May 23, 1961 H. W. ROCKWELL 2,985,147

HYDRAULIC VALVE

Filed Sept. 12, 1957 2 Sheets-Sheet 1

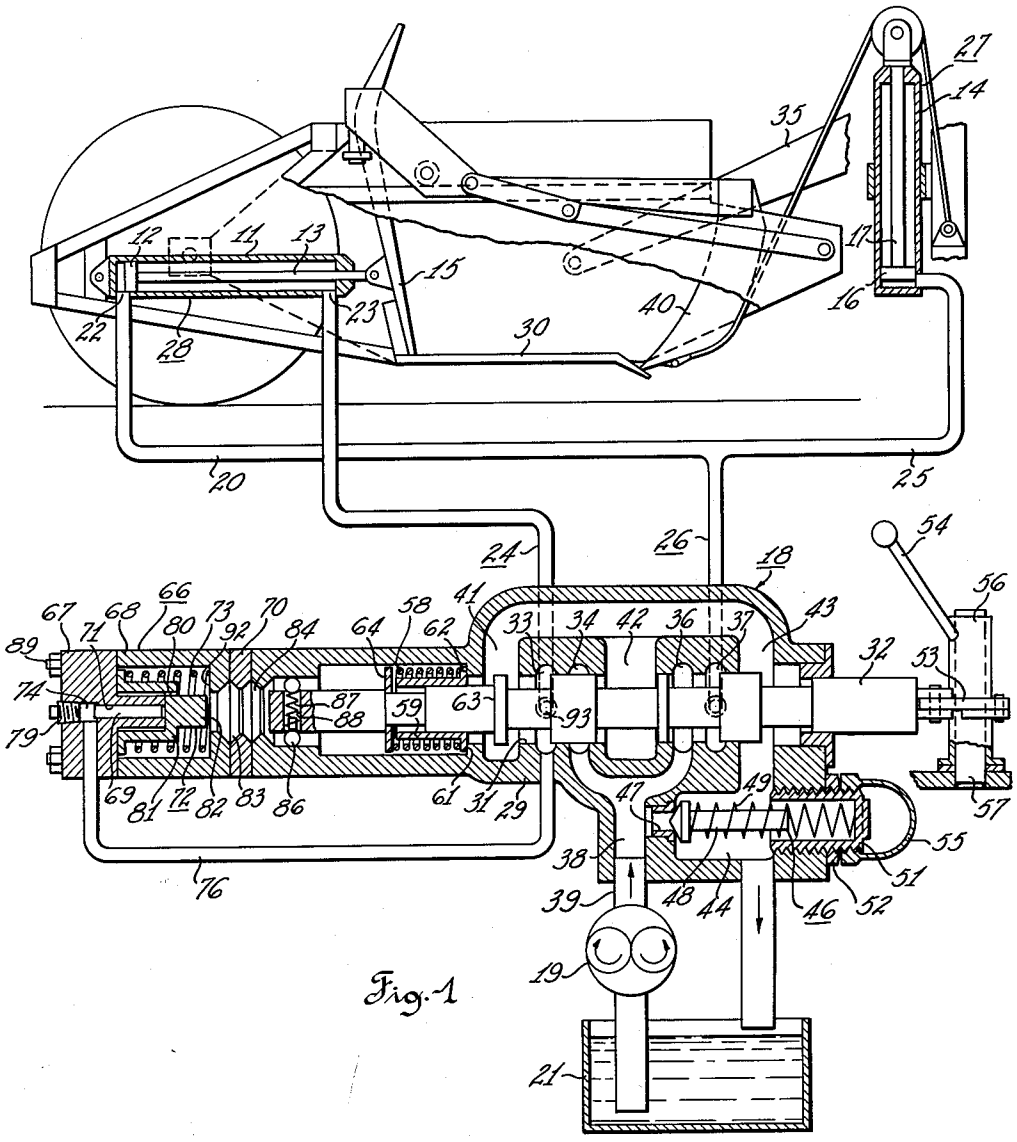

Fig. 1

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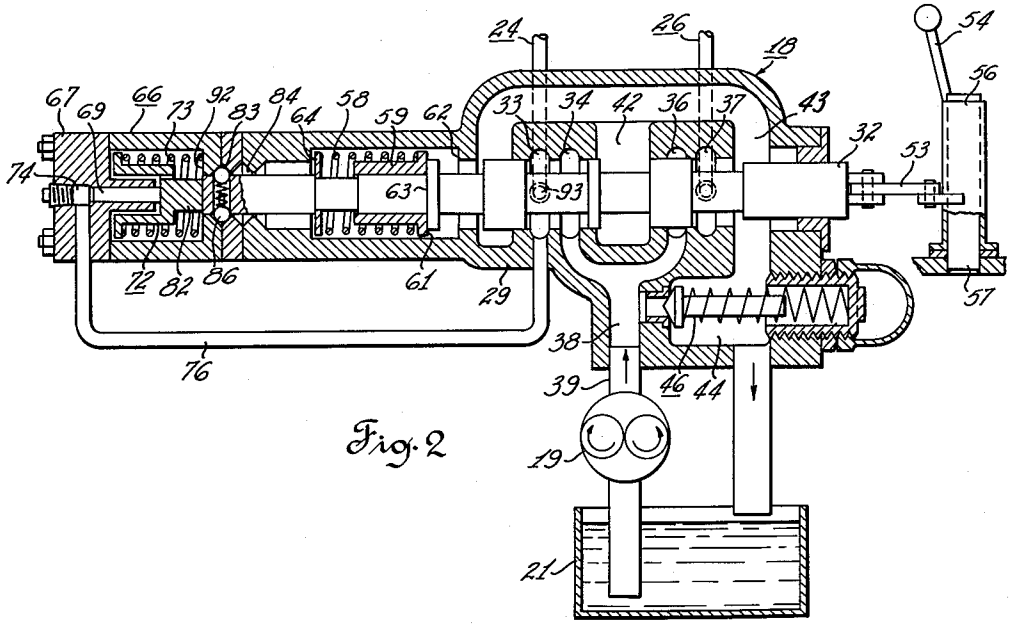

Fig. 2

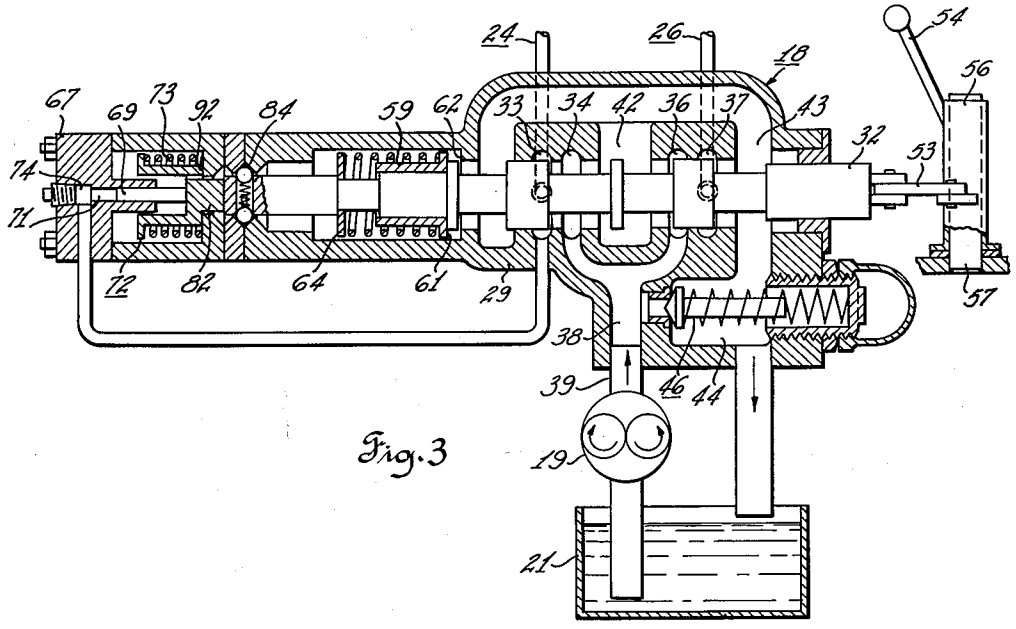

Fig. 3

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HYDRAULIC VALVE

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3 Claims. (Cl. 121—46.5)

This invention relates to a control valve for pressure fluid systems having one or more fluid operated rams and more particularly to an improved valve that is automatically disengaged from a detent position and restored to another position in response to a predetermined pressure condition in the system.

The hydraulic ram used in many types of industrial, aeronautical or agricultural equipment is supplied with high pressure fluid from a pump driven by a suitable prime mover and is selectively actuated by a control valve. Such a control valve is usually located conveniently at an operator's station.

The improvement which is the subject of this invention may be applied to the well known open center type of control valve having a centrally disposed slidable valve spool. Such a valve is generally provided with a "hold" position, in which power fluid to the ram is blocked off and the pressure fluid continuously recirculates in the system. It may also be provided with a "float position," in which the hydraulic ram is not under hydraulic restraint. In an operating position of the valve, the power fluid causes the ram to perform its particular work function. The control valve is generally brought to a desired position or setting by displacing the valve spool. The valve spool may be displaced manually by a suitably connected hand lever.

In some applications it is desirable to eliminate the necessity of continually holding the valve in a given position during an operating cycle. In some cases, detents have been used to hold the valve spool in a desired operating position after it has been displaced manually. In such valves of the prior art it was necessary that the operator manipulate the hand lever at the proper time to disengage the valve from the detent in order that it may be returned to the "hold" or the "float" position after the operating cycle has been completed.

In the complicated pressure fluid system used to operate the apron and ejector of a motor scraper, in which the present invention is embodied as an illustration, the operator, having so many other things to do during certain phases of the work cycle, can hardly be expected to watch the operation of a particular ram or actuated part to determine when the valve spool should be displaced to the "hold" or the "float" position. In a control valve having a detent mechanism, it is desirable, therefore, that some means be provided to automatically release the detent holding the valve spool in an operating position and return the valve to the "hold" or the "float" position and engage a detent if one is provided for the position. The present invention contemplates making use of the pressure build-up resulting from the increased back pressure in the discharge lines and the increased pressure in the supply lines which occur as the ram nears the completion of its movement.

From a standpoint of economy it is also desirable that the detent disengaging mechanism be readily attachable to a conventional type of open center hydraulic spool type of valve with only minor structural modifications in order to permit the mechanism to be utilized on existing spool type valves.

It is an object of this invention to provide a control valve that requires only an initial displacement of the valve spool to actuate a pressure fluid ram and that will automatically return to another desired position when the ram has completed its movement.

Another object of this invention is to provide an auxiliary mechanism for a control valve incorporating a means for maintaining the valve in an operating position until the ram which it operates has completed a desired movement and for automatically returning the valve to a nonoperating position such as a "hold" or "float" position.

It is still another object of the present invention to provide a control valve for a pressure fluid system operating a hydraulic ram in which a pressure responsive means are provided for automatically returning the valve from an operating position to a "hold" or "float" position after the ram has completed its movement by utilizing a pressure increase occurring in the system.

A further and more general object of this invention is to provide a control valve for a pressure fluid system to control a power ram, which does not require that the operator maintain the valve in an operating position manually after once having placed it in an operating position and which does not have to be manually returned to a "hold" or "float" position after the ram has completed its movement.

Other objects and advantages of this invention are made apparent in the following specification by reference to the accompanying drawings, wherein:

Fig. 1 is a schematic diagram of a pressure fluid system incorporating the valve which is the subject of the present invention;

Fig. 2 is a longitudinal section through the valve showing the valve in an operating condition; and

Fig. 3 is a longitudinal section through the valve showing the valve in a "float" position.

Referring to Fig. 1, the pressure fluid system shown therein comprises a double acting cylinder **11** containing a piston **12** connected to a piston rod **13**, a single acting cylinder **14** containing a piston **16** connected to a piston rod **17**, a control valve **18**, a pump **19**, a fluid reservoir **21**, and suitable fluid connections. The pump **19** is driven by a suitable prime mover, not shown, and draws fluid from the reservoir **21** and delivers it to the control valve **18**. The cylinder **11** has fluid ports **22**, **23** at its opposite ends connected by the cylinder conduits **24** and **26**, respectively, to the cylinder ports in the control valve **18**. The conduit **26** has two branches **20** and **25** connecting with the cylinders **11** and **14**, respectively. The double acting cylinder **11** is pivotally connected to an ejector **15** of a motor scraper, a rear portion of which is shown schematically in Fig. 1. A scraper bowl **30** is pivotally connected by the draft yoke **35** to a tractor (not shown). The single acting cylinder **14** actuates the scraper apron **40** to permit material to be loaded and unloaded from the scraper bowl **30** and is supported in a transverse portion of the draft yoke **35**. Although the present invention is shown embodied in a hydraulic circuit having a single and a double acting ram, **27** and **28**, controlled by one control valve **18**, it should be apparent that this invention is not limited to such hydraulic circuits.

The construction of the control valve **18** is also illustrated in Figs. 2 and 3. A valve body **29** is formed with a centrally disposed bore **31** for receiving a valve spool **32**. The bore **31** is interrupted by a series of four axially spaced annular grooves **33**, **34**, **36** and **37**. The valve body **29** is formed with an inlet chamber **38** which connects with the inlet line **39** and receives pressure fluid

from the discharge side of the pump 19. Also formed in the valve body 29 are three exhaust passages 41, 42, 43 connecting with the exhaust chamber 44.

A relief valve 46 is disposed transversely within the control valve 18, to unload the inlet chamber 38 into the exhaust chamber 44 when the discharge pressure reaches a predetermined limit. The relief valve 46 includes a valve seat member 47, a tapered valve plunger 48 and a compression spring 49 urging the plunger 48 against the seat member 47. The spring compression is adjusted to a predetermined setting by the set screw 51. The jam nut 52 locks the set screw 51 against accidental rotation. A protective cap 55 is removed when adjustments are made to the relief valve setting.

The axial movement of the valve spool 32 is accomplished by means of a manually operated linkage comprising a link 53 pivotally connected to the valve spool 32 and at its opposite ends to an operating handle 54 extending from a sleeve 56 rotatably supported on a vertical shaft 57 which is rigidly associated with the valve body 29. The handle 54 is integrally formed with the sleeve 56. To effect a displacement of the valve spool 32, the operator moves the handle 54 to rotate the sleeve 56 about the vertical shaft 57 thereby imparting axial movement to the link 53 and the valve spool 32.

The valve spool 32 is normally urged to the hold position by a coil spring 58 embracing a bushing 59 slidably mounted at one end of the valve spool 32. The bushing 59 has a flanged end face 61, a portion of which may abut against a shoulder 62 formed in the valve body 29 and a portion of which may abut against a shoulder 63 on the valve spool 32. The spring 58 is restrained at one end by a washer 64.

Movement of the valve spool 32 to the right of the hold position is resisted by the spring 58. During the movement to the right the valve spool 32 slides in the bushing 59 and the shoulder 63 separates from its contact with the flanged portion 61 of the bushing 59. Axial movement of the valve spool 32 to the left of the hold position is not opposed by the spring 58. During movement of the valve spool 32 to the left the flanged portion 61 of the bushing 59 loses contact with the shoulder 62 in valve body 29, and the spring 58 is simply carried by the valve spool 32.

A detent disengaging mechanism 66 is provided at one end of the valve 18 and comprises a head cap 67, an end housing 68, an actuating pin or piston 69 reciprocably mounted in a central bore 71 in the head cap 67, a spacer 70, a follower 72 and a return spring 73. The head cap 67 has a chamber 74 which is connected with the annular groove 33 by a conduit 76. The head cap 67 is provided with a plug 79 to permit the inspection or removal of the actuating pin 69. The follower 72 has a hole 80 drilled in a web 81 to prevent a hydrostatic lock from developing. It should be noted that as the follower 72 is urged to the right by the actuating pin 69, the return spring 73 is compressed. When the hydraulic force exerted against the actuating pin 69 is released, the spring 73 will return the follower 72 and the actuating pin 69 to their initial position. The follower has a projecting finger 82, the end of which is engageable against the valve spool 32 to displace it from a detent groove 83.

As shown in Figs. 1, 2 and 3, the detent groove 83 for the operating position is formed by the counterbore in the end housing 68 and its matching counterbore at the left side of the spacer 70. The detent groove 84 for the float position is formed by the counterbore in the valve body 29 and its matching counterbore at the right end of the spacer 70. A pair of detent balls 86 are biased outwardly by a spring 87 and are carried in a radially extending bore 88 in the valve spool 32. The head cap 67, the end housing 68, and the spacer 70 are secured to the valve body 29 by four studs 89.

It is to be noted that there are no detent grooves to the right of the groove 84 and consequently, there will be no detent action when the spool 32 is moved to be right. In some applications another detent groove may be desirable. However, in a hydraulic circuit of the type used to operate the apron and ejector of a motor scraper, it is necessary on one of the power strokes to provide for a certain degree of control of the movement of the ram. When the load is being ejected from a scraper bowl, the rate of ejection can be effectively controlled by regulating the axial position of the valve spool 32. Thus, the pressure fluid supplied to the cylinder conduit 26 can be controlled by the amount of overlap of the spool lands over the annular groove 37. Inasmuch as the operator must regulate the power supplied by the hydraulic ram 28 to the ejector and must direct his attention to the manner in which the load is being ejected, the efficiency of the work operation is not affected by the fact that the operator must manually engage the operating handle 54 to regulate the hydraulic ram 28.

Referring to Figs. 1 and 2, when the valve spool 32 is set in the operating position illustrated in Fig. 2, the double acting ram 28 is returning the ejector to an initial loading condition and the apron is being lowered. The cylinder conduit 26 is now in communication with the exhaust chamber 44. During the latter part of the travel of the apron, hydraulic fluid is forced out of the single acting cylinder 14 into the conduit 26 which is also receiving return fluid from the double acting cylinder 11. The increased resistance to flow resulting from the extra return fluid causes a corresponding increase in the pressure of the return fluid in the double acting cylinder 11 which tends to resist the motion of the piston 12. This back pressure rises rapidly as the piston 12 approaches the end of its travel, and the resistance presented to the motion of the piston 12 also causes a pressure increase on the power fluid side of the piston 12 since the delivery volume of the pump 19 is constant. The resultant increased pressure on the power side of the piston 12 is communicated through the cylinder conduit 24 to the annular groove 33 and then through the connecting conduit 76 to the chamber 74 in the head cap 67 of the detent disengaging mechanism 66. When this pressure reaches a predetermined amount, the follower 72 exerts a force of sufficient magnitude to overcome the resistance of the detent balls 86 and urge the actuating pin or piston 69 against the follower 72 to move the spool 32 back to the "float" position as shown in Fig. 3. A shoulder 92 formed in the end housing 68 prevents the follower 72 from overtraveling the neutral position. The detent balls 86 and the valve spool 32 then engage the groove 84 which detains the valve spool 32 in the "float" position. In the "float" position fluid port 23 is vented to exhaust chamber 44 through conduit 24, groove 33 and exhaust passages 42 and 43; and fluid port 22 and cylinder 24 are vented to exhaust chamber 44 through conduit 26, groove 37 and exhaust passage 43, it being readily apparent that in this condition pistons 12 and 16 are both permitted to float in their respective cylinders. It should be apparent to one skilled in the art that the valve spool 32 may be returned to other positions or settings as required by the particular application. In some instances, it may be desirable to eliminate the "float" position and return the valve spool directly to a "hold" position.

Although the conduit 76 is connected at one end to the valve body 29 and communicates with the annular groove 33 through a suitable port 93, it should be apparent that this conduit can be connected at any location in the hydraulic system that provides the necessary pressure increase to overcome the resistance presented by the two detent balls 86 and to displace the valve spool 32. In hydraulic circuits where the hydraulic pump is driven by the engine of a vehicle, as is the case in the applicant's preferred embodiment of his invention, the precise point in the travel of the piston of a double acting cylinder at which sufficient pressure will be developed in the power

fluid to return the valve spool to a float position will necessarily vary to some extent with the engine speed. The speed of an engine serving as the prime mover for the pump will determine the hydraulic pump output.

When the hydraulic valve is in a "wide open" or operating position, as it is when the valve spool **32** is engaged by the two detent balls **86** in the detent groove **83**, as shown in Fig. 2, the rate of travel of the piston **12** in the double acting cylinder **11** will depend upon the hydraulic pump output **19**. The speed at which the piston **12** travels determines the rate of flow of the return fluid from the cylinder **11** inasmuch as the rate of flow of the returning pressure fluid in the conduit **26** is directly proportional to the pressure rise caused by the resistance to fluid flow. Consequently, the valve spool **32** is returned to the "float" position earlier in the piston travel when the engine is operated at higher speeds than it would be if the engine were running at slower speeds.

It is possible that the valve spool **32** may not be returned to the "float" position until the piston **12** is at the end of its power stroke. Although this is not a normal condition of operation, it is a condition for which some provision must be made. The relief valve **46** in the inlet chamber **38** of the hydraulic valve **18** will relieve any excessive pressure which might cause damage to the hydraulic system. Any pressure sufficient to unseat the relief valve **46** would be more than adequate to return the valve spool **32** to the "float" position. It is to be noted that the hydraulic control valve **18** in the particular application disclosed herein performs the double function of controlling the single acting ram **27** as well as the double acting ram **28**. To move the double acting piston **12** to the left, as viewed in Fig. 1, the operator manipulates the control handle **54** to cause the spool **32** to shift to the left of its hold position which position will be more fully described hereinbelow. For this particular shift of the spool **32** the detent balls **86** are disengaged from the groove **84** and are positioned to engage the groove **83**, and the valve spool is detained in an operating position in which the port **23** is connected with conduit **24** to permit pressure fluid to be admitted to the right end of the double acting cylinder **11**. Likewise, for this operating position, the valve spool **32** is positioned so that the port **22** connecting with the cylinder conduit **26** communicates with exhaust passage **43** so as to conduct the flow of the return fluid to the reservoir **21**. Although power fluid is being supplied only to the double acting cylinder **11**, return fluid from one end of the double acting cylinder **11** and from the single acting cylinder **14** is being conducted to the reservoir **21**. As the double acting piston **12** approaches near the end of its travel, the single acting piston **16** is forcibly ejecting the pressure fluid from its cylinder **14** by virtue of the apron and ejector linkage. The rate of travel of the double acting piston **12** also increases near the end of its stroke. The introduction of this additional fluid through all the restrictive passages encountered by the fluid as it is conducted to the reservoir and the increased rate of piston travel result in a sudden build-up of the back pressure. Since the double acting piston **12** must operate against this back pressure and since the volume of pressure fluid being supplied at the power side of the piston **12** is constant, the fluid pressure at the power side of the piston **12** will proportionately increase with the rise in the back pressure. This increase in pressure is reflected in all the passages through which the power fluid is conducted. In the preferred embodiment of this invention, a connection at the control valve **18** opening to the annular groove **33** has been selected. It should be readily apparent that a tube can be connected at various other points in the hydraulic system.

When the pressure increase in the annular groove **33** reaches a predetermined point, the actuating pin **69** moves to the right urging the follower **72** against the end of the valve spool **32** to disengage the two detent balls **86** from the groove **83**. Once the resistance of the detent balls **86** is overcome, the spool **32** freely moves to the float position as shown in Fig. 3. Once the spool is in the "float" position any further movement of the actuating pin **69** and the follower **72** is limited by the shoulder **92**.

In the "float" position the spool **32**, as shown in Fig. 3, does not completely block off the annular grooves **33**, **37**. The bore **71** of the disengaging mechanism **66** is in free communication with the low pressure fluid return passage **42**. As the result of this decreased pressure, the hydraulic force acting against the end of the actuating pin **69** is insufficient to resist the spring force exerted by the spring **73**. The energy stored in the compressed spring **73** will now be utilized in returning the follower **72** and the actuating pin **69** to their initial starting position and out of contact with the end of the valve spool **32**. The valve spool **32** can now be shifted to the operating position to the left of the "float" position without interference from the follower **72**. In view of the shoulder **92** formed in the end housing **68** to limit the movement of the follower **72**, the disengaging mechanism **66** is inoperative when the valve spool **32** is in the "float" position or whenever it is moved to the right of the "float" position.

When an operator desires to move the double acting piston **12** and the single acting piston **16** to extend the piston rods **13** and **17** outwardly, he manipulates the control handle **54** to shift the valve spool **32** to the right until the annular groove **33** communicates with the exhaust passage **41** and the annular groove **37** communicates with the groove **36** to conduct power fluid to the cylinder conduit **26**. For this position of the valve spool **32** power fluid is directed to the double acting cylinder **11** and the single acting cylinder **14** which will cause hydraulic force to be exerted against the pistons **12**, **16** thereby causing the piston rods **13**, **17** to extend outwardly and perform the desired work operation.

The movement of the valve spool **32** to the right is resisted by the centering spring **58** which is compressed against the shoulder **62** of the bushing **59**. Since from an operational standpoint, it is necessary that some degree of regulation be provided for the work operation performed by the extension of the two rams **27**, **28**, no detent position is provided for this control setting of the valve **18**. The characteristics of the centering spring **58** are such that it will exert a sufficient force when compressed to automatically return the valve spool **32** to a "hold" position when the the operator releases the control handle **54**. The "hold" position is well understood in the art and has, therefore, not been illustrated in the drawings. It will be apparent from the position of the valve in Fig. 1 that in a "hold" position spool **32** will be displaced slightly to the left with the detent balls **86** positioned just to the right of detent groove **84**, spring **58** being substantially decompressed to releasably maintain spool **32** in this position. It will also be noted that in a "hold" position annular grooves **33** and **37** will respectively be blocked by the lands of spool **32** and power fluid delivered by pump **19** will be directed back to the reservoir **21** through grooves **34** and **36**, exhaust passages **42** and **43**, and exhaust chamber **44**.

The detent disengaging and return mechanism of the present invention is particularly adaptable to installations where hydraulically actuated accessories or components are under the control of a single operator. It is especially helpful in vehicles where the operator must manipulate both the vehicle and operate the accessories or components simultaneously. In hydraulically operated motor scrapers of the type in which the applicant has embodied his invention, the bowl lifting, the apron raising and lowering, and ejector mechanisms are hydraulically actuated. In some cases individual control valves are used for each of these mechanisms. Under certain operating conditions the operator is required to steer the vehicle, declutch and shift gears, and also at the same

time operate one or more control valves to position the scraper bowl, to raise or lower the apron or to retract or extend the ejector. If the operator were required to keep one hand on a hydraulic control valve, it would not be possible for him to steer and shift gears with the remaining hand.

This consideration becomes important where a motor scraper is being used for short hauling. The time required to return the vehicle to the loading site may be so short that the operator's entire attention may be required for steering, shifting gears and maneuvering the motor scraper into position to dig a new load. During the return interval the operator must return the ejector to a loading position and lower the apron from an elevated position. Returning the ejector to the loading position is a relatively slow process. If the operator were required to hold a control handle continuously during this period of time, he would not be able to maneuver the vehicle.

By utilizing the detent-disengaging and automatic return mechanism herein described, it is possible to operate a hydraulic cylinder by merely initially displacing the control handle until it engages a detent. It is not necessary to hold the control handle **54** in the displaced position inasmuch as it is held in this position by a detent until the piston rod **13** has completed its movement, at which time the spool **32** is automatically restored to a nonoperating position and the flow of power fluid to the cylinder **11** accordingly stops. It should be readily apparent that the mechanism can be readily adapted to conventional types of valve spools without any major modifications to the structure.

Considering this invention from a general point of view, it will be apparent that the "hold" and "float" positions are both nonoperating or nonworking positions wherein the position or setting of spool **32** is such that power fluid it not causing either of hydraulic pistons **11** and **16** to perform work, as distinguished from the operating position illustrated in Fig. 1 with the spool shifted to the far right, and the operating position illustrated in Fig. 2 with the spool shifted to the far left. It will also be readily apparent that spool **32** is shiftable to the right completely independently of the disengaging mechanism **66**, with return spring **73** and follower **72** serving as a biasing means for urging piston **69** out of thrust transmitting relationship with valve spool **32**. So far as the invention is concerned it is immaterial whether or not the disengaging mechanism **66** is operative to automatically return spool **32** from an operating position to a "float" or to a "hold" position, the significance of this arrangement being that the spool is automatically returned from one of two operating positions to an intermediate nonoperating position, with spring **58** esrving as a biasing means for urging the spool to a nonoperating position from the other of the two operating positions. It will be noted that a range of adjustment of the valve spool between the intermediate nonoperating position and the latter mentioned operating position, as shown in Fig. 1, may be accomplished entirely independently of the disengaging mechanism **66**.

While only one particular embodiment of the applicant's invention has been described herein, it should be understood that the applicant's invention is not restricted thereto in that it is intended to cover all modifications of the invention which would be apparent to one skilled in the art and that come within the scope of the appended claims.

What is claimed is:

1. A hydraulic control valve for interchanging the supply and return connections to a double acting hydraulic ram said valve comprising in combination a housing having a ported valve spool bore, a piston bore, and a return chamber in communication with said valve spool bore, a valve spool slidable in said ported bore having two operating positions and an intermediate nonoperating position, a pair of axially spaced cylinder ports joining said supply and return connections to said double acting ram, a piston reciprocable in said piston bore and disposable in and out of thrust transmitting relationship with said valve spool, a first detent means holding said valve spool in one of said operating positions, a second detent means holding said valve spool in said nonoperating position, a follower axially slidable with said piston being interposed between said piston and valve spool and displaceable in and out of abutting relationship with one end of said valve spool, spring means yieldably urging said follower out of said abutting relationship, a pilot port formed in said ported bore and circumferentially spaced therein, and means connecting said pilot port with the pressure side of said piston, said piston having an effective area reacting to displace said follower thereby disengaging the valve spool from said first detent means and shift the valve spool into engagement with said second detent means when the pressure acting upon said effective area reaches a predetermined amount.

2. In a fluid pressure system, a fluid control valve for regulating fluid flow to and from a double acting hydraulic ram, said control valve comprising a housing, a ported spool valve bore formed in said housing; an axially reciprocable valve spool in said bore having two operating positions and intermediate float and hold positions; first detent means for releasably retaining said valve spool in said float position; a second detent means for releasably retaining said spool in one of said operating positions; biasing means reacting between said housing and said valve spool for urging the latter toward said hold position from the other of said operating positions; and a disengaging mechanism for automatically returning said spool to said float position from said one operating position, said mechanism including a piston bore in said housing formed at one axial end of said spool valve bore, a pressure port in said bore, passage means for connecting said pressure port in fluid communication with the pressure side of said pressure system, a piston member axially slidable in said piston bore, a follower slidably mounted within said housing being interposed between said piston and valve spool, and movable in and out of abutting relationship with one end of said valve spool, said piston member being axially displaced by a predetermined pressure within said pressure system thereby urging said follower into thrust transmitting relationship with said valve spool and displacing the latter into said float position, and biasing means reacting between said follower and said housing for urging said follower out of abutting relationship with said valve spool.

3. In a fluid pressure system, a fluid control valve for regulating fluid flow to and from a double acting fluid motor, said control valve comprising a housing, a ported spool valve bore formed in said housing; an axially reciprocable valve spool in said bore having two operating positions and an intermediate nonoperating position; a disengaging mechanism for automatically returning said valve spool to a nonoperating position from one of said operating positions, said mechanism including a piston bore in said housing formed at one axial end of said spool valve bore, a piston member axially slidable in said piston bore, means for venting one end of said piston member to fluid pressure within said pressure system, a thrust transmitting member operatively interposed between said piston member and said valve spool, and biasing means reacting between said thrust transmitting member and said housing yieldably maintaining said piston member out of thrust transmitting relationship with said valve spool, said piston member being responsive to a predetermined pressure in said pressure system to overcome said biasing means and to displace said valve spool into said nonoperating position; a detent means for releasably maintaining said valve spool in one of said operating positions; and other biasing means reacting be-

tween said housing and said valve spool for urging the latter toward a nonoperating position from the other of said operating positions.

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