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Koch et al.

[11] **3,913,449**

[45] **Oct. 21, 1975**

[54] **POSITION-RESPONSIVE HYDRAULIC CYLINDER**

[75] Inventors: **James Allan Koch,** Hudson; **Roger John Nelson,** Cedar Falls; **Donald LeRoy Henderson,** Waterloo, all of Iowa

[73] Assignee: **Deere & Company,** Moline, Ill.

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[52] **U.S. Cl.** **91/368;** 91/380; 92/113

[51] **Int. Cl.²** **F15B 9/10**

[58] **Field of Search** 91/380, 382, 368, 448

[56] **References Cited**

UNITED STATES PATENTS

1,651,838	12/1927	Roberts	91/380
3,292,499	12/1966	Duffy	91/382
3,428,143	2/1969	King et al.	91/380

FOREIGN PATENTS OR APPLICATIONS

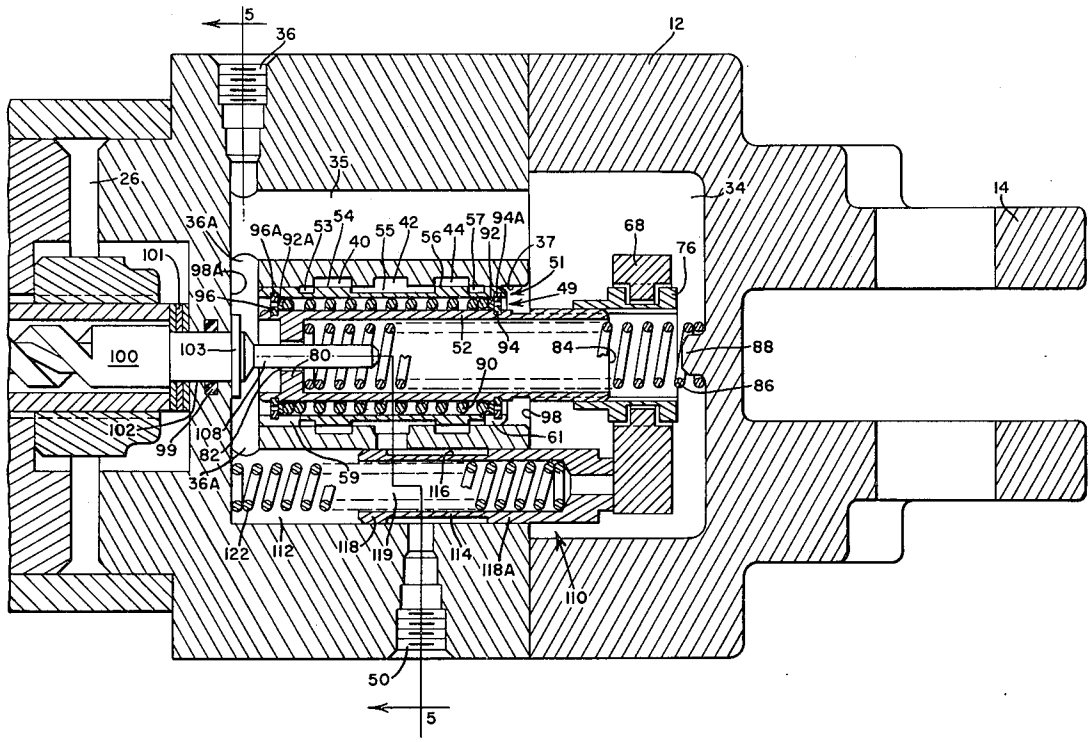
5,005	3/1884	United Kingdom	91/380

Primary Examiner—Paul E. Maslousky

[57] **ABSTRACT**

A double acting hydraulic cylinder with integral valves is described wherein rod extension is directly proportional to positioning of a control level. A change in the control lever to a certain setting causes an integral control valve to move to either side of a neutral position to selectively connect the cylinder chambers to the source or reservoir and thus to cause movement of the rod. In response to rod movement, a threaded feedback means causes movement of the valve such that, when the desired position of the rod is reached, the valve is returned to the neutral position. With the aid of an integral float valve, the control lever can be placed at a maximum or minimum setting and both chambers will be connected to the reservoir such that the position of the rod would be dependent on external forces on the rod.

22 Claims, 6 Drawing Figures



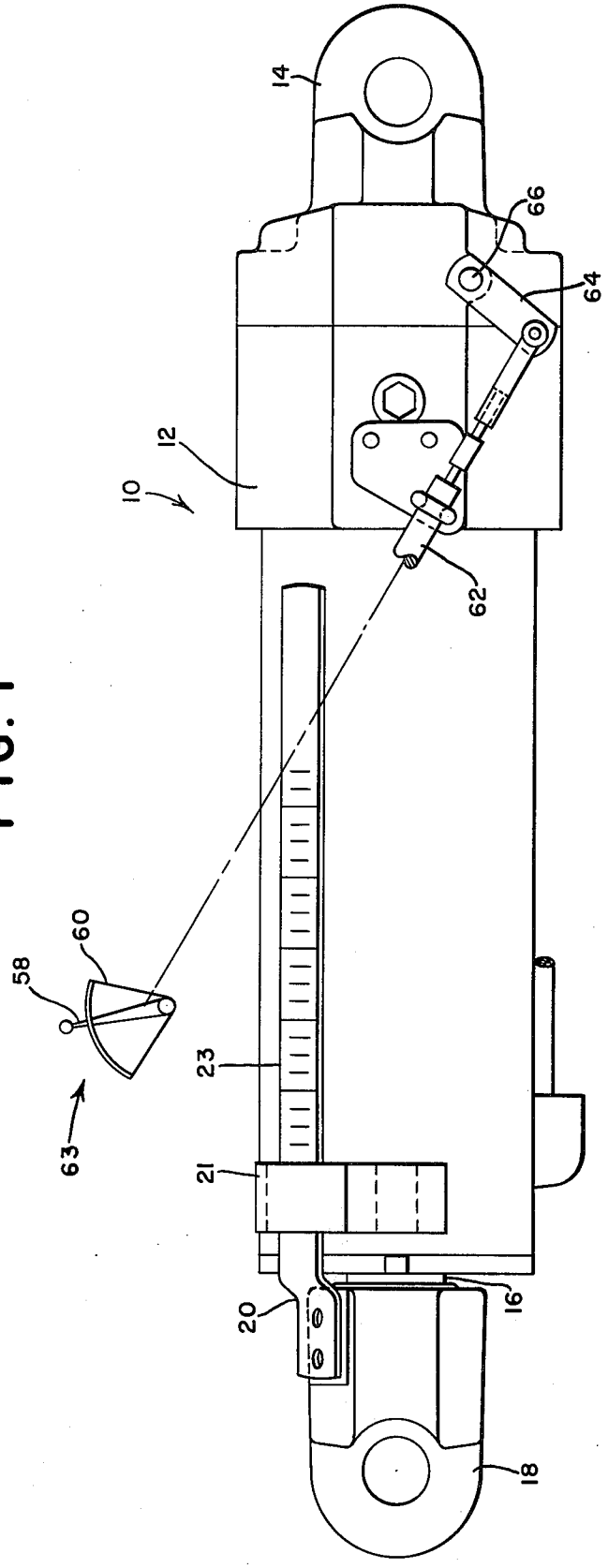


FIG. 1

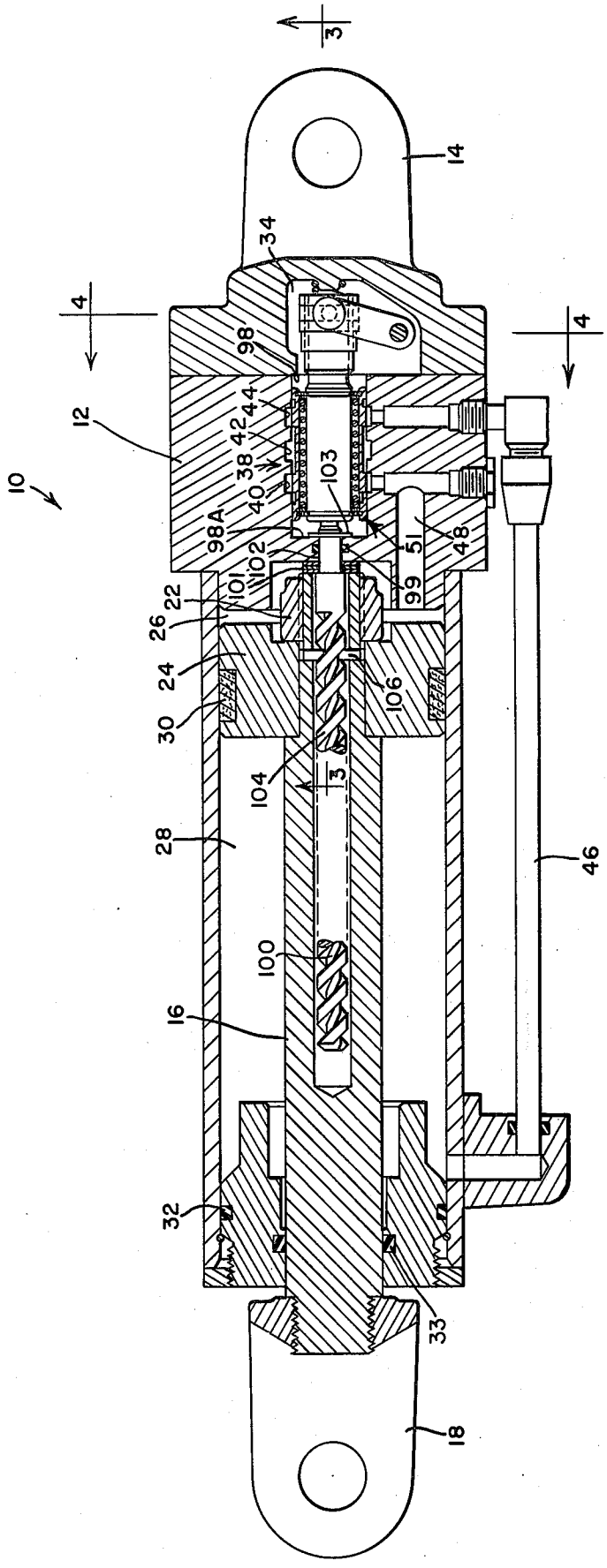

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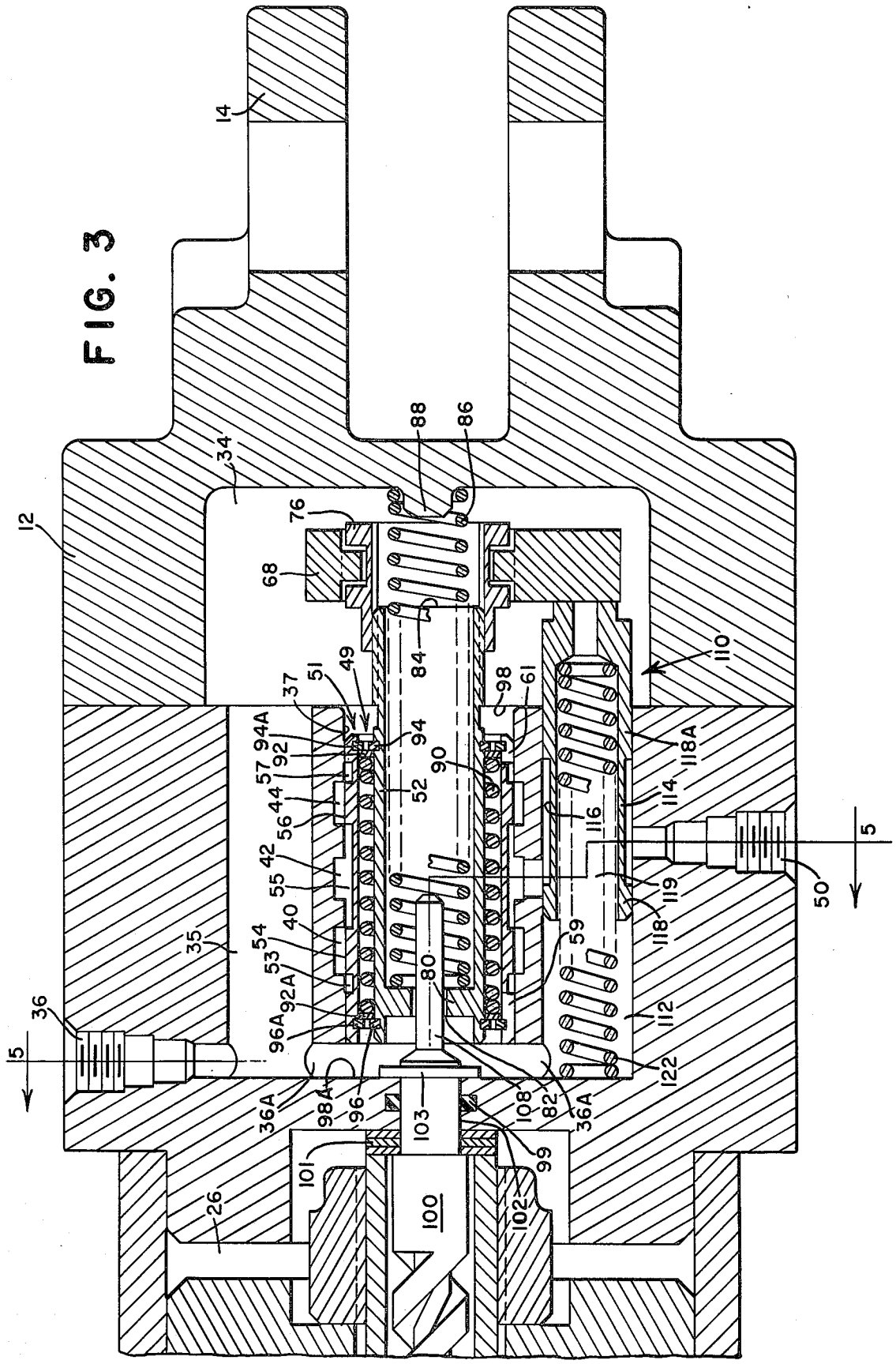
FIG. 2

FIG. 3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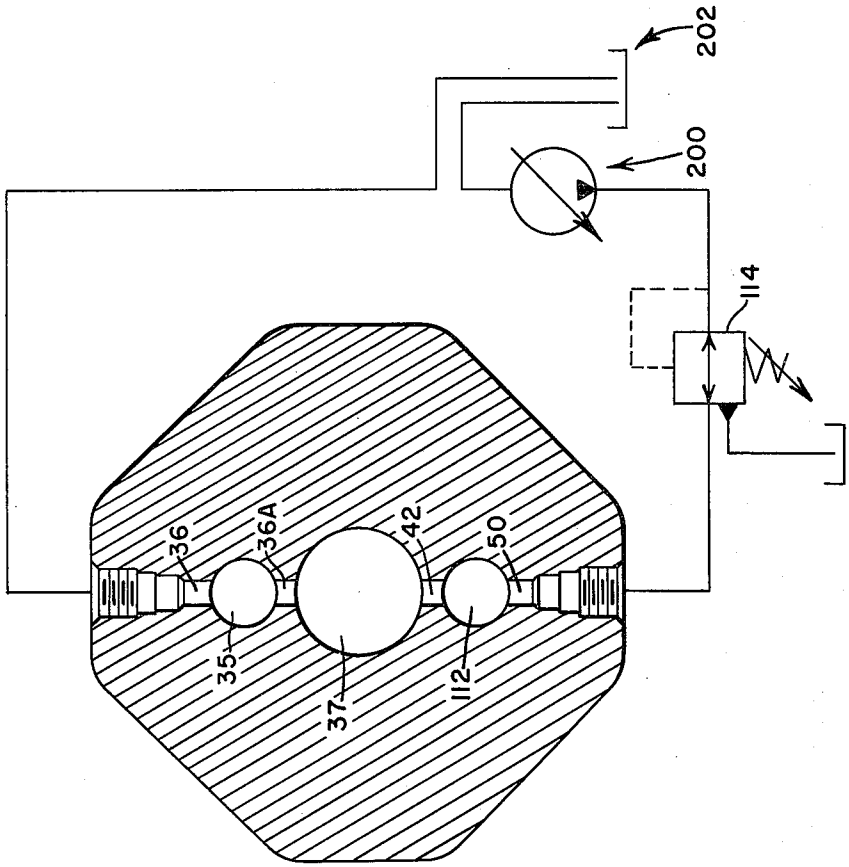

FIG. 5

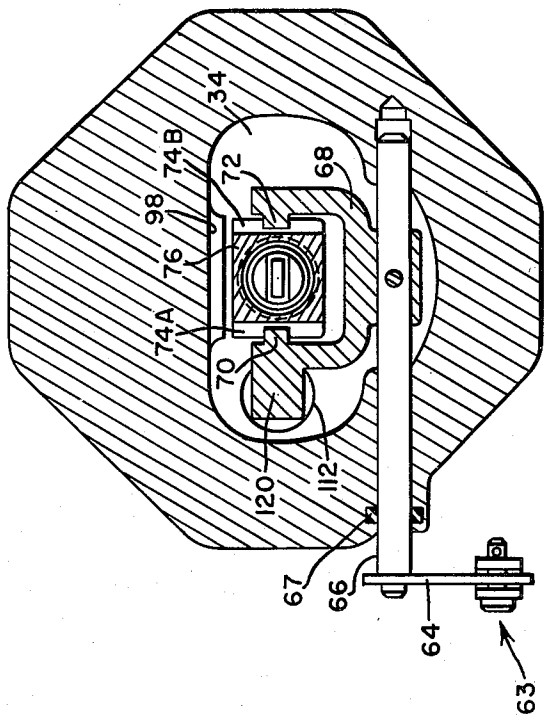

FIG. 4

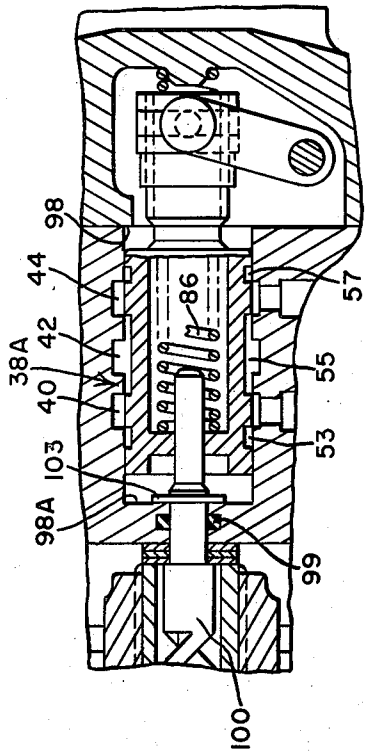

FIG. 6

POSITION-RESPONSIVE HYDRAULIC CYLINDER

BACKGROUND OF THE INVENTION

The present invention relates generally to hydraulic cylinders and more specifically to a position-responsive hydraulic cylinder having an integral feed back means and integral control and float valves.

Previously position-responsive hydraulic cylinders were developed which made use of spring-type feedback means as shown in U.S. Pat. No. 2,966,891 to J. G. Williams and U.S. Pat. No. 3,511,134 to R. A. Wittren. These feedback means were complex in that adjustments were required for controlling spring tension versus control fluid pressure loading against a flexible diaphragm.

In addition, spring feedback means are inherently unstable under high speed operation over long rod extensions due to surging of the spring which will cause control valve flutter and may interfere with the proper operation of the cylinder.

SUMMARY OF THE INVENTION

It is a general object of this invention to present a position-responsive hydraulic cylinder having an integral valve and direct mechanical feedback means not subject to flutter wherein the position of the control lever is directly proportional to the length of rod extension.

The above is accomplished by enclosing within a cylinder body a bi-directional movable piston and rod assembly and an integral three position four-way control valve for positioning the rod. By moving a control lever, the operator can move the control valve to either side of a neutral position to feed fluid to the cylinder chambers so as to cause movement of the rod in either direction. A feedback means including a member having a threaded engagement with the piston and rod assembly is directly coupled to the control valve and returns it to the neutral position when the desired rod setting is obtained.

It is a subsidary object to provide a position-responsive cylinder wherein at least at one position of the control lever, the rod can be freely moved. This is accomplished through the use of a float valve which, upon adjustment of the control lever, is moved to connect either the source or the reservoir to the control valve; the former connection allowing position responsiveness and the latter allowing the position of the rod to the dependent on external forces on the rod.

The above and additional objectives and advantages of the invention will become apparent to those skilled in the art from a reading of the following detailed description when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a side view of the position-responsive hydraulic cylinder of this invention.

FIG. 2 is a cross-sectional view of the hydraulic cylinder of this invention.

FIG. 3 is a cross-sectional view of a portion of the hydraulic cylinder of this invention taken along line 3—3 of FIG. 2.

FIG. 4 is a cross-sectional view of the hydraulic cylinder of this invention taken along 4—4 of FIG. 2.

FIG. 5 is a cross-sectional view of the porting of the integral valves of this invention taken along line 5—5 of FIG. 3, and also illustrates a schematic hydraulic system in which the cylinder could be used.

FIG. 6 is a partial cross-sectional view similar to FIG. 3 of a portion of the hydraulic cylinder in an alternate embodiment of this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

During the detailed description of the preferred embodiment, reference to the front end of the cylinder shall mean the end on the left-hand side of the views shown in FIGS. **1,2,3,** and **6.** Similarly, the rear end of the cylinder shall mean the end on the right-hand side of the views shown in these drawings.

Referring now to FIGS. **1** and **2,** the position-responsive hydraulic cylinder **10** of this invention is shown. The cylinder **10** includes a housing **12** having on the rear end an attaching yoke **14** for attaching the cylinder to a supporting structure such as the rear of an agricultural tractor (not shown). Slidably received within housing **12** is a piston **24** and rod **16** assembly having a yoke **18** affixed to its forward end for accepting and carrying and end member such as a tractor-drawn plow (not shown). A cantilever arm **20** rigidly fastened to yoke means **18** is slidably received in a bracket **21** mounted on housing **12** in order to prevent relative rotative movement between housing **12** and rod **16.** Also, by impressing on arm **20** indicia **23** a visual indication of the position of rod **16** with respect to housing **12** can be obtained.

Referring now to the cross-sectional views of FIGS. **2** through **5,** the internal working components of this invention are clearly shown. Rod **16** has secured to the rear end thereof, by retaining means **22,** the piston **24** which divides housing **12** into first and second chambers **26** and **28,** respectively. Appropriate sealing means **30** prevents leakage between the chambers, and the forward end of the housing **12** contains sealing O ring **32** and rod sealing means **33** to prevent leakage of the hydraulic fluid from chambe **28.**

In addition to chambers **26** and **28,** housing **12** also includes a cavity **34** to the rear of chamber **26.** Cavity **34** communicates with a reservoir **202** of a conventional hydraulic fluid system through a bore **35** and a reservoir connected port **36.** Received within a control valve bore **37** and axially in line with rod **16** is a control valving means or three position four-way control valve **38** for selectively controlling the flow of fluid into and from chambers **26** and **28.** In the wall defining bore **37** are a plurality of spaced apart annular grooves which comprise the working ports for valve **38** and which are designated as first port **40,** second port **42** and third port **44.** Port **40** is connected through a passage **48** to chamber **26,** and port **44** is connected through a passageway **46** to chamber **28.** Port **42** is connected through a port **50** to a remote hydraulic pressure source **200** such as a hydraulic pump.

Valve **38** includes an outer porting means **51** which is slidable in a direction parallel to the longitudinal axis of the cylinder and is stoppable by a first stop means or bore bottom **98A** in the forward direction and a second stop means or cavity shoulder **98** in the rearward direction. Concentrically arranged on porting means **51** are spaced apart annular lands **54** and **56** defined on each side by grooves **53, 55** and **57.** Grooves **53** and **57** com-

municate with the reservoir through respective slots **59** and **61** which communicate with a passageway **36A** to port **36** and with cavity **34**, respectively. Lands **54** and **56** are constructed to block off ports **40** and **44** from port **42** in the neutral position. Rearward movement of porting means **51** establishes a fluid communication between ports **42** and **44** to permit pressurized fluid to flow into chamber **28** while port **40** is connected to the reservoir through groove **52** and slot **59**. Similarly, forward movement of porting means **51** establishes a fluid communication between ports **42** and **40** to permit pressurized fluid to flow into chamber **26** while port **44** is open to the reservoir through groove **57** and slot **61**.

Axially received within porting means **51** and interconnected to an inner overtravel means **52**, which will hereinafter be described, is an interconnecting means **49** comprising a helical spring **90** interposed therebetween and held by retaining means comprising the cooperation of washers **92** with rings **94** and **94A** and washer **92A** with rings **96** and **96A**. The rings are positioned in grooves provided in each end of porting means **51** and overtravel means **52**. Each end of spring **90** bears against one of the washers and the washers in turn bear against the retaining rings. This interconnection permits common movement of porting means **51** and overtravel means **52** to a predetermined distance in the rearward direction until porting means **51** abuts shoulder **98** and the movement of portion means **51** is abrogated, but overtravel means **52** is permitted to continue movement until a nut **76** attached to the overtravel means **52** abuts the rear wall of cavity **34**. In the forward direction, portion means **51** and overtravel means **52** will both be stopped by bore bottom **98A**.

Tubular overtravel means **52** which is axially received within the interconnecting means **49** includes a closed forward end **80** having therein an oblong aperture **82** and an open rearward end **84** wherein a biasing means or compression spring **86** may be interposed within the interior of overtravel means **52** to extend from closed end **80** to a positioning means **88** on the rear wall of cavity **34**. Compression spring **86** serves to take up manufacturing tolerances, eliminate free play between valve **38** and a selector means **63** and the nut **76**, both of which will hereinafter be described, and permit a control cable **62**, included in the selector means **63**, to act only in response to tensile positioning commands.

On the rear end of overtravel means **52** is an externally threaded portion which is readedly engaged with internally threaded nut **76**. Nut **76** has two slots **74A** and **74B** in opposite sides into which lugs **70** and **72** of a bifurcated arm member **68** slidably protrude. Member **68** is fixed to a pivot shaft **66** which is pivotally carried by housing **12** with a seal **67** and protrudes therefrom to the exterior of cylinder **10**. Affixed to shaft **66** exterior to housing **12** and fixed relative to member **68** is a crank arm **64** which is a portion of the selector means **63**, as shown in FIG. **1**. Arm **64** is actuated by means of the control cable **62** which is operatively connected with a further portion of the selector means **63** consisting of a control lever **58** and a quadrant **60** for operation by the operator.

When repositioning of rod **16** is desired, movement of control lever **58** from the old position to a new position causes pivotation of shaft **66** and movement of member **68**, through cable **62** and arm **64**, to cause longitudinal movement of nut **76**. Since overtravel means **52** is threadedly engaged to nut **76**, it will move longitudinally as will the interconnecting means **49** and porting means **51**. Thus, as valve **38** moves longitudinally, lands **54** and **56** will move so as to affect communication of the source through port **42** with either port **40** or **44** depending upon the direction of travel, while connecting the other port to the reservoir through groove **53** or groove **57** thereby causing rod **16** to either extend or retract towards the new position.

If the movement of control lever **58** is so great that port **42** will be blocked off by axial movement of porting means **51**, overtravel means **52** operates to prevent this. Porting means **51** will be stopped by shoulder **98** before port **42** is blocked and overtravel means **52** continues to move axially rearward, and relative movement between porting means **51** and overtravel means **52** will be permitted by the compression of spring **90** of interconnecting means **49**. Overtravel means **52** in conjunction with interconnecting means **49** permits full range adjustment of control lever **58** without requiring sequential stepping through intermediate settings.

Once the desired new position of rod **16** has been obtained, the source must be disconnected, and this is done automatically by feedback means **100** rotatably carried by a journal **102** containing a sealing O-ring **99** provided in housing **12** between the chamber **26** and bore **37**. Feedback means **100** has forward of journal **102**, a threaded portion **104** which threadedly engages actuation means or pins **106** carried by rod **16**. As rod **16** is extended or retracted, this longitudinal movement induces rotary movement of feedback means **100**. Retaining means or snap ring **103** prevents forward longitudinal movement and thrust washers **101** may be added to eliminate longitudinal movement and thrust of the feedback means **100**. Rearward of journal **102**, feedback means **100** includes a projecting pintle **108** having a shape mating with and passing through the oblong aperture **82** in end **80** of overtravel means **52**. Thus, rotary movement of feedback means **100** induces rotary movement of overtravel means **52**. Since nut **76** is nonrotatably held by member **68**, the threaded engagement induces longitudinal movement of valve **38** which returns to the neutral position.

With feedback means **100** cylinder **10** is completely position repsonsive to the operator's command signal. In effect the position of control lever **58** indicates and is directly proportional to the position of rod **16**. In addition cylinder **10** automatically compensates for fluid seepage between the chambers **26** and **28** or between the valve ports because such seepage results in changes in rod **16** position which rotates feedback means **100** causing valve **38** to move longitudinally and place the proper ports in communication with source or reservoir as necessary to compensate for the seepage. As the seepage is replaced rod **16** will move back to its original position causing feedback means **100** to counterrotate and bring valve **38** back into the neutral position. Further, feedback means **100** permits the cylinder **10**, when used in conjunction with a pressure regulating valve **114** to provide a constant output load at rod **16**; in effect the cylinder **10** becomes a constant force generator at any rod position.

With the addition of a float valving means or float valve **110**, the cylinder **10** can be placed in a free float condition wherein both chambers **26** and **28** are connected to the reservoir and hence, rod **16** can be freely extended or retracted by application of exterior force

on rod 16. Float valve 110 is interposed between port 50 and port 42 as can be seen from the cross-sectional views of FIGS. 4 and 5 and is slidably received within a valve bore 112 connected by passageway 36A to the reservoir, and further is urged against member 68 for movement therewith by a biasing means or spring 122. It has an annular groove 116 bordered on its ends by lands 118 and 118*a*, and an internal passageway 119 establishing communication between bore 112 and cavity 34. Annular groove 116 is of sufficient longitudinal length to normally allow fluid communication between port 42 and port 50 which are offset longitudinally from each other; however, when control lever 58 is extended to a minimum rod extension position, float valve 110 moves rearward so that land 118 blocks off communication between port 50 and port 42, and port 42 connects to bore 112 and through crosshole 36A to the reservoir. Since valve means 51 would be moved rearwardly to connect port 40 to groove 53, in this position both chambers 26 and 28 are open to the reservoir allowing rod 16 to be freely adjustable by application of exterior force on the rod 16.

The operation of this invention commences with the operator selecting a length to which he wishes rod 16 to retract or extend by positioning control lever 58. This movement of control lever 58 causes pivotation of shaft 66 and movement of member 68 through an arc which causes lugs 70 and 72 to push against nut 76 which in turn moves in either a forward or rearward direction as does valve 38. This motion of valve 38 allows pressurized fluid from the source to flow to either chamber 26 or 28, while fluid in the other chamber is exhausted to the reservoir. As rod 16 begins to extend or retract, feedback means 100 commences to rotate, causing valve 38 to rotate and threadedly engage or disengage from nut 76 and hence move longitudinally with respect thereto. When rod 16 has reached its desired position, the valving means 38 will have longitudinally moved a sufficient distance to be in the neutral position and ports 40 and 44 will be blocked off from the source connected port 42.

When the operator desires to put the cylinder in a float position, he adjusts control lever 58 to the float position, less than a minimum rod extension position, causing member 68 to pivot fully in one direction and float valve 110 to be urged by spring 122 fully in the one direction and communication between the reservoir and port 42 to occur. Consequentially, the chamber in communication with port 42 will be connected with the reservoir and simultaneously the other chamber also will be in communication with the reservoir through either groove 53 or 57, and rod 16 can then be freely moved by pulling or pushing on it relative to housing 12.

In another preferred embodiment, the amount of adjustment of control lever 58 is made to match exactly, the amount of travel of valve 38A as shown in FIG. 6, which would eliminate the need for the overtravel means 52 and interconnecting means 49. The same numbers as in prior figures refer to the same parts in this embodiment.

Thus, it is apparent that there has been described a position-responsive hydraulic cylinder which fully satisfies the objects, aims and advantages set forth above. While the invention has been described in conjunction with specific embodiments thereof it is evident that many alternatives, modifications and variations will be apparent to those skilled in the art in light of the foregoing description. Accordingly, it is intended to embrace all such alternatives, modifications, and variations that fall within the spirit and scope of the appended claims.

We claim:

1. A position-responsive hydraulic cylinder for use in a hydraulic system including a source of fluid pressure and a fluid reservoir, said hydraulic cylinder comprising: a cylinder body having a longitudinal bore; a piston and rod assembly slidably mounted in the bore to form an expandable pressure chamber therewith, and extending from one end of the cylinder body; valving means mounted in the cylinder body at the end thereof opposite from the one end and movable to either side of a neutral position to selectively connect the chamber with the source or reservoir; selector means operatively associated with the valving means to effect the position thereof; float valving means slidable within the cylinder body and interposed between the source and the valving means and positionable by the selector means to disconnect the source and connect the reservoir to the valve means; feedback means operatively associated with the valving means and the piston and rod assembly responsive to movement of the piston and rod assembly to a position selected by the position of the selector means to move the valving means to the neutral position; the feedback means including a member having a threaded engagement with the piston and rod assembly rotatable upon movement of the piston and rod assembly and connected to the valving means to move the valving means to a neutral position upon rotation.

2. A position-responsive hydraulic cylinder as claimed in claim 1 wherein the piston and rod assembly is provided with a longitudinal bore in the rod closed at one end and open at the other; and the member having a threaded engagement with the piston and rod assembly extends into the bore in the rod and is movable rotatably with respect to and in response to the movement of the piston and rod assembly.

3. A position-responsive hydraulic cylinder as claimed in claim 1 including biasing means for urging the valving means against the selector means.

4. A position-resonsive hydraulic cylinder as claimed in claim 1 still further including biasing means for urging the float valving means against the selector means.

5. A position-responsive hydraulic cylinder as claimed in claim 4 wherein the float valving means abuts the member movably carried by the cylinder body.

6. A position-responsive hydraulic cylinder as claimed in claim 1 wherein said selector means includes a nut threadedly engaged with the valving means and nonrotatably interconnected with a member movably carried in the cylinder body such that movement of the member induces longitudinal movement of the nut, and a control lever interconnected to said member for causing movement thereof.

7. A position-responsive hydraulic cylinder as claimed in claim 1 wherein said valving means includes porting means slidable and stoppable by first and second stop means in the cylinder body and operatively associated with overtravel means; said overtravel means being axially received within and separated from the porting means by interconnecting means for relative axial movement therebetween.

8. A position-responsive hydraulic cylinder as claimed in claim 7 wherein said interconnecting means between the porting means and overtravel means is a spring interposed therebetween with retaining means contiguous to at least one end of said spring; said retaining means having first annular stop means affixed to the overtravel means and second annular stop means affixed to the porting means and aligned with the first annular stop means; said retaining means further having an annular ring interposed between the spring and the first and second stop means.

9. A position-responsive hydraulic cylinder for use in a hydraulic system including a source of fluid pressure and a fluid reservoir, said hydraulic cylinder comprising: a cylinder body having a longitudinal bore; a piston and rod assembly slidably mounted in the bore to form an expandable pressure chamber therewith, and extending from one end of the cylinder body; valving means mounted in the cylinder body at the end thereof opposite from the one end and movable to either side of a neutral position to selectively connect the chamber with the source or reservoir; selector means operatively associated with the valving means to effect the position thereof; said selector means includes a nut threadedly engaged with the valving means and nonrotatably interconnected with a member movably carried in the cylinder body such that movement of the member induces longitudinal movement of the nut, and a control lever interconnected to said member for causing movement thereof; and feedback means operatively associated with the valving means and the piston and rod assembly responsive to movement of the piston and rod assembly to a position selected by the position of the selector means to move the valving means to the neutral position; said feedback means including a member having a threaded engagement with the piston and rod assembly rotatable upon movement of the piston and rod assembly and connected to the valving means to move the valving means to a neutral position upon rotation.

10. A position-responsive hydraulic cylinder for use in a hydraulic system including a source of fluid pressure and a fluid reservoir, said hydraulic cylinder comprising: a cylinder body having a longitudinal bore; a piston and rod assembly slidably mounted in the bore to form an expandable pressure chamber therewith, and extending from one end of the cylinder body; valving means mounted in the cylinder body at the end thereof opposite from the one end and movable to either side of a neutral position to selectively connect the chamber with the source or reservoir; said valving means includes porting means axially slidable between first and second stop means in the cylinder body and operatively associated with overtravel means; said overtravel means being axially received within and separated from the porting means by interconnecting means for axial movement greater than the distance between said first and second stop means; selector means operatively associated with the overtravel means to effect the position of the valving means; and feedback means operatively associated with the overtravel means and the piston and rod assembly responsive to movement of the piston and rod assembly to a position selected by the position of the selector means to move the valving means to the neutral position; said feedback means including a member having threaded engagement with the piston and rod assembly rotatable upon movement of the piston and rod assembly and connected to the overtravel means to move the valving means to a neutral position.

11. A position-responsive hydraulic cylinder as claimed in claim 10 wherein the interconnecting means between the porting means and overtravel means is a spring interposed therebetween with retaining means contiguous to at least one end of said spring; said retaining means having a first annular stop means affixed to the overtravel means and a second annular stop means affixed to the porting means and aligned with the first annular stop means; said retaining means further having an annular ring interposed between the spring and the first and second stop means.

12. A position-responsive hydraulic cylinder for use in a hydraulic system including a source of fluid pressure and a fluid reservoir, said hydraulic cylinder comprising: a cylinder body having a longitudinal bore; a piston and rod assembly slidably mounted in the bore to form inner and outer expandable pressure chambers therewith, and extending from one end of the cylinder body; valving means mounted in the cylinder body at the end thereof opposite from the one end and movable to either side of a neutral position to selectively connect one of the chambers to the source and the other chamber to the reservoir; selector means operatively associated with the valving means to effect the position thereof; float valving means slidable within the cylinder body and interposed between the source and the valving means and positionable by the selector means to disconnect the source and connect the reservoir to the valving means; and feedback means operatively associated with the valving means and the position and rod assembly responsive to movement of the piston and rod assembly to a position selected by the position of the selector means to move the valving means to the neutral position; said feedback means including a member having a threaded engagement with the piston and rod assembly rotatable upon movement of the piston and rod assembly and connected to the valving means to move the valving means to the neutral position upon rotation.

13. A position-responsive hydraulic cylinder as claimed in claim 12 wherein the position and rod assembly is provided with longitudinal bore in the rod closed at one end and open at the other; the member having a threaded engagement with the piston and rod assembly extends into the bore in the rod and is movable rotatably with respect to and in response to the movement of the piston and rod assembly.

14. A position-responsive hydraulic cylinder as claimed in claim 12 including biasing means for urging the valve means against the selector means to take up tolerance accumulations and eliminate free play.

15. A position-responsive hydraulic cylinder as claimed in claim 12 still further including a biasing means for urging the float valving means against the selector means.

16. A position-responsive hydraulic cylinder as claimed in claim 15 wherein the float valving means abuts the member movably carried by the cylinder body.

17. A position-responsive cylinder as claimed in claim 12 wherein said selector means includes a nut threadedly engaged with the valving means and nonrotatably interconnected with a member carried in the cylinder body such that movement of the member thereof induces longitudinal movement of the nut, and

a control lever interconnected to said member for causing movement thereof.

18. A position-responsive hydraulic cylinder as claimed in claim **12** wherein said valving means includes porting means slidable and stoppable by first and second stop means in the cylinder body and operatively associated with overtravel means; said overtravel means being axially received within and separated from the porting means by interconnecting means for relative axial movement therebetween.

19. A position-responsive hydraulic cylinder as claimed in claim **18** wherein said interconnecting means between the porting means and overtravel means is a spring interposed therebetween with a retaining means contiguous to at least one end of said spring; said retaining means having first annular stop affixed to the porting means and aligned with the first annular stop means, said retaining means further having annular ring interposed between the spring and the first and second stop means.

20. A position-responsive hydraulic cylinder for use in a hydraulic system including a source of fluid pressure and a fluid reservoir, said hydraulic cylinder comprising: a cylinder body having a longitudinal bore; a piston and rod assembly slidably mounted in the bore to form inner and outer expandable pressure chambers therewith, and extending from one end of the cylinder body; valving means mounted in the cylinder body at the end thereof opposite from the one end and movable to either side of a neutral position to selectively connect one of the chambers to the source and the other chamber to the reservoir; selector means operatively associated with the valving means to effect the position thereof; said selector means includes a nut threadedly engaged with the valving means and nonrotatably interconnected with a member carried in the cylinder body such that movement of the member thereof induces longitudinal movement of the nut, and a control lever interconnected to said member for causing movement thereof; and feedback means operatively associated with the valving means and the piston and rod assembly responsive to movement of the piston and rod assembly to a position selected by the position of the selector means to move the valving means to the neutral position; said feedback means including a member having a threaded engagement with the piston and rod assembly rotatable upon movement of the piston and rod assembly and connected to the valving means to move the valving means to the neutral position upon rotation.

21. A position-responsive hydraulic cylinder for use in a hydraulic system including a source of fluid pressure and a fluid reservoir, said hydraulic cylinder comprising: a cylinder body having a longitudinal bore; a piston and rod assembly slidably mounted in the bore to form inner and outer expandable pressure chambers therewith, and extending from one end of the cylinder body; valving means mounted in the cylinder body at the end thereof opposite from the one end and movable to either side of a neutral position to selectively connect one of the chambers to the source and the other chamber to the reservoir; said valving means includes porting means axially slidable between first and second stop means in the cylinder body and operatively associated with overtravel means, said overtravel means being axially received within and separated from the porting means by interconnecting means for axial movement greater than the distance between said first and second stop means; selector means operatively associated with the overtravel means to effect the position of the valving means; and feedback means operatively associated with the overtravel means and the piston and rod assembly responsive to the movement of the piston and rod assembly to a position selected by the position of the selector means to move the valving means to the neutral position; said feedback means including a member having a threaded engagement with the piston and rod assembly rotatable upon movement of the piston and rod assembly and connected to the overtravel means to move the valving means to a neutral position upon rotation.

22. A position-responsive hydraulic cylinder as claimed in claim **21** wherein the interconnecting means between the porting means and overtravel means is a spring interposed therebetween with a retaining means contiguous to at least one end of said spring; said retaining means having a first annular stop affixed to the porting means and aligned with the first annular stop means, said retaining means further having an annular ring interposed between the spring and the first and second stop means.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,913,449 Dated 21 October 1975

Inventor(s) James Allan Koch et al

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 6, line 44, change "resonive" to --responsive--;

Column 8, line 32, change "position" to --piston--;
line 43, change "position" to --piston--.

Signed and Sealed this

Tenth Day of August 1976

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks