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Neuman

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[54] **PISTON CYLINDER ASSEMBLY**

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[51] **Int. Cl.** **F15b 15/22**

[58] **Field of Search** 92/85; 91/394, 395, 396, 91/409, 408, 404, 26, 25, 24, 318

[56] **References Cited**

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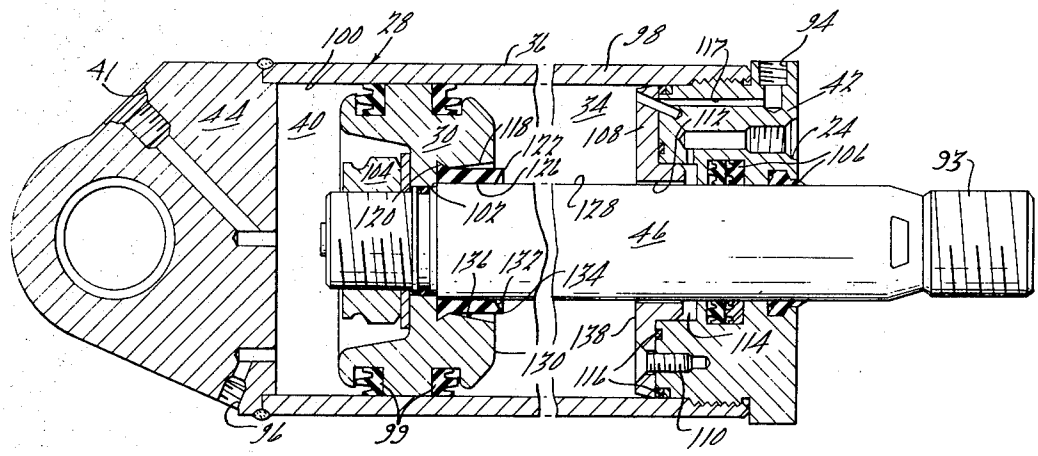
[57] **ABSTRACT**

A hydraulic circuit for use in a lift truck having a valve responsive to a difference in the pressures of the fluids on opposite sides of the piston of a piston cylinder assembly. The valve is spring-biased to a first position and movable to a second position when the fluid pressure on one side of a spool within the valve exceeds the fluid pressure on the opposite side of the spool by a value in excess of the value of the force of the spring. The spool, when in its second position, prevents a flow of fluid to one side of the piston. The piston cylinder assembly has a rod connected to one side of the piston and extending out of the cylinder. The rod and cylinder define therebetween an annular fluid transfer passage. An annular seal is connected to the piston and designed to encompass and seal the annular passage when the piston is adjacent the end of the cylinder in which the annular passage is located. The annular passage is sealed to entrap a quantity of fluid between the piston and cylinder to prevent direct contact therebetween. Additional passages communicate the fluid on each side of the piston to the opposite sides of the spool.

7 Claims, 2 Drawing Figures



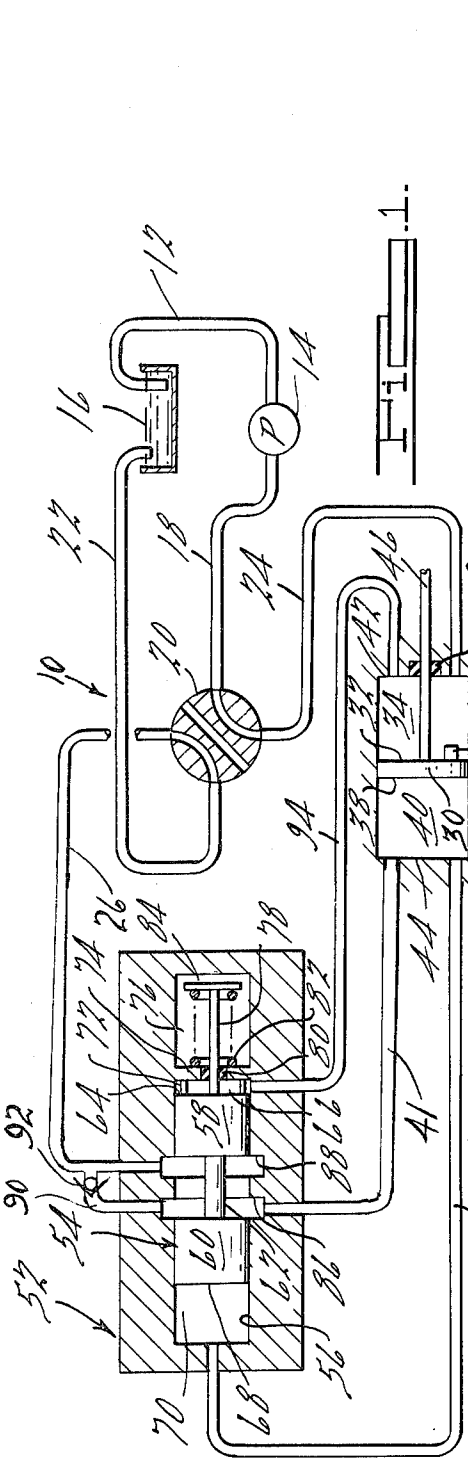


Fig. 1.

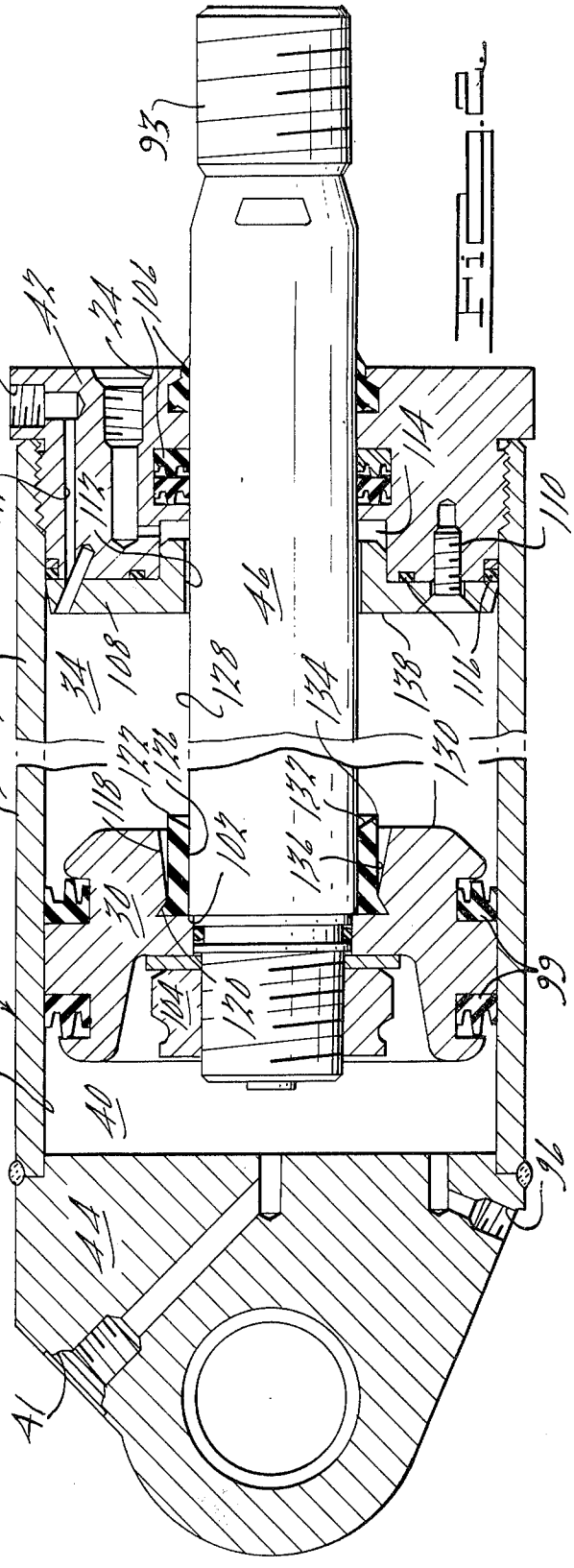


Fig. 2.

PISTON CYLINDER ASSEMBLY

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates generally to an overload protection device for use on vehicles and, more particularly, to a piston cylinder assembly for use on such vehicles.

2. Description of the Prior Art

The problem of preventing vehicles, such as lift trucks, from overturning has been investigated by a number of individuals, see, for example, U.S. Letters Pat. No. 2,774,437 (Remde), 2,767,394 (Arnot et al.), and 3,059,710 (Pien). Several individuals have made use of the fact that the force tending to overturn the lift truck is related to the force exerted on the push rod of one of the piston cylinder assemblies used to tilt the mast. One concept carries this fact further to show that the force on the push rod is directly related to the difference in the pressures of the fluids in the cylinder on opposite sides of the piston in the given piston cylinder assembly. In making use of this concept, the fluid pressures on each side of the piston are transmitted to a pressure responsive valve which prevents further tilting when the moment tending to overturn the lift truck approaches an unsafe value. This concept is set out in U.S. Letters Pat. No. 3,007,593 (Hancock). In order to effectively use the difference in pressure concept, a pressure, other than zero, must be transmitted from the side of the piston having the greatest fluid pressure. Hancock fails to recongize this fact in that the piston of Hancock may contact the end of the cylinder during tilting of the mast causing the fluid pressure from that side of the piston to become zero thereby making the pressure responsive valve ineffective.

SUMMARY OF THE INVENTION

The present invention has application to devices such as a counterbalanced vehicle having a mast, boom, arm or other primary load member movable relative to a frame by a piston cylinder assembly interconnecting the primary load member and the frame and means operative to sense the difference in pressure on opposite sides of the piston and transmit this differential pressure signal to a suitable device to preclude further movement of the piston relative to the cylinder.

According to a feature of the invention, the rod of the piston cylinder assembly, as it projects through one end of the cylinder, defines therewith an annular passage encircling the rod and communicating with the exterior of the cylinder and the chamber in the cylinder at the rod side of the piston, and means is provided to seal the annular passage when the piston is near the one end of the cylinder to entrap fluid between the piston and the one end of the cylinder and prevent contact therebetween thereby insuring that a positive pressure signal is available from that side of the piston for transmittal to the pressure sensing means. An annular resilient seal, which encircles the rod, is secured to the one side of the piston and projects toward the one end of the cylinder beyond the piston to encompass and seal the annular opening when the piston approaches the one end of the cylinder.

According to another feature of the invention the annular passage of the piston cylinder assembly is adapted to be connected to a fluid receiving passage in a fluid circuit, and another passage, that is always in communication with the exterior of the cylinder and the fluid in the chamber at the rod end, is provided in the cylinder for transmitting a pressure signal to the pressure sensing means; the other passage and the annular passage form separate and distinct passages from the chamber at the rod end of the cylinder to the exterior of the cylinder.

BRIEF DESCRIPTION OF THE DRAWINGS

A preferred embodiment of the invention is disclosed in the accompanying drawings, wherein:

FIG. 1 is a schematic plan view of a hydraulic circuit embodying a piston cylinder assembly according to the invention; and

FIG. 2 is a side elevational view, in section, of one-half of a piston cylinder assembly according to the invention.

DETAILED DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates a hydraulic circuit **10** having a conduit **12** interconnecting a pump **14** and a reservoir **16.** A conduit **18** connects pump **14** to a port of selector control **20.** Another port of selector control **20** is connected to reservoir **16** via conduit **22.** Conduits **24** and **26** are also connected to ports of selector control **20.** Selector control **20** is operative upon movement to: connect conduit **18** to conduit **26** and conduit **22** to conduit **24**; connect conduit **18** to conduit **24** and conduit **22** to conduit **26**; and connect conduit **18** to conduit **22.**

A piston cylinder assembly **28** has a piston **30** having an annular side **32** partially defining a first chamber **34** in cylinder **36** and a full area side **38** partially defining a second chamber **40** in the cylinder. Conduits **24** and **41,** respectively, communicate with first and second chambers **34** and **40** through first and second end portions **42** and **44.** A push rod **46** is connected to annular side **32** of piston **30** and projects out of first end **42** of cylinder **36** through seal **48.** A resilient seal **50** is secured to and projects away from annular side **32** of piston **30.** When piston **30** arrives at a position proximate first end **42,** seal **50** seals conduit **24** and thereby prevents fluid from flowing from first chamber **34** to conduit **24.**

A valve **52** includes a spool **54** that is movable between a first and second position in a generally cylindrical cavity **56.** Spool **54** includes a pair of end portions **58** and **60** that are rigidly interconnected by a reduced section **62.** The end portions are in sliding engagement with the cylindrical wall of cavity **56.** End portion **58** has an annular side **64** partially defining first chamber **66** in cavity **56** while end portion **60** includes a full area side **68** partially defining second chamber **70** in cavity **56.** A pair of axially spaced annular spaces **86** and **88** are located intermediate chambers **66** and **70.** Projections **72** are secured to annular side **64** and adapted to contact one surface of a wall **74** that separates chamber **66** from a spring cavity **76** that is located in valve **52.** A rod **78** is secured at one end to end portion **58** and projects through an opening in wall **74** into spring cavity **76.** An annular seal **80** encircles rod **78** and separates the environment of chamber **66** from that of spring cavity **76.** A compression spring **82,** under load, encircles rod **78** in spring cavity **76** and has one end contacting a surface of wall **74** and another end contacting a circular disk **84** that is secured to the other end of rod **78.**

Spool 54 is illustrated in FIG. 1 in its first position. Annular spaces 86 and 88 communicate with one another via the annular space around center section 62. Movement of spool 54 to the second position results in the cylindrical surface of end portion 58 sealing annular spaces 86 and 88 from one another. Conduits 26 and 41, respectively, communicate with annular spaces 86 and 88. Spool 54 acts as a valve to allow fluid to flow from conduit 26 around center section 62 to conduit 41 when spool 54 is located in its first position and to prevent fluid from flowing from conduit 26 around center section 62 to conduit 41 when spool 54 is located in its second position. Another conduit 90 communicates with annular space 86 and conduit 26. A one-way check valve 92 located in conduit 90 allows to flow only from annular space 86 to conduit 26.

The pressures of the fluids in chambers 34 and 40 are transmitted via conduits 94 and 96, respectively, to chambers 66 and 70. The ratio of the area of annular side 32 to the area of full area side 38 of piston 30 is equal to the ratio of the area of annular side 64 to the area of full area side 68 of spool 54. Movement of spool 54 is governed by the preload and rate of spring 82 and the difference in the pressures of the fluids in chambers 34 and 40. The preload of the spring is governed by the maximum tensile force desired on rod 46 prior to the beginning of movement of spool 54 from its first to its second position and the rate of the spring is governed by the incremental pressure rise desired at full open to full closed position of spool 54.

When the force exerted on the annular side 64 by the pressure of the fluid in chamber 66 exceeds the combined force exerted by the pressure of the fluid in chamber 70 on full area side 68 and the preload of spring 82 spool 54 begins to move to the left in FIG. 1 toward its second position. As the force on annular side 64 increases relative to the force on full area side 68, a point is reached when end portion 58 seals annular space 86 from annular space 88.

If piston 30 contacted first end 42 of cylinder 36 the force exerted on annular side 32 would be transmitted directly to the first end thereby causing the pressure of the fluid in chamber 34 to become zero. In such an instance spool 54 would become unresponsive to the tensile force exerted on rod 46 since the pressure of the fluid in chamber 66 would also be zero. Seal 50 prevents this from happening by sealing passage 24 and entrapping a quantity of fluid between piston 30 and first end 42. The seal is resilient to prevent a noticeable transmittal of force from the piston to the first end. By entrapping a quantity of fluid between the piston and the first end, increases in the tensile force on rod 46 will result in corresponding increases in the pressure of the fluid in chamber 34 and accordingly increases in the pressure of the fluid in chamber 66.

Looking now at FIG. 2, piston cylinder assembly 28 is illustrated in detail and includes an annular body portion 98 defining a cavity 100 that is enclosed by first and second ends 42 and 44. Piston 30 is in sliding engagement with the inner cavity defining surface of body portion 98 and includes resilient seals 99 for preventing fluid flow between chambers 34 and 40. Push rod 46 has a shoulder 102 in abutting engagment with piston 30. A nut 104 in in threaded engagement with rod 46 to secure the rod and piston together. A number of resilient seals 106 mounted in first end 42 encircle rod 46. First end 42 includes an annular plate 108 secured to the body portion of first end 42 by a number of screws 110, only one shown, that are circumferentially spaced around rod 46. An annular opening 112 in plate 108 defines an annular passage between rod 46 and plate 108 that communicates with chamber 34 and an annular cavity 114 in first end 42. Annular cavity 114 communicates with conduit 24. Annular seals 116 are located between plate 108 and the body portion of first end 42 to prevent fluid from flowing therebetween. Conduit 94 communicates with chamber 34 via a passage 117 through first end 42. As illustrated, in FIG. 2, passage 117 must be located in a position so that it is never sealed by piston 30.

On the annular side of piston 30 there is included an annular cavity 118 defined by the outer surface of frustum of a cone. Annular cavity 118 is concentric with rod 46 and diverges in cross-sectional are from left to right in FIG. 2. At the left-hand end of annular cavity 118 there is located an enlarge annular groove having an outer conical surface 120 diverging from right to left in FIG. 2 and beginning at the termination point of the surface defining annular cavity 118. A resilient annular seal 122 conforms to surface 120 and is in abutting engagement with the outer cylindrical surface 128 of rod 46 juxtaposition piston 30. The second end of annular seal 122 projects outwardly into chamber 34 away from the outermost surface 130 of piston 30 and includes a dish-shaped opening 132 converging outwardly from left to right in FIG. 2 and defined by the outer surface of a frustum of a cone. Dish-shaped opening 132 terminates at an outer circular edge 134. The diameter of outer circular edge 134 is greater than the diameter of annular opening 112 in plate 108. The outer cylindrical surface 136 of annular seal 122 is spaced from the defining surface of conical cavity 118.

In operation, selector control 20 is moved to communicate conduits 18 and 26 with one another and conduits 22 and 24 with one another. Fluid is thereby introduced into chamber 40 and removed from chamber 34 causing piston 30 to move to the right in FIG. 2. When piston 30 arrives at a position proximate end 42, outer edge 134 of seal 122 contacts surface 138 of plate 108 thus sealing annular passage 112 from chamber 34. When passage 112 is sealed fluid is no longer permitted to flow out of chamber 34 and further movement of piston 30 to the right in FIG. 2 will result only in an increase in pressure in chamber 34. Seal 122 is free to yield under the force of movement of piston 30 to the right and will eventually compress to conform in part to cavity 118. Due to the mass of material of seal 122 extending beyond surface 130 of piston 30 toward end 42, at no time will surface 130 of piston 30 contact surface 138 of cylinder 36. After seal 122 conforms in part to cavity 118 the remainder of seal 122 extending beyond surface 130 will compress between surfaces 130 and 138. During compression between surfaces 130 and 138 seal 122 tightly grips rod 46 due to the radial forces exerted by the pressure of the fluid in chamber 34. To cause piston 30 to move to the left in FIG. 2 selector control is moved to the position illustrated in FIG. 1. Fluid is forced through conduit 24 against seal 122. Seal 122 gives readily due to the reduced seal surface presented by dish-shaped opening 132 allowing fluid to enter chamber 34. Simultaneously, fluid in chamber 40 is free to flow to reservoir 16 via conduit 41 and either past center portion 62 or through check valve 92 into conduit 26.

The circuit of FIG. 1 may be used in the same manner as a portion of the circuit illustrated and described in U.S. Letters Pat. No. 3,007,593 (Hancock). For example, in FIG. 3 of Hancock, valve **52** of the disclosure can be substituted for valve **16** of Hancock and piston cylinder assembly **28** of the disclosure can be substituted for tilting jack **6** of Hancock. Other connections and substitutions will be obvious to those skilled in the art. Other uses for the circuit are also contemplated.

What is claimed is:

1. A fluid actuated piston cylinder assembly having a fluid supply passage and a fluid receiving passage, for use with a fluid circuit, comprising:

a housing having a body portion intermediate first and second end portions, the body and end portions defining together a cavity;

a piston within the cavity in sliding engagement with the body portion and dividing the cavity into first and second chambers, both chambers containing a fluid, the first chamber being partially defined by the first end portion;

a rod connected to the piston and extending out of the cavity through the first end portion, the first end portion and the rod defining therebetween an annular passage adapted to be the sole communication between the first chamber and the fluid receiving passage; and

a resilient member encircling the rod and having a first end engaging the piston and a second end projecting away from the piston towards the first end of the housing, the circumferential portion of the second end of the resilient member being of a size to encompass the annular passage and having a surface area normal to the axis of said resilient member that varies along the axis of said resilient member from a relatively small surface cross-sectional area at said second end to the full cross-sectional area of said resilient member at an axial position intermediate said first and second ends thereby presenting a sealing surface when abutting the first end portion of the cylinder which is substantially smaller in cross-sectional area than the total cross-sectional area of said resilient member;

whereby when the piston approaches a position proximate the first end the resilient member seals the annular passage entrapping a quantity of fluid between the piston and the fluid end, thereby ensuring that a fluid pressure is maintained within the first chamber.

2. A piston cylinder assembly according to claim **1** further comprising means defining a sensing passage in the housing communicating with the first chamber and the exterior of the housing, the sensing passage being located for communication with entrapped quantities of fluid.

3. A piston cylinder assembly according to claim **1** wherein said arrival responsive means is further operative to allow the flow of fluid from said fluid receiving passage to said first chamber when the differential pressure between said fluid receiving passage and said first chamber is a minor fraction of the absolute pressure in said first chamber.

4. A piston cylinder assembly comprising:

a housing having a body portion intermediate first and second end portions, the body and end portions together defining a cavity;

a piston within the cavity in engagement with the body portion and mounted for movement between the cavity defining surfaces of the end portions;

a rod connected to the piston and extending out of the cavity through the first end portion, the first end portion and the rod defining therebetween an annular passage in communication with the cavity and the exterior of the housing;

an annular resilient member encircling the rod and having first and second ends, with the first end engaging the piston, and the second end projecting away from the piston toward the first end portion to contact the cavity defining surface of the first end portion when the piston is located a given distance away from the first end portion, and having a cross-sectional area which encompasses the portion of the annular passage communicating with the cavity and having a surface area normal to the axis of said resilient member that varies along the axis of said resilient member from a relatively small surface cross-sectional area at said second end to the full cross-sectional area of said resilient member at an axial position intermediate said first and second ends to maintain a quantity of fluid between the piston and the first end portion upon contact between the second end of the resilient member and the first end portion to prevent direct contact between the piston and the first end portion and to form a minimal area seal encompassing said annular passage.

5. A piston cylinder assembly according to claim **4** wherein:

the piston defines an radially outwardly extending annular opening;

the resilient member is substantially cylindrical in configuration; and

the first end of the resilient member has an annular shoulder in mating engagement with the annular opening in the piston.

6. A piston cylinder assembly according to claim **4** wherein:

a dish-shaped opening is located within the second end of the resilient member;

the annular passage is circular; and

the second end has a circular outer edge having a diameter greater than the diameter of the annular passage and defining the outer boundary of the dish-shaped opening.

7. A piston cylinder assembly according to claim **4** further comprising means defining a sensing passage in the housing communicating with the first chamber and the exterior of the housing, the passage being separate from the annular passage and located to communicate with the space between the piston and the first end portion.

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