Sept. 10, 1968 E. A. WIRTZ 3,400,634

VENT MEANS FOR HYDRAULIC CIRCUIT

Filed Oct. 21, 1966 2 Sheets-Sheet 1

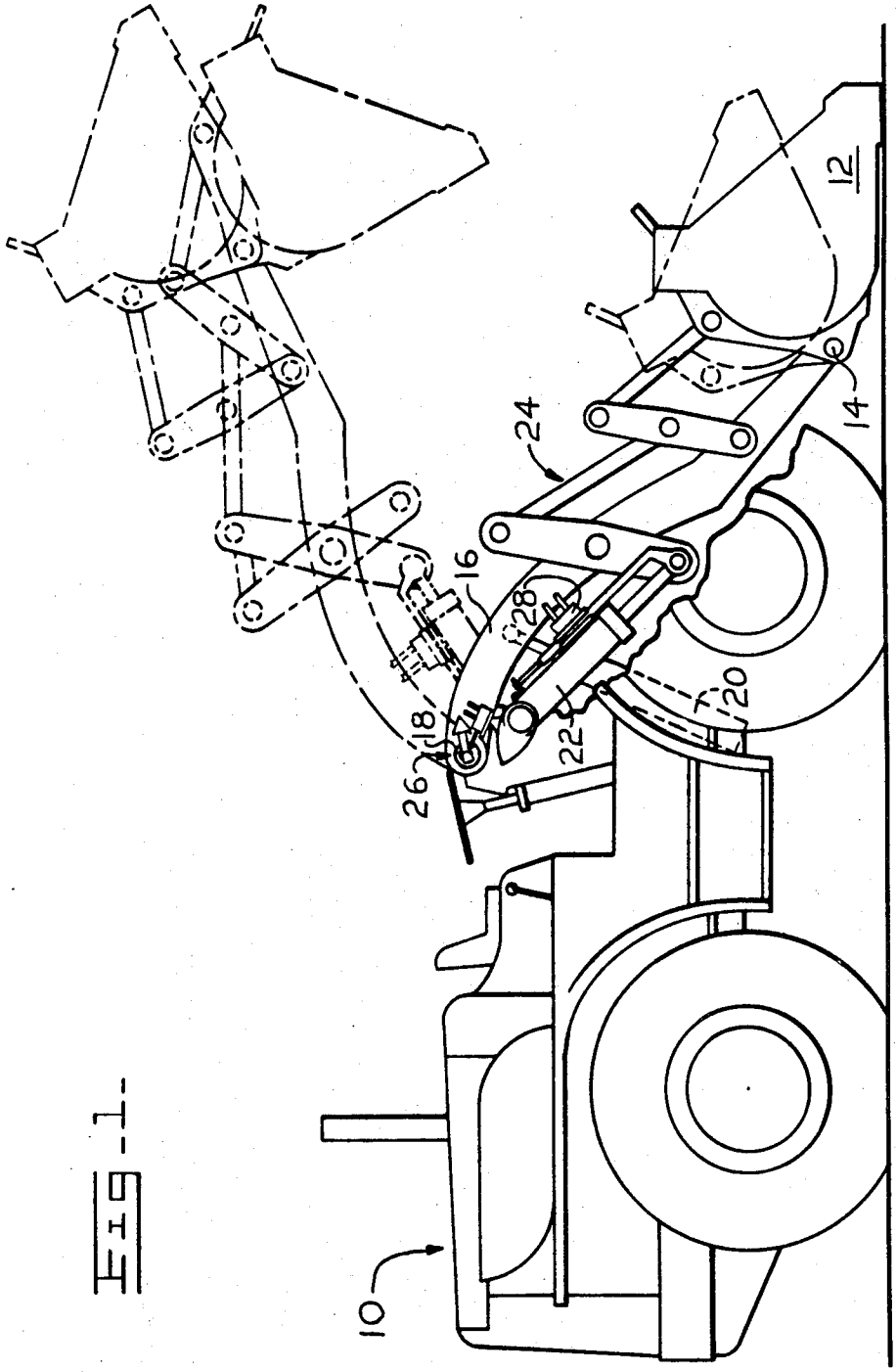


Fig. 1

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Fig. 2.

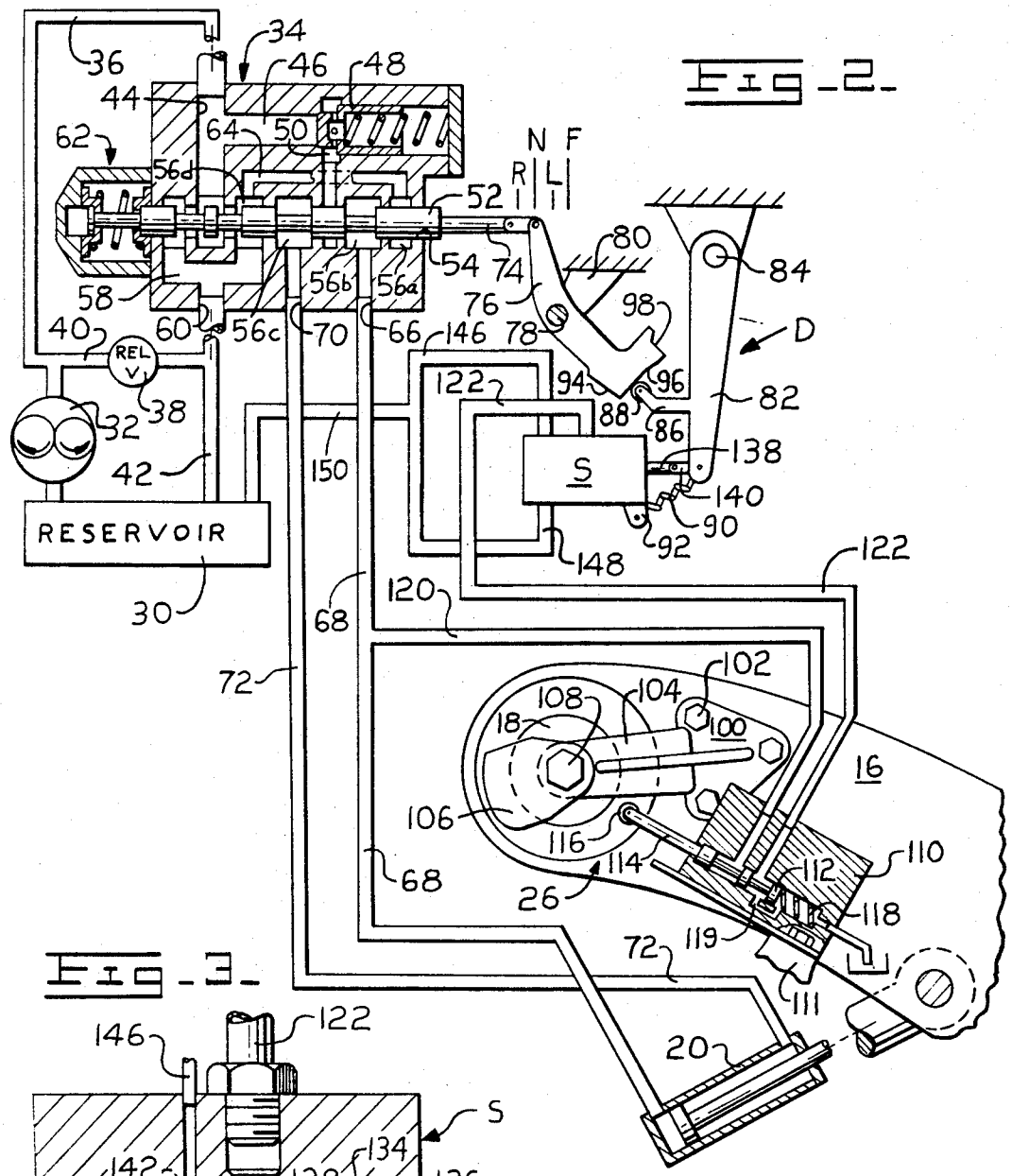
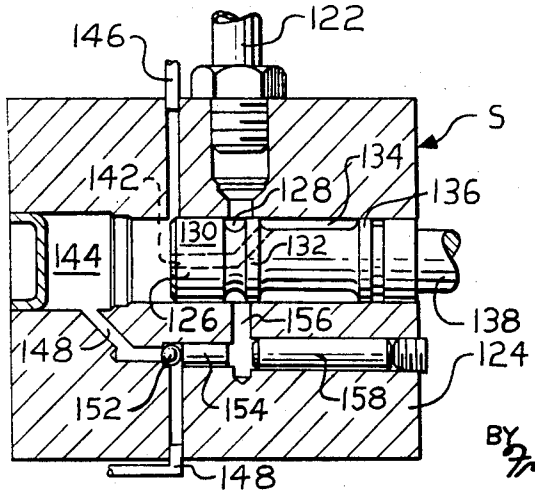


Fig. 3.



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ABSTRACT OF THE DISCLOSURE

A hydraulically actuated control device is provided for automatically arresting the operation of a fluid motor during preselected portions of an operating cycle. The control device has means for selectively venting the hydraulic circuit to a zone of reduced pressure only after operation of the motor has been arrested.

This invention relates to a hydraulic control device and more particularly to a device for venting the hydraulic circuit during each cycle of operation and for conditioning the hydraulic circuit to interrupt operation of a hydraulic motor.

This invention can be employed to control the flow of actuating pressure fluid to hydraulic motors, particularly linear actuators, in order to interrupt operation of the motor at a desired time, thus positioning an element, whether it be a linkage mechanism, a turntable, or a boom, which is actuated by the motor, at any particular location.

The invention is particularly applicable to tractor-mounted loaders of the kind employed for digging earth with a scoop or bucket. Although controls of this general type are known and have been relatively successful in providing automatic positioning of a loader bucket, problems have arisen relating to the entrainment of air in the hydraulic system causing erratic operation and at times rendering the automatic positioning mechanisms inoperative until such time as the air is purged from the system. This invention provides a hydraulic circuit which includes a master-slave hydraulic cylinder assembly having a cyclically operable valve which is effective, during each cycle of operation of the positioning mechanism, to vent the hydraulic circuit to the atmosphere and thereby maintain the hydraulic circuit free of entrapped air.

Moreover, one of the principal objects of this invention is to provide a single circuit system which will vent itself of entrapped air during each cycle of operation and still provide the entire system pressure for arresting operation of a fluid motor. Thus the system prevents any loss of pressure due to venting during the motor arresting portion of the operating cycle.

Another object of this invention is to provide a hydraulically actuated positioning mechanism wherein the hydraulic circuit is cyclically vented to the atmosphere.

Another object of this invention is to provide a shiftable hydraulic motor valve to vent a portion of the working fluid to a zone of reduced pressure in order to purge and thus maintain the working fluid free of entrapped air.

Another object of this invention is to employ the pressure fluid of the main hydraulic circuit to operate a control device which arrests movement of a positioning mechanism at a desired point.

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

In the drawings:

FIG. 1 shows a wheeled vehicle having a bucket positioning mechanism incorporating the control device of this invention;

FIG. 2 is a diagrammatic, partially in section, of the hydraulic circuit of this invention; and

FIG. 3 is an enlarged sectional view of the novel master-slave hydraulic cylinder assembly of the present invention.

Referring to FIG. 1, a loading apparatus generally indicated by the numeral **10** includes a bucket **12** pivotally connected at **14** to a pair of arms **16**. The arms **16** are pivotally connected at **18** to the frame of the loading apparatus with pivotal movement of the arms **16** about the pivot connection **18** being effected by a hydraulic motor **20**, preferably a jack. The bucket **12** is interconnected to a tilt motor **22** by a linkage system **24** which operates to hold or retain the bucket **12** in a fixed position relative to the horizontal as it is raised. Retraction of the motor **22** causes the linkage mechanism **24** to effect pivotal movement of the bucket **12** about the pivot **14** thus dumping the contents from the bucket.

The hydraulic circuit for operating the hydraulic motors **20** and **22** includes a lift kick-out mechanism **26** operating to interrupt flow of hydraulic fluid to the motor **20** when the arms **16** have been raised to a predetermined position and a cam kick-out mechanism **28** operating to control the action of the motor **22** in order to effect tilting of the bucket **12** about the pivot connection **14** when the arms **16** are in their raised position.

As shown in FIG. 2, the portion of the hydraulic circuit for actuating the motor **20** comprises a reservoir **30** which contains hydraulic fluid that is distributed to the circuit by a pump **32** having the discharge port thereof connected to the inlet port of a control valve **34** by a conduit **36**. A conventional relief valve **38**, located in a branch conduit **40**, maintains the pump discharge pressure at a predetermined value by operating to return a portion of the pressure fluid to the reservoir through the conduit **40** and a conduit **42** open to the reservoir **30**.

Pressure fluid from the conduit **36** is discharged to communicating passageways **44** and **46** formed in the body of the control valve **34**. A check valve **48** operates in response to the level of pressure in the passageway **46** to establish communication between the passageway **46** and another passageway **50** which communicates pressure fluid to a bore **54** containing a reciprocable control spool **52**. The bore **54** is formed with a plurality of longitudinally spaced annular recesses **56***a*, **56***b*, **56***c*, **56***d*, which in conjunction with the lands of the spool control the flow of pressure fluid through the valve **34**. The passageway **44** distributes pressure fluid to a generally U-shaped cavity **58** and a port **60** to which is connected the conduit **42** to thereby return the pressure fluid to the reservoir **30**. A conventional spring centering mechanism **62** is provided for restraining or biasing the spool **52** in a neutral position, which is the position illustrated in the drawing. While in the neutral position, it will be noted that the passageway **44** is in communication with the cavity **58** so that fluid discharged by the pump **32** is immediately returned to reservoir **30** by the conduit **42**.

The spool **52** is adapted to assume various adjusted positions indicated by the letters R, N, L, and F being respectively, the raise position wherein pressure fluid is communicated to the motor **20** effecting extension thereof, a neutral position wherein fluid is returned directly to the reservoir **30**, the lower position wherein fluid is communicated to the motor **20** in order to effect retraction thereof, and a float position wherein fluid is communicated to the rod end and head end of the fluid motor **20** permitting the bucket to be lowered by gravity and to be able to freely follow the terrain over which it is being moved. The annular recesses **56***a* and **56***d* have extending therebetween an internal passageway **64** defining a fluid flow path for returning fluid exhausted from the head end of the hydraulic motor **20** to the recess **56***d*, through

the cavity 58 and to the reservoir 30 by the conduit 42. The recess 56*b* communicates pressure fluid from the passageway 50 to the head end of the motor 20 by a port 66 and a conduit 68 whereas pressure fluid communicated to the recess 56*c* by the passageway 50 is communicated, by a port 70 and a conduit 72, to the rod end of the motor 20.

Assuming that it is desired to extend the fluid motor 20, the operator positions the spool 52 adjacent the position indicated by the letter R, blocking communication between the passageway 44 and the U-shaped cavity 58 and establishing communication between the passageway 50 and the discharge port 66. Under these circumstances the pressure fluid from the pump increases the pressure in the passageway 46 to a sufficient value to cause opening of the check valve 48 and allowing the pressure fluid to flow through the passageway 50 into the annular recess 56*b* and through the discharge port 66 and the conduit 68 to the head end of the hydraulic motor 20 thus causing extension thereof.

Retraction of the hydraulic motor 20 is accomplished by moving the spool 52 in the position indicated by the letter L establishing communication between the passageway 50 and the conduit 70 and between the conduit 68 and the passageway 64. With the check valve 48 open, pressure fluid is distributed to the hydraulic motor 20 by the conduit 72 causing retraction of the motor 20. The fluid exhausted from the head end of the hydraulic motor 20 flows through the conduit 68 to the annular recess 56*b*, to the annular recess 56*a*, through the passageway 64 and to the annular recess 56*d* which is in communication with the discharge port 60 thus returning the exhausted fluid to the reservoir 30 by the conduit 42.

The lift kick-out mechanism 26 includes a valve operating in response to the pivotal movement of the arm 16 for communicating pressure fluid derived from the control valve 34 to a master-slave assembly S. Operation of the slave assembly S is effective to release a detent mechanism D thereby conditioning the control valve 34 to interrupt the flow of pressure fluid to the motor 20 and thus halt pivotal movement of the arms 16.

In accordance with the basic features of this invention the hydraulic system illustrated in FIG. 2 is arranged to employ the high pressure fluid for releasing the detent mechanism D and means are incorporated in the slave assembly S for selectively venting the hydraulic circuit in order to purge air which may be entrained in the hydraulic system.

As shown, the spool 52 has an extension 74 pivotally connected to an actuating lever 76 mounted for rotation with a shaft 78 which is rotatably mounted in a bracket 80 secured to the frame of the machine. Shifting of the spool to any of the indicated positions is accomplished when the operator rotates the shaft 78 in turn rotating the lever 76 thus effecting reciprocation of the spool 52. In addition to the lever 76 the detent mechanism D comprises another lever 82 pivotally connected to the frame of the machine at 84 and formed with a laterally projecting support arm 86 on the end of which is rotatably mounted a roller 88. The lever 82 is urged in a clockwise direction by a spring 90 having one end attached to the lower end of the lever 82 and the remaining end attached to a small bracket 92 secured to the body of the slave assembly S.

The lower end of the actuating lever 76 is formed with cam surfaces 94, 96 and 98 against which the roller 74 is held in engagement by the spring 90. These cam surfaces are effective in conjunction with the force of the spring 90 to retain the lever 76 and the spool 52 in a desired adjusted position.

It can be seen that rotation of the lever 76 in order to position the spool 52 of the valve 34 in the raised position rotates the lower end of the lever 76 in a counterclockwise direction permitting the roller 88 to come in rolling contact with the cam surface 94 and thus cause, by virtue of the spring 90, clockwise rotation of the lever 82. When the roller 88 is in contact with the cam surface 94, the spool 52 is held in the raised position.

Another important feature of this invention pertains to a high pressure kick-out mechanism operating to communicate pressure fluid discharged through the conduit 68 to the slave assembly S in order to rotate the lever 82 of the detent mechanism in a counterclockwise direction thereby returning the spool 52 to its neutral position and interrupting movement of the arms 16 at a desired raised position.

As shown in FIG. 2, the kick-out mechanism comprises a base plate 100 rigidly mounted on the arms 16 by plurality of bolts 102. A bracket 104, secured to the plate 100 has a cam 106 secured thereon in any suitable manner and preferably as shown by means of a bolt 108. A valve 110 is rigidly supported on a boss 111, forming part of the frame of the loading apparatus. This valve includes a spool 112 having an outward extension 114 on the end of which is rotatably mounted a roller 116. The spool 112 is normally held in the illustrated position by a spring 118 located within the bore of the valve.

Passageway 119 is provided for communicating with a drain during certain sequences of operation. The valve 110 is connected by means of a conduit 120 to the conduit 68 and by means of a conduit 122 to the slave assembly S. During such times that the control valve 34 is adjusted to discharge pressure fluid from the pump 32 to the conduit 68 in order to pressurize the head end of the motor 20, the cam 106 engages the roller 116 moving the spool 112 to the right (as viewed in FIG. 2) thereby establishing communication between the conduit 120 and 122 thus communicating pressure fluid to the slave assembly S.

When the spool 52 is shifted leftwardly in order to admit pressure fluid to the conduit 68 causing extension of the motor 20, the actuating lever 76 is rotated in a counterclockwise direction and the lever 82 by virtue of the spring 90 is rotated in a clockwise direction establishing rolling engagement between the roller 88 and the cam surface 94.

The slave assembly S is hydraulically arranged with the valve 110 and mechanically arranged with the detent mechanism D to vent the fluid in the conduit 122 and to permit the spring centering mechanism 62 to return the spool 52 to its neutral position when the arms 16 have reached a predetermined raised position.

As shown in FIG. 3, the master-slave assembly S comprises a main housing 124 having a valve spool 126 reciprocably mounted therein. Valve spool 126 has a first annular groove 128 formed between a first land portion 130 and an intermediate land portion 132. Similarly, a second annular groove 134 is formed on the spool 126 between the intermediate land 132 and a third land portion 136. An elongated rod portion 138 extends outwardly from one end of the spool 126 and is pivotally connected at 140 to the lower portion of lever 82.

A passageway 142 (shown in dotted outline) in the spool 126 establishes fluid communication between annular groove 134 and spool cavity 144. Cavity 144 communicates with reservoir 30 via a first small diameter bleed conduit 146 and a second small diameter bleed conduit 148. Conduits 146 and 148 are preferably conveniently joined to a conduit 150 for leading to the reservoir 30.

A small ball check valve 152 is positioned in conduit 148 for selectively preventing fluid in cavity 144 from draining to reservoir 30. A floating piston 154 is positioned in a passageway 156 which is always open to the pressure in conduit 122 via one of the annular spool recesses 128 or 134. Passageway 156 and floating piston 154 are of substantially greater diameter than the bleed conduit 148. Consequently, equal pressures in cavity 144 and passageway 156 would result in ball check 152

blocking conduit **148** from draining to reservoir **30**. A spacer plug **158** is provided to limit the lateral movement of the floating piston **154**.

In describing the operation it will be assumed that the hydraulic motor **20** is to be extended thereby raising the arms **16**. The operator effects rotation of shaft **78** thereby causing lever **76** to move to position R and the detent mechanism D is adjusted so that roller **88** is in contact with the cam surface **94**. Since the biasing force of spring **90** exceeds the pressure in the slave assembly cavity **144**, the spool **126** will move leftwardly into the cavity.

At this time the ball check **152** moves to the right and allows the fluid in cavity **144** to vent to reservoir **30** via conduit **148**. As the arms **16** reach their predetermined raised position, the spool **112** of the valve **110** is shifted by the cam **106** to establish communication between the conduits **120** and **122** thereby communicating pressure fluid to the slave assembly S. Valve spool **126** is at this time positioned sufficiently far to the left to provide communication between the conduit **122** and the passageway **156** via the annular groove **134**. At this juncture it should be noted that the ball check **152** instantly seats to block off the drain conduit **148** due to floating piston **154** having a greater cross-sectional area than the passageway **148**. Thus, at this critical phase of the operation the entire pressure fluid of the circuit is passed through spool passageway **142** to the cavity **144** which causes instant rightward movement of the spool **126** since the pressure in chamber **144** is greater than the biasing force of spring **90**. Such shifting of spool **126** in turn causes counterclockwise rotation of the lever **82** and consequent disengagement of roller **88** from the cam surface **94**. Thus, the spring centering mechanism **62** of the control valve **34** is made effective to position the spool **52** in a neutral position blocking flow of pressure fluid to the conduit **68** to arrest further extension of motor **20**. After the spool **126** has moved to the right to approximately the position shown in FIG. 3, any air that may be entrapped in the hydraulic system is purged through reduced diameter conduit **146** back to reservoir **30**. Once the conduit **68** has been blocked by the valve spool **52**, the spring **118** causes the valve spool **112** to move to the position shown in FIG. 2 thereby opening conduit **122** to drain via passageway **119**. Also, it will be apparent that after valve spool **126** of the slave assembly moves to the position shown in FIG. 3 the ball check **152** will unseat and thereby open bleed conduit **148** to reservoir **30**.

Thus, the novel master-slave assembly S is effective during one portion of the operating cycle (raising of arms **16**) to direct the entire volume of fluid under pressure in conduit **122** to cause a quick release of the detent mechanism D thereby preventing faulty operation through loss of fluid pressure during this critical period. On the other hand, the master-slave assembly S is also effective, during another portion of each operating cycle, to purge any air that may be entrapped in the hydraulic system.

Although the subject hydraulic system has been disclosed and described in relation to a loader bucket lift system, it could also be applied to the bucket tilt controls for automatically interrupting movement of the bucket at its proper loading position when rotating between a dump and "tilt-back" position. It is also conceivable that the system could be applied to the control of any implement where it is desirable that the implement being actuated be automatically stopped in a predetermined position.

What is claimed is:

1. A control device for a hydraulic circuit comprising a movable support, a hydraulic motor being arranged to impart movement to said support, a control valve mechanism for communicating pressure fluid to said motor to cause operation thereof, means including a pressure operated device connected to the circuit for maintaining said valve mechanism in a position communicating pressure fluid to said motor, and means actuated in response to the position of said support and being operable to communicate pressure fluid to said pressure operated device for disconnecting said motor from a source of pressure fluid in order to arrest movement of said movable support, said pressure operated device further having means for selectively venting said circuit to a zone of reduced pressure after said motor has been disconnected from said source of pressure fluid.

2. A control device as set forth in claim **1** wherein said hydraulic motor comprises a double acting linear actuator, said control valve having a spool reciprocably mounted therein and adjustable to communicate pressure fluid to said actuator to effect extension and retraction thereof, a detent mechanism rendered operative when said spool is adjusted to effect extension of said actuator and maintain said spool in its adjusted position, said pressure operated device comprising a fluid operated detent release mechanism including a housing having a reciprocable valve element formed with land portions and a rod portion, means effective upon extension of said actuator for communicating pressure fluid from said control valve to an annular recess formed between land portions intermediate said reciprocal valve element, a passageway in said valve element communicating fluid from said annular recess to a chamber defined by one of said lands and said housing to effect shifting of said valve element, said valve element being connected to said detent mechanism so that upon shifting thereof said detent is released and said actuator disconnected from said source of pressure fluid, and vent conduit means for communicating with said chamber after said valve element has shifted to release said detent, said vent means effective for exhausting a part of the fluid communicated to said chamber to a zone of reduced pressure to thereby purge entrapped air from the circuit.

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