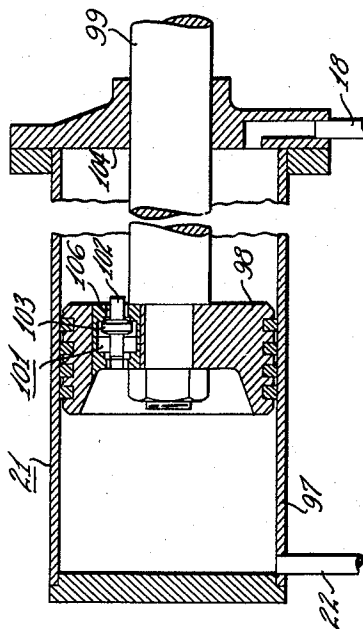


Fig. 6

Inventor
Reynold M. Anderson
by Henry J. Neumann
Attorney

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HYDRAULIC CONTROL SYSTEM

Reynold M. Anderson, Cedar Rapids, Iowa, assignor to Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

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9 Claims. (Cl. 37—129)

This invention relates to hydraulic control systems comprising a means for directing fluid under pressure to hydraulic jacks regulating the movement of various operating elements of a machine.

The present subject matter is more particularly concerned with a hydraulic control system directing the flow of fluid pressure to a single and a double acting hydraulic jack controlling the movement of the apron and ejector of a motor scraper. Although the present invention is described in connection with hydraulically actuated jacks used to control the apron and ejector of a motor scraper, it will be readily apparent in the course of this disclosure that this invention will have many other analogous applications.

A hydraulic system for controlling the apron and ejector of a motor scraper generally includes a reservoir, a hydraulic jack controlling the movement of the apron, a hydraulic jack actuating the ejector mechanism, a pump drivingly connected to an engine or other power source, suitable passages to conduct the flow of fluid from one element of the system to another, and a single control valve or separate control valves for directing the flow of fluid pressure to the hydraulic jacks. The control valve in such a system is provided with various operating settings, such as "ejector return," "hold" and "eject" settings. In the "ejector return" setting the control valve directs the pressure fluid to one end of the double acting ejector jack, and fluid must be allowed to escape from the apron jack cylinder. For the "hold" setting the control valve cuts off the fluid pressure supply to the hydraulic jacks and exhausts the fluid pump discharge into the reservoir. For the "eject" setting the control valve directs the flow of pressure fluid to the hydraulic jacks to allow the ejector jack to move the ejector forward and the apron jack to assist in raising the apron.

It is desirable to provide a "float" setting near the end of the apron and ejector return motion to relieve the system from hydraulic restraint in order that the weight of the apron can be utilized to return the ejector to its initial loading position. For this setting the control valve directs all pressure fluid passages into communication with the fluid reservoir.

In order to simplify the controls, it is desirable that a single valve control both the ejector and the apron.

The efficiency of certain types of earth moving operations is determined to a large extent by the time required to complete a given cycle of loading, hauling, ejecting and returning. In order to contribute to the efficiency of such earth moving operations, a hydraulically controlled motor scraper must be provided with a control system for the scraper operating elements that will not unduly interfere with the operator's control of the vehicle and that will not have any inherent time wasting operational characteristics.

The operational characteristics of the control system become particularly important in earth moving operations in which the loads are moved a short distance and

a rapid cycle of loading, hauling, ejecting and returning is maintained. In such operations, the return phase of the cycle may be so brief that the operator is predominantly occupied with shifting of gears and steering the motor scraper into position for a new load. If it were necessary for the operator to hold the control valve in a particular actuating setting until the apron and ejector were moved from their ejecting positions to their loading positions, the operator would have to do this before or after the scraper return cycle with a consequent loss of productive time. It is highly desirable to eliminate any necessity for manually holding the control valve in the "ejector return" setting in order that the apron and ejector may be moved to their loading positions during the interval that the motor scraper is completing its return trip to the loading site.

During the unloading period of the cycle, it is necessary that the operator initiate a forward movement of the ejector and raise the apron to allow the material to pass. These movements are initiated when the control valve is placed in the "eject" setting. To achieve this result, the valve directs the flow of fluid pressure to the ejector and apron jacks. From an operational standpoint it is not necessary that this setting be automatically detained when the operator shifts the control to this position but that the operator selectively engage this setting as the operating conditions require. It is desirable that when the operator releases his hand from manual engagement of the "eject" setting of the control valve that it be automatically returned to a neutral or "hold" setting whereby any desired opening of the apron and forward position of the ejector can be retained as the unloading of the scraper progresses.

It will become readily apparent from a consideration of the aforementioned requirements of the hydraulic system that the sequential arrangement of the four control valve settings is an important factor contributing to the operating efficiency of the control system. It would certainly be undesirable to have the most frequently used settings of the control valve in intermediate positions which might frequently result in the operator having to "fish" for the desired setting or to override the desired setting and inadvertently engage one of the other control settings. Thus, it is desirable that the "ejector return" and "eject" settings be located at the extreme positions of the valve travel so that they can be readily and positively engaged. The "hold" or neutral setting should be positioned at some intermediate point between the "ejector return" and "eject" settings. The "float" setting should be located at some approximate location to the "ejector return" setting so that the operator can easily shift from this low speed return to the "float" setting. Such a sequential arrangement of the settings results in simplified operation which makes it possible to easily and efficiently control the various operating elements.

A difficulty encountered in a hydraulic control system having a single acting apron jack and a double acting ejector jack controlled by one valve is that a considerable amount of back pressure builds up in the system during the "ejector return" and "apron lowering" phase of the operation. When the apron and ejector are being returned to their loading positions during the interval when the vehicle is being driven back to the loading site, the single acting apron lift jack is connected to the hydraulic fluid return or low pressure side of the ejector cylinder hydraulic circuit. It is always necessary to maintain some fluid pressure in such a return line to overcome the frictional resistance to fluid flow presented by the return lines, the various fittings and manifold. This back pressure is proportional to the rate of flow of

the fluid. When the motor scraper engine is operated near maximum speed, as it generally is when the vehicle is being returned to the loading site, the high rate of fluid flow in the control system will increase the back pressure in the return line until it reaches such a magnitude that the apron lift jack may be locked by fluid restraint so as to cause the apron to hang in a raised position. Shifting the control valve from the "ejector return" setting to the "hold" setting will not eliminate this objectionable feature inasmuch as the "hold" setting will only lock the apron in a raised position. Unless this back pressure in the return line can be effectively relieved, the earth moving operation must be delayed to permit the engine speed to slow down sufficiently to allow the apron to return to the closed position.

It is the principal object of this invention to provide a fluid pressure control system which will take care of the hereinbefore outlined requirements in a simple, practical and entirely satisfactory manner.

More specifically, it is an object of this invention to provide a hydraulic control system that will allow the apron and ejector of a scraper to be operated by a single manual control lever.

It is an object of this invention to provide a hydraulic control valve having four settings, respectively, "ejector return," "float," "hold" and "eject," arranged in the foregoing sequence so that the operator can easily and quickly identify a desired control valve setting.

It is another object of this invention to provide a hydraulic control system which will permit the apron and ejector of a hydraulically operated motor scraper to be returned semi-automatically to a loading position.

It is a further object of this invention to provide a hydraulic control system which will permit the high speed return of the apron and ejector to a loading condition during the latter part of the return travel by a simple shift of a control lever.

It is still a further object of this invention to eliminate objectionable back pressure in the return line of the hydraulic control system resulting from increased pump output due to high engine speeds and resultant increase in the resistance to fluid flow in the system.

These and other objects of this invention will be evident from the following description when read in connection with the accompanying drawings in which:

Fig. 1 is a schematic view of the control system and the apron and ejector of a motor scraper, the control valve being shown in an enlarged longitudinal sectional view illustrating the valve in the "hold" setting;

Fig. 2 is a schematic view similar to Fig. 1 illustrating the control valve in an "ejector return" setting;

Fig. 3 is a schematic view similar to Fig. 1 illustrating the control valve in a "float" setting;

Fig. 4 is a schematic view similar to Fig. 1 illustrating the control valve in an "eject" setting;

Fig. 5 is a plan view of a motor scraper showing the location of the control valve and the apron and the ejector jacks; and

Fig. 6 is an enlarged sectional view of the ejector piston.

Referring to Figs. 1 through 4, there is shown a hydraulic control system for the apron 11 and ejector 12 of a motor scraper 15, illustrated in Fig. 5. The hydraulic system includes a reservoir 13, a gear type pump 14, a relief valve 16 and a hydraulic control valve 17 for directing pressure fluid to and from two cylinder conduits 18 and 19. The cylinder conduit 18 communicates directly with one end of the double acting hydraulic jack 21. The cylinder conduit 19 has two branches 22 and 23. Branch 22 communicates with the other end of the double acting hydraulic jack 21 while branch 23 communicates with a single acting hydraulic jack 24.

Pressure fluid is supplied to the control valve 17 by the pump 14 through an input conduit 26. The pump 14

is driven by the vehicle's engine, and its output, therefore, varies with the engine's speed. An exhaust conduit 27 connects the control valve 17 with the reservoir 13 and a pump supply conduit 28 connects the reservoir 13 to the pump 14.

The control valve 17 includes a housing or valve body 29, a valve spool 31, a detent mechanism 32, an inlet chamber 33 and a return chamber 34. It is of an open center type, the centrally disposed inlet branches 36, 37 freely communicating with three laterally spaced channels 30, 35, 40 of the return chamber 34, when the valve spool 31 is set at various positions. The valve spool 31 is reciprocally mounted in a bore 39 in the valve housing 29 and controls the direction of fluid flow through the control valve 17. The bore 39, in which the valve spool 31 is fitted, is interrupted by the annular recesses 41, 42, 43 and 44 so as to form a series of lands 46, 47, 48, 49, 50 and 51. The valve spool 31 is provided with a series of spaced collars 52, 53, and 54 formed by the annular grooves or reduced portions 56, 57, 58 and 59, which upon sliding movement of the valve spool 31 are adapted to cooperate with the spaced recesses 41, 42, 43 and 44 to direct the flow of fluid from the pump discharge through the control valve 17 in a particular manner. The recess 41 is provided with a port 61 connecting with the cylinder conduit 18. The recess 44 has a port 62 connecting with the cylinder conduit 19. The other two recesses 42 and 43 have ports 63 and 64 freely communicating with the inlet branches 36 and 37 of the inlet chamber 33. Thus, the annular grooves 56, 57, 58 and 59 coact with the bore 39 as the valve spool 31 is moved to form four passage means which control the flow of hydraulic fluid from the inlet chamber 33, to the return chamber 34 and to and from the two conduit ports 61 and 62.

The axial movement of the valve spool 31 is accomplished by means of a manually operated linkage comprising a link 66 pivotally connected to the valve spool 31 and at its opposite ends to a lever arm 67 extending from a sleeve 68 rotatably supported on a vertical shaft 69 rigidly associated with the valve housing 29. A control handle 71 is integrally formed with the sleeve 68. To effect sliding of the valve spool 31 in its bore 39, the operator moves the control handle 71 to rotate the sleeve 68 about the vertical shaft 69 thereby imparting axial movement to the link 66 and the valve spool 31.

The valve spool 31 is normally urged to the "hold" setting by the coil spring 72 embracing a bushing 73 slidably mounted at one end of the valve spool 31. The bushing 73 has a flanged end 74, an outer portion of which abuts against a shoulder 76 and an inner portion of which engages a shoulder 77 on the valve spool 31, as shown in Fig. 1. The spring 72 is held at the opposite end by a U-shaped spring lock 78. When the valve 17 is assembled, the spring 72 is under sufficient compression to hold a pair of detent balls 79 against an annular ridge 81 and the valve spool 31 is thus maintained in the "hold" position.

Movement of the valve spool 31 to the right from the "hold" position is resisted by the coil spring 72. During this movement to the right the valve spool 31 slides in the bushing 73 and the shoulder 77 separates from its contact with the flanged portion 74 of the bushing 73. Movement of the valve spool 31 to the left of the "hold" setting is not opposed by the spring 72. During this movement of the valve spool 31 the flanged portion 74 of the bushing 73 loses its contact with the shoulder 76 in the valve housing 29, and the spring 72 is simply carried by the valve spool 31. Thus, the only resistance to movement is that presented by the detent mechanism 32.

The detent mechanism 32 includes a housing 82 which is attached to the valve housing 29 by the studs 83. The housing 82 has a central bore 84, for reception of an end portion 86 of the valve spool 31 and is formed with two annular indentations or grooves, 87 and 88, to provide two detent positions for the valve spool 31. To prevent

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the valve spool 31 from being moved to the left beyond the detent position fixed by the annular groove 87, a stop 85 is provided between the two detent balls 79. The stop 85 limits the minimum radial displacement of the detent balls 79 so as to prevent any movement of the detent balls 79 to the left of the groove 87. The diameter of the bore to the right of the groove 84 is enlarged sufficiently to permit the passage of the detent balls 79. The stop 85 does not restrict the movement of the spool 31 to the right.

The relief valve 16 is disposed transversely in the valve body 29 to unload the inlet chamber 33 into the return chamber 34 when the discharge pressure reaches a predetermined limit. The relief valve 16 includes a valve seat member 90, a tapered valve plunger 91 and a compression spring 92 urging the plunger 91 against the seat member 90. The spring compression is adjusted to a predetermined setting by the screw 93. The jam nut 94 locks the screw 93 against accidental rotation. The protective cap 96 is removed when adjustments are made to the valve setting.

The double acting hydraulic jack 21 serves to retract and to extend the ejector 12 and to assist in raising the apron 11. The single acting hydraulic ram 24 is provided to lift the apron during one portion of its travel. The double acting hydraulic jack 21 has a cylinder 97 within which is reciprocally disposed a piston 98 connected to piston rod 99. The piston rod 98 is exposed to hydraulic fluid pressure admitted by the cylinder conduit 18 on one side and by the branch 22 of the cylinder conduit 19 on the other side.

Referring to the detailed illustration in Fig. 6, a plunger type poppet valve 101 is installed in the piston 98. When the piston 98 reaches the right end of the cylinder 97, as shown in Fig. 2, the stem 102 of a plunger 103 strikes the head 104 of the cylinder to open the poppet valve 101 and allow the pressure fluid to escape through a restricted opening 106.

Having reference to Figs. 1 through 5, the hydraulic jack 21 is mounted on a support member 108 rigidly attached to the bowl frame 109 of the scraper. The ejector 12 is provided with a rearwardly extending channel stem 111 to which the piston rod 99 is connected. The ejector 12 is mounted so as to move between a rearward position wherein it constitutes a wall closing the otherwise open rearward end of a main bowl 112 and a forward position adjacent to the scraping edge 113 of the bowl 112. The apron 11 is movable between a lower position adjacent the scraping edge 113 where it closes the otherwise open forward end of the main bowl 112, as shown in Fig. 4, and an upper position away from the scraping edge 113 where it leaves the main bowl 112 open at the forward end, as shown in Fig. 3. During the scraping and loading part of the operation cycle it is necessary to raise the apron 11 only to a limited extent as is necessary to provide a satisfactory ingress opening for earth. During this phase of the cycle the ejector 12 is in a fully retracted position. After the scraper bowl 112 is filled, the apron 11 is lowered. During the unloading period of the cycle the apron 11 is raised to its elevated position to permit the ejection of all the earth from the scraper bowl 112.

The ejector 12 is provided with integral side carriages 114. Each carriage 114 has a vertical roller 116 engaging a horizontal channel 117 defined by the reinforcing shape on a side wall 118 of the bowl frame 109. The carriages 114 are also provided with lateral rollers 119 which engage the side walls 118 of the bowl to guide the ejector 12. The apron 11 has a pair of integral arms 121 that are pivoted at a point 122 below and to the front of the axis 123 of the vertical roller 116 on the carriage 114. Each of the rearwardly extending arms 121 of the apron 11 has a downward projection 124. A restraining link 126 is pivotally connected at one end to this projection 124 and at the other end it is pivotally connected to the bowl side wall 118. The link 126 guides and restrains the motion

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of the apron 11 and also serves to prevent any substantial ejector motion during the initial opening movement of the apron 11. The linkage is such that the apron is approximately balanced in the fully open position when the ejector 12 is fully forward, as shown in Fig. 2.

The early part of the apron motion is initiated by the single acting hydraulic jack 24 which is horizontally disposed in a transverse portion 127 of a connecting yoke 128, as shown in Fig. 5. The cable connections to the jack 24 are such that the cable 129 lifting the apron 11 is under tension when the hydraulic jack 24 is actuated, as shown in Figs. 1 and 2. It is only during the early opening part of the apron motion that the cable 129 lifts the apron 11 and breaks the toggle lock of the linkage. In the later opening part of the apron motion, the pressure exerted upon the ejector 12 by the double acting hydraulic jack 21 is effective to complete the movement of the apron 11 with partial help from and without any hindrance from the operating cable 129.

Figs. 1, 2, 3 and 4 schematically show the positions of the apron 11 and ejector 12 for the four settings of the control valve 17. In the "hold" setting, as shown in Fig. 1, hydraulic pressure fluid from the pump 14 discharges into the inlet chamber 33 and the two branches 36, 37, through the passage formed by recesses 42, 43, the grooves 57, 58 and lands 48, 49 to the return chamber 34. The cylinder conduits 18 and 19 are sealed off from the inlet fluid pressure by the collars 52 and 54, respectively, being positioned over the recesses 41 and 44. For this setting of the control valve 17, no power fluid is supplied to the hydraulic jacks 21, 24 and any return of the fluid is blocked off by the valve spool 31. Consequently, the apron 11 and ejector 12 will remain locked in position when the valve spool 31 is engaged in the "hold" setting.

In the "ejector return" setting, as shown in Fig. 2, the valve spool 31 is moved axially to a position at the extreme left end of its travel. The pressure fluid inlet branch 37 has been closed off by the collar 54 overlapping the lands 49, 50 to seal the recess 43 and port 64. Pressure fluid from branch 36 communicates with the cylinder conduit 18 through the passage formed by ports 61, 63, the recesses 41, 42, the land 47 and the groove 57. Thus, it can be seen that pressure fluid is directed by this setting to the ejector cylinder 97 in order to retract the ejector 12 and is exhausted from the single acting apron lift jack 24 into the reservoir 13. The annular groove 87 is engaged by the detent balls 79 to hold the valve spool 31 in this setting.

For the "float" setting as shown in Fig. 3, the valve spool 31 is moved axially to the left of the "hold" setting. The detent groove 88 engages the detent balls 79 to maintain the valve spool 31 in this setting. For this control setting the ports 61, 62, 63 and 64 are in free communication with the return chamber 34. The cylinder conduit port 61 opens to the return channel 35, through the passage formed by the recesses 41, 42, the lands 47 and 48, and the groove 57. The cylinder port 62 communicates with the return channel 40 through the passage formed by the recess 44, the land 51 and the groove 59. The two inlet branches 36, 37 communicate with the return channel 35 through the passage formed by ports 63, 64, the recesses 42, 43, the lands 48, 49 and grooves 57, 58. Both hydraulic jacks 21 and 24 are now freed of any hydraulic restraint. This valve setting is utilized near the end of the apron and ejector return motion when the ejector 12 is almost completely returned to a loading position and the apron side arms 121 are at an angle of less than 45° from the horizontal. In view of the fact that the apron 11 and ejector 12 are now freed from any hydraulic restraint, the weight of the apron 11 will return both the ejector 12 and the apron 11 to a fully closed position. With the removal of hydraulic restraint the return of the apron 11 and ejector 12 is made possible. The "float" setting of the control valve 17 eliminates objec-

tionable excessive back pressure that builds up during the latter part of the apron and ejector return travel. It likewise permits the potential energy of the elevated apron 11 to be utilized in returning the ejector 12 to its fully retracted or loading position and allows the piston 131 of the single acting apron lift jack 24 to return to its initial lifting position.

Fig. 4 illustrates the "eject" setting of the valve spool 31. In this position the valve spool 31 is in the extreme right position. The inlet port 63 is now sealed by the collar 52 of the valve spool 31. The cylinder conduit port 61 in the recess 41 is in free communication with the return channel 30 through the channel formed by the grooves 56 and land 46. Fluid from one side of the piston 98 can now be exhausted into the reservoir 13. The collars 53, 54 cooperating with lands 49, 51 prevent pressure fluid from branch 37 from communicating with the return chamber 34. The recesses 43, 44 are in free communication with each other through the passage formed by land 50 and the groove 58 of the valve spool 31 so that hydraulic pressure fluid can enter the cylinder conduit 19 and its branches 22, 23 to actuate the ejector and apron lift jacks 21 and 24.

When the valve spool 31 is placed in the "eject" setting while the ejector 12 is in a fully retracted position, the hydraulic pressure fluid admitted to cylinder conduit 19 will be initially utilized to lift the apron 11 and break the "toggle" lock of the linkage. Thus, the "eject" setting can be used to lift the apron 11 for the purpose of loading the scraper bowl 112.

It should be noted that valve spool 31 must be manually held in the "eject" position against the action of the compression spring 72. When the operator removes his hand from the operating lever 71, the valve spool 31 automatically returns to the "hold" setting and is detained in this setting by spring force.

Referring now to Fig. 5, it is seen that the valve spool 31 of the control valve 17 is actuated by the hand control lever 71 conveniently mounted beside the operator's seat 132 of a two wheel tractor 130 of a motor scraper 15. Sidewise movement of the control lever 71 shifts the valve spool 31 into four operating positions, "ejector return," "float," "hold" and "eject." Pulling the lever 71 towards the operator places the valve spool 31 in the "eject" control position. Pushing the control lever 71 away from the operator places the valve spool 31 in the "eject return" position. When the operator manually releases the control lever 71 from the "eject" position, the valve spool 31 automatically returns to the intermediate "hold" or neutral position by the biasing action of the spring 72. The other intermediate position, referred to as the "float" position, is provided with a detent to eliminate any necessity for continual manual engagement of the hand lever 71.

The loading of the scraper requires that the apron 11 be raised slightly more than the depth of the cut to be made so as to allow the cutting edge 113 of the bowl to enter the ground. To raise the apron 11 slightly the operator pulls the control lever toward himself placing the valve spool 31 in the "eject" position. When the valve spool 31 is in this position, pressure fluid is allowed to enter through cylinder port 62 into the cylinder conduit 19 and the branches 22, 23 connecting with the ejector and apron jacks 21, 24. As hereinbefore described, the pressure fluid actuates the apron lift piston 131 until the toggle lock on the ejector and apron linkage is broken. The operator manually holds the control lever 71 in the "eject" position until the desired apron height is obtained and then simply removes his hand from the control lever 71, the spool automatically returning to the "hold" or neutral position. In the "hold" position the cylinder conduits 18, 19 are blocked off by the collars 52, 54 of the valve spool 31 and pressure fluid is thereby prevented from entering or leaving the ejector and apron jacks 21 and 24. The apron 11 will therefore remain in the

selected position of lift until the operator again manually shifts the control lever 71.

After the scraper is fully loaded, the apron 11 must be lowered to close the bowl 112. The operator then shifts the control lever 71 to the first detent position groove 88 from the neutral position of the lever 71, which places the valve spool 31 in the "float" position. In the "float" position fluid pressure in the apron lift cylinder is relieved by connecting the cylinder conduit 19 with the return chamber 34 by the passage formed within the valve bore 39 by the annular groove 59. For this setting of the control valve 17 the apron 11 is no longer under any hydraulic restraint and the weight of the apron 11 itself can be utilized in returning it and the ejector 12 to a closed position.

When the motor scraper arrives at the unloading site, the operator pulls the control lever 71 toward himself to place the valve spool 31 in the "eject" position. In this setting of the control valve 17 pressure fluid is admitted through the cylinder conduit 19 to both the ejector and apron jacks 21, 24. As previously described the apron 11 opens first and allows material to spill before the ejector 12 is moved forward by the ejector jack 21. When the ejector 12 is moved forward, the mechanical linkage between the ejector 12 and the apron 11 causes the apron 11 to move upward and forward. After all the material has been ejected from the scraper bowl 112, the operator must then return the ejector 12 and apron 11 to the loading position and also drive the motor scraper to the loading site. On a short haul, the time required to return the motor scraper may be so short that the operator's entire attention may be required for steering, shifting gears and maneuvering the scraper into position to start a new cut on the loading site. If it were necessary for the operator to manually hold the control lever 71 in a particular position until the apron 11 and ejector 12 were returned to their loading positions, it would not be possible for the operator to shift gears and maneuver the scraper during this interval.

In the applicant's hydraulic control system it is only necessary that the operator push the control lever 71 away from himself to move the valve spool 31 to the "ejector return" position, where it will be held by the detent mechanism 32. In this setting of the valve spool 31, pressure fluid is admitted to the forward end of the ejector cylinder 97 to retract the ejector 12. As hereinbefore described, the mechanical linkage between the apron 11 and ejector 12 causes the movement of the ejector 12 to lower the apron 11. When the apron side arms 121 are at an angle of less than 45° from horizontal, the operator pulls the control lever 71 toward himself to engage the detent position groove 88 which places the valve spool 31 in a "float" position. In this setting of the valve spool 31 both conduits 18 and 19 and the fluid pump discharge enter the control valve 17 and are opened to the fluid reservoir 137 thereby relieving the system of any hydraulic restraint. The weight of the apron 11 now returns the ejector 12 to a loading position and closes the scraper bowl 112.

At the beginning of the ejector return movement, the apron 11 is in a high lift position. The cable 129 connecting the apron 11 with the apron lift jack 24 is slack, as shown in Fig. 2. Most of the apron return travel is completed before the slack has actually been taken out of the cable 129. It should be noted that during this portion of the travel, the piston 131 of the apron lift jack 24 does not move and only pressure fluid from the ejector jack 21 is being returned to the fluid reservoir 13. It is not until the slack is removed from the apron cable 129 by the lowering motion of the apron 11 that the apron piston 131 begins to move and hydraulic fluid is returned from the apron jack 24 as well as from the ejector jack 21. This increased fluid flow proportionately increases the resistance and a back pressure is created which tends to resist the motion of the apron lift jack

24 and the ejector return jack 21. The back pressure reaches a maximum point as the ejector 12 approaches the end of its travel, since the relative motion of the apron 11 with respect to the ejector is greatly accelerated at this time. Shifting the valve spool 31 to the "float" position eliminates this build-up of back pressure in the system by connecting the inlet chamber 33 and the cylinder conduits 18, 19 with the fluid reservoir 13.

Inasmuch as the terminology employed to describe the various positions of a hydraulic control valve 17 are generally quite arbitrary, the four positions or settings of the valve spool 31 to control the flow of fluid to and from the pump 14 are defined and identified herein as follows:

(1) "Ejector return" position.—Pressure fluid is delivered by the pump 14 through the inlet branch 36 and the passage formed by the annular groove 57 and land 47 into the cylinder conduit 18 connecting with the ejector jack 21. The branches 22 and 23 are opened to the reservoir 13. Thus the piston 131 of the apron jack 24 is free of hydraulic force and the ejector jack 21 is subjected to fluid pressure thereby retracting the ejector 12.

(2) "Float" position.—Pressure fluid from the branches 36, 37 and from the cylinder conduits 18, 19 is directed by the valve spool into the return chamber 34 and then to the reservoir 13. Thus, the system is relieved of any hydraulic restraint.

(3) "Hold" position.—Pressure fluid is delivered by the pump 14 into the two inlet branches 36, 37 and directed by the valve spool 31 into the return chamber 34 leading to the reservoir 13. The ports 61, 62 connecting the valve bore 39 with the cylinder conduits 18, 19 are blocked off by the collars 52 and 54. The jacks 21 and 24 are locked in position. In this setting the pressure fluid simply circulates through the control valve 17 and is returned to the reservoir 13.

(4) "Eject" position.—Pressure fluid is delivered by the pump 14 to the control valve 17 into the cylinder conduit 19 and through the branches 22, 23 leading to the ejector and apron jacks 21 and 24. One end of the ejector cylinder 97 is opened by the control valve 17 to the reservoir 13. In this position of the valve spool 31, both hydraulic jacks 21 and 24 are subjected to fluid pressure.

In the normal operation of the system, the relief valve 16 remains closed. If the pressure in the inlet chamber 33 builds up to a predetermined limit the pressure will lift the plunger 91 and bypass the pump discharge into the return chamber 34 and thence to the reservoir 13.

Although the invention is shown embodied in a motor scraper, it should be understood that it is not intended to limit the invention to that particular installation and that the invention may be embodied in such other forms and modifications as are embraced by the scope of the appended claims.

What is claimed is:

1. A four way control valve for a hydraulic system including a double acting hydraulic jack, a single acting hydraulic jack, a fluid reservoir, a pump having a suction and a discharge side, a first conduit means connected with one end of said double acting hydraulic jack, a second conduit means having a first branch connected with the other end of said double acting hydraulic jack and a second branch connected with said single acting hydraulic jack, said control valve comprising: a housing defining therein an elongated bore, inlet and return chambers formed within said housing and communicating with said bore, a first conduit port connecting with said first conduit means and communicating with said bore, a second conduit port connecting with said second conduit means and communicating with said bore, a valve spool slidably and centrally disposed within said bore, said valve spool being selectively settable in four control po-

sitions, successively, "ejector return," "float," "hold" and "eject," said "ejector return" position of said valve spool directing the flow of pressure fluid from said discharge side of said pump to said first conduit port and for simultaneously directing the flow of pressure fluid from said second conduit port to said return chamber, said "float" position of said valve spool directing the flow of pressure fluid from said discharge side of said pump and from said first and second conduit ports into said return chamber of said valve, said "hold" position of said valve spool directing the flow of pressure fluid from said inlet chamber of said valve to said return chamber and simultaneously blocking off said first and second conduit ports, said "eject" position of said valve spool directing the flow of pressure fluid from the inlet chamber of said valve to said second conduit port and simultaneously directing the flow of fluid from said second cylinder conduit to said return chamber, detent means engaging said valve spool in said "ejector return" and "float" positions, and spring means returning said valve spool from said "eject" position to said "hold" position.

2. A four way hydraulic control valve comprising: a valve housing defining therein an elongated bore, a pressure fluid inlet chamber formed in said housing and having a first and second branch in communication with said bore, a return chamber formed in said housing and having a first, second and third channel in communication with said bore, a first cylinder conduit port formed within said housing and communicating with said bore, a second cylinder conduit port axially spaced from said first port and communicating with said bore, a valve spool centrally disposed within said bore and presenting a first, second, third and fourth annular groove axially separated by a first, a second and a third collar, said valve spool having four predetermined points of axial travel defining control positions, a first passage formed within said bore by said second annular groove and connecting said first fluid pressure inlet branch with said first cylinder conduit port and a second passage formed within said bore by said fourth annular groove and connecting said second cylinder conduit port with said third return channel, when said valve spool is at said first point of travel in one axial direction; a first passage formed within said bore by said second annular groove and connecting said first cylinder conduit port with said first pressure fluid inlet branch, a second passage formed within said bore by said third annular groove and connecting said second pressure fluid inlet branch with said second return channel, and a third passage formed within said bore by said fourth annular groove and connecting said second cylinder conduit port with said third return channel, when said valve spool is moved to said second point of travel in said axial direction, a first passage formed within said bore by said second annular groove and connecting said first pressure fluid inlet branch with said second return channel and a second passage formed within said bore by said third annular groove and connecting said second pressure fluid inlet branch with said second return channel, when said valve spool is moved to said third point of axial travel in said same axial direction; a passage formed within said bore by said first annular groove and connecting said first cylinder conduit port with said first return channel and a second passage formed within said bore by said third annular groove and connecting said second fluid pressure inlet branch with said second cylinder conduit port, when said valve spool is moved to said fourth point of axial travel in said same axial direction.

3. A four way hydraulic control valve comprising: a valve housing defining an elongated bore, a pressure fluid inlet chamber formed in said housing and having a first and second branch in communication with said bore, a return chamber formed in said housing and communicating with said bore, a valve spool centrally and slidably

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disposed within said bore, said bore having first, second, third and fourth recesses axially spaced within said bore, said second and third recesses being connected with said first and second branches of said pressure fluid chamber, a first cylinder conduit port formed within said housing and connecting with said first recess, a second control conduit port formed within said housing and connecting with said fourth recess, said valve spool presenting a first, second, third and fourth annular groove axially separated by a first, second and third collar, said control valve being settable in four control positions: a first position in which said second annular groove forms a passage within said bore to connect said first recess with said second recess, said third collar blocks off said third recess and said fourth annular groove forms a passage to connect said fourth recess with said return chamber, a second position in which said second annular groove forms a passage within said bore to connect said first and second recesses with said return chamber, said third annular groove forms a passage to connect said third recess with said return chamber and said fourth annular groove forms a passage within said bore to connect said fourth recess with said return chamber, a third position in which said first collar blocks off said first recess, said second annular groove forms a passage within said bore to connect said second recess with said return chamber, said third annular groove forms a passage within said bore to join said third recess with said return chamber and said third collar blocks off said fourth recess, a fourth position in which said first annular groove forms within said bore a passage joining said first recess with said return chamber, said first collar blocks off said second recess, and said third annular groove forms a passage within said bore connecting said third and fourth recesses.

4. A four way hydraulic control valve comprising: a valve housing defining therein an elongated bore presenting a series of four axially spaced ports, a return chamber formed within said housing and having a first, second and third channel in communication with said bore, a pressure fluid inlet chamber formed within said housing and having a first and second branch connecting with said second and third ports, respectively, a valve spool slidably disposed in said bore and presenting a first, second, third and fourth annular groove separated by a first, second and third collar, said valve spool having four settable control positions obtained by axially sliding said spool in one axial direction, a first position defined by a predetermined amount of travel of said spool in one axial direction in which said first port is connected with said second port by a passage formed within said bore by said second annular groove, a second position at a predetermined point of travel in said axial direction in which said first and second ports connect with said second channel of said return chamber through a passage formed within said bore by said second annular groove, said third port is connected with said second channel of said return chamber by a passage formed within said bore by said third annular groove, and said fourth port is connected with said third channel of said return chamber by a passage formed by said fourth annular groove, a third position at a predetermined point of travel in said axial direction in which said first port is blocked off by said first collar, said second port is connected with said second channel of said return chamber by a passage formed within said bore by said second annular groove, said third port is connected with said second channel of said return chamber by a passage formed within said bore by said third annular groove and said fourth port is blocked off by said third collar, a fourth position defined by a predetermined amount of travel in said axial direction in which said first port is connected with said first channel of said return chamber by a passage formed within said bore by said first annular groove, said first collar blocks off said second port, and said third and

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fourth ports are connected by a passage formed within said bore by said third annular groove.

5. A four way hydraulic control valve comprising: a housing defining therein an elongated bore, an inlet chamber formed in said housing and having a first and second branch in communication with said bore, a return chamber having a first, second and third channel communicating with said bore, a first and a second cylinder conduit port formed in said housing and in communication with said bore, a slidable valve spool centrally disposed within said bore and having a predetermined amount of axial travel, said valve spool having a first, second, third and fourth annular groove separated axially by a first, second and third collar, said valve spool being settable in four positions, a first position in which said first branch of said inlet chamber is connected with said first cylinder conduit port by a passage formed within said bore by said second annular groove, said second branch of said inlet chamber is blocked off by said third collar and said second cylinder conduit port is connected with said third channel of said exhaust chamber by a passage formed within said bore by said fourth annular groove, a second position in which said first conduit port and said first branch of said inlet chamber are connected with said second channel of said return chamber by a passage formed by said second annular groove, said second branch of said inlet chamber is connected with said second channel of said return chamber by a passage formed within said bore by said third annular groove, and said second conduit port is opened to said third channel of said return chamber by a passage formed within said bore by said fourth annular groove, a third position in which said first collar blocks off said first conduit port, said first branch of said inlet chamber is connected with said second channel of said return chamber by a passage formed within said bore by said second annular groove, said second branch of said inlet chamber is connected with said second channel of said return chamber by a passage formed within said bore by said annular groove and said second conduit port is blocked off by said third collar, and a fourth position in which said first conduit passage is connected with said first channel of said return chamber by a passage formed within said bore by said first annular groove, said first branch of said inlet chamber is blocked off by said first collar, and said second branch of said inlet chamber is connected with said second conduit port by a passage formed within said bore by said third annular groove, said first and fourth positions being at the opposite limits of said predetermined travel of said valve spool.

6. A fluid pressure system comprising: a double acting hydraulic jack, a single acting hydraulic jack, a fluid reservoir, a pump having a suction and a discharge side, a four way hydraulic control valve, fluid passage means for returning fluid from said control valve to said reservoir and for conducting fluid from said discharge side of said pump to said control valve and from said reservoir to said suction side of said pump, a first conduit means connecting said control valve with one end of said double acting hydraulic jack, a second conduit means connecting said control valve with the other end of said double acting hydraulic jack and the single acting hydraulic jack, said control valve having four successively settable control positions, a first position for directing the flow of pressure fluid from said discharge side of said pump to said first conduit means, a second position for connecting said discharge side of said pump, said first conduit and said second conduit means with said fluid reservoir, a third position for blocking off said first and second conduit means and for connecting said discharge side of said pump with said reservoir, a fourth position for connecting said discharge side of said pump with said second conduit means and for connecting said first conduit means with said reservoir, detent means holding said control valve in said first and second positions and

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spring means returning said valve from said fourth to said third position.

7. In a fluid pressure system for controlling the apron and ejector of a motor scraper having an apron and ejector mechanically interconnected so that the weight of the apron can be used to retract said ejector to a central loading position when said apron is at a predetermined elevation, a double acting hydraulic jack actuating said ejector, a single acting hydraulic jack operably connected to said apron, a fluid reservoir, a pump having a suction and a discharge side, a control valve having inlet and return chambers, fluid passage means for returning fluid from said return chamber of said control valve to said reservoir and conducting fluid from said discharge side of said pump to said inlet chamber of said control valve and from said reservoir to said suction side of said pump, a first cylinder conduit connecting said control valve with one end of said double acting jack, and a second cylinder conduit connecting said control valve with the other end of said double acting jack and with said single acting hydraulic jack, said valve having a spool axially settable in four successive control positions, respectively, "ejector return," "float," "hold" and "eject," said "ejector return" position of said valve spool directing the flow of pressure fluid from said discharge side of said pump to said first cylinder conduit and for simultaneously directing the flow of pressure fluid from said second cylinder conduit to said reservoir, said "float" position of said valve spool directing the flow of pressure fluid from the discharge side of said pump and from said first and second cylinder conduits into said return chamber of said valve, said "hold" position of said valve spool directing the flow of pressure fluid from said inlet chamber of said valve to said return chamber of said valve and simultaneously blocking off said first and second cylinder conduits, said "eject" position on said valve spool directing the flow of pressure fluid from the inlet chamber of said valve to said second cylinder conduit and simultaneously directing the flow of fluid from said first cylinder conduit to said return chamber.

8. A hydraulic control valve comprising: a valve housing defining therein an elongated bore, a pressure fluid inlet chamber formed in said housing and having a first and second branch communicating with said bore, a valve spool centrally and slideably disposed for axial movement within said bore and presenting a first, a second, third and fourth annular groove axially separated by a first, second and third collar, said valve spool being selectively settable in four successive axial positions, a first conduit port formed within said housing and communicating with said bore, a second conduit port formed within said housing and communicating with said bore, a return chamber formed in said housing and having a first, second and third channel communicating with said bore, said second annular groove forming a passage in said bore connecting said first conduit port with said first inlet branch, said third collar blocking off said second branch, and said fourth annular groove forming a passage in said bore connecting said second conduit port with said third channel when said spool is moved to its first axial position; said second and third annular grooves forming passages in said bore connecting said first and

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second branches of said inlet chamber and said first conduit port with said second channel and said fourth annular groove forming a passage in said bore connecting said second conduit port with said third channel when said spool is moved to its second axial position; said first collar blocking off said first conduit port, said second and third annular grooves forming passages in said bore connecting said first and second branches with said second channel and said third collar blocking off said second conduit port when said spool is moved to said third axial position; and said first annular groove forming a passage in said bore connecting said first conduit port with said first channel, said first annular collar blocking off said first branch and said third annular groove forming a passage in said bore connecting said second branch with said second conduit port when said valve is moved to said fourth axial position.

9. In a fluid pressure system for controlling the apron and ejector of a motor scraper, a control valve comprising: a hollow shaped body to provide an inlet chamber, a return chamber, a first conduit port and a second conduit port, a valve member movably mounted within said valve body and settable successively in four control positions in a predetermined range of travel in the same direction, said valve member having a first, second, third and fourth passage means coacting with said valve body to control the flow of fluid to said return chamber, from said inlet chamber and to and from said first and second conduit ports; said first passage means connecting said first conduit port with said return chamber and said third passage means connecting said inlet chamber with said second conduit port when said valve member is set in said first control position; said second and third passage means respectively connecting said inlet chamber with said return chamber when the valve member is moved in the same direction to the second control position; said second passage means connecting said inlet chamber and said first conduit port with said return chamber, said third passage means connecting said inlet chamber with said return chamber and said fourth passage means connecting said second conduit port with said return chamber when said valve member is moved in the same direction to said third control position; and said second passage means connecting said inlet chamber with said first conduit port and said fourth passage means connecting said second conduit port with said return chamber when said valve member is moved in the same direction to said fourth control position.

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