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BOOM SNUBBING DEVICE AND CONTROL VALVE THEREFOR

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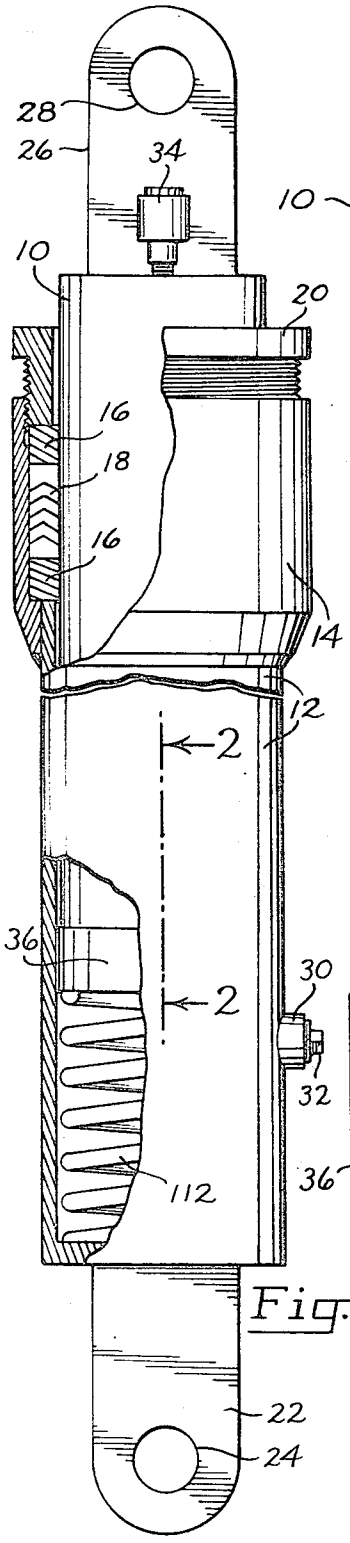

Fig. 1.

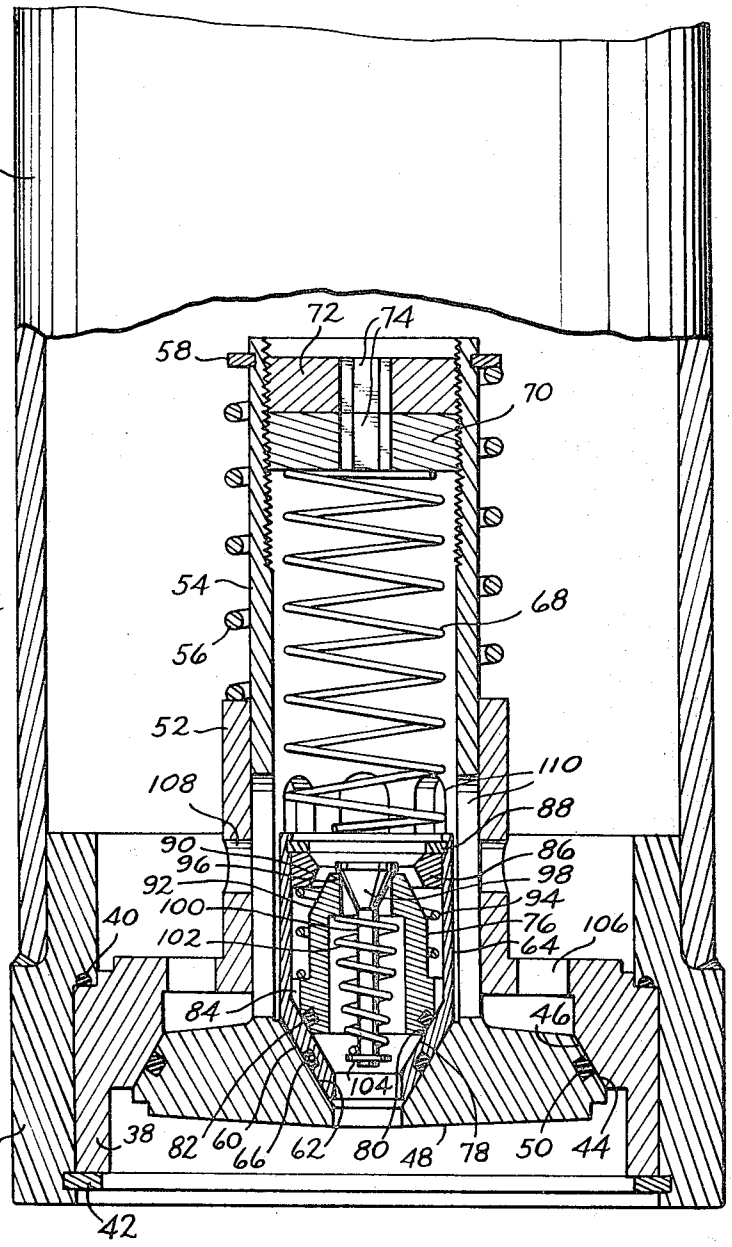

Fig. 2.

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BOOM SNUBBING DEVICE AND CONTROL VALVE THEREFOR

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ABSTRACT OF THE DISCLOSURE

The inner end of the elongated inner tube of a pair of telescoping tubes forming an extensible hydraulic boom snubbing cylinder, carries a control valve assembly of four substantially concentric spring loaded valves. The largest valve opens to transfer hydraulic fluid quickly from the inner tube to the outer tube as the boom is lowered; the smallest valve opens to meter fluid slowly from the outer tube to the inner tube as the boom is elevated; the next to smallest valve opens with the smallest valve when the boom is elevated at a faster rate; if the boom elevation is still faster the next to smallest valve closes against the next to largest valve and the smallest valve dampens the boom elevation rate; and if the boom elevates with uncontrolled speed the next to largest valve opens to relieve the hydraulic pressure in the inner tube.

Background of the invention

This invention relates to snubbing devices for load lifting booms, and more particularly to a valve assembly for controlling the operation of an hydraulic boom snubbing device.

Boom snubbers provided heretofore have included control valves of various constructions for allowing rapid lowering of the boom and for controlling the speed of elevation of the boom. However, such prior valves are deficient in their effectiveness of operation and they are of complex and costly construction. Moreover, they are incorporated in the snubber in such manner as to involve considerable time for assembly and disassembly, for maintenance and repair, thus contributing adversely to substantial reduction in the productive operating time of the boom.

Summary of the invention

Broadly, the boom snubbing device of this invention includes a control valve assembly in which a plurality of substantially concentric valves function automatically and selectively to permit rapid lowering of a boom and controlled raising of the boom to insure safety of boom operation.

It is the principal object of the present invention to overcome the disadvantages of prior boom snubbers by the provision of a boom snubbing device including a control valve assembly of simplified and economical construction and which is capable of assembly and disassembly with speed and facility.

The foregoing and other objects and advantages of this invention will appear from the following detailed description, taken in connection with the accompanying drawing of the preferred embodiment.

Brief description of the drawing

FIG. 1 is a foreshortened plan view of a boom snubbing device incorporated a control valve embodying the features of the present invention, parts being broken away to disclose details of construction.

FIG. 2 is a fragmentary sectional view taken on the line 2—2 in FIG. 1 and showing details of construction of the control valve assembly.

Description of the preferred embodiment

Referring particularly of FIG. 1 of the drawing, the boom snubbing device comprises an elongated extensible hydraulic cylinder formed of elongated telescoping inner and outer tubes **10** and **12**, respectively, each closed at its outer end. A housing **14** of enlarged diameter is welded or otherwise secured to the inner end of the outer tube and projects therefrom to form an annular space between it and the inner tube for the removable reception of the fluid seal assembly of bushings **16** and interposed packing **18**. This assembly is retained by the threaded gland **20** adjustably secured to the housing by such means as the interengaging threads.

Projecting from the closed end of the outer tube is a mounting tab **22** provided with a transverse opening **24** by which to secure it pivotally to the cab of a load lifting boom structure. Similarly, a tab **26** projects from the closed end of the inner tube and is provided with a transverse opening **28** for pivotal attachment to the boom.

Adjacent the closed outer end of the outer tube is a hollow nipple **30** removably closed by the plug **32**, for filling the cylinder with hydraulic fluid. A relief valve **34** is provided at the closed end of the inner tube and functions to relieve rupturing pressures within the tube.

The foregoing arrangement, together with valve means for controlling the extension and retraction of the cylinder, generally is of well known construction, as exemplified in U.S. Patent No. 2,627,985.

In accordance with the present invention, simplified control valve means is provided for controlling the extension and retraction of the cylinder, and such control valve means is illustrated in FIG. 2.

To the inner end of the inner tube **10** there is secured, as by welding, the hollow piston **36**. The outer surface of the piston forms a snug but sliding fit with the inner surface of the outer tube **12**. Within the bore of the hollow piston is removably received a hollow valve seat member **38**. Cooperating shoulders on the piston and valve seat member, and the interposed O-ring seal **40**, provides a fluid tight abutment between the parts, and they are secured in this position releasably by the split keeper ring **42** which is seated removably in an annular groove in the piston.

The valve seat member is provided with a tapered valve seat **44** corresponding to the taper of the valve face **46** on the back flow valve head **48**. An annular O-ring **50** on the valve head enhances the sealing engagement of these surfaces. The valve seat member also is provided with a hollow central guide sleeve **52** which slidably receives the hollow stem **54** on the back flow valve head **48**. A coil spring **56** encircles the inner end portion of the stem, abutting at one end against the sleeve **52** and at its opposite end against the split keeper ring **58** mounted removably in an annular groove adjacent the inner end of the stem. The spring thus urges the valve head resiliently into sealing engagement with the valve seat member. However, removal of the valve head and attached stem, for replacement or repair, is achieved simply by removing the keeper ring, as will be apparent.

The valve head **48** has a central opening communicating with the hollow stem, and an inner portion of this opening is tapered to form a valve seat **60** matching the taper of the face **62** on the adjacent end of the hollow safety valve member **64**. An O-ring **66** carried by the safety valve member enhances the sealing engagement between these matching surfaces. The safety valve member **64** is slidable freely in the hollow stem **54** and is urged resiliently into sealing engagement with the seat **60** by means of the backing spring **68**. One end of this spring abuts the inner end of the safety valve member and the opposite end abuts an adjustment plug **70** mounted ad-

justably in the stem by means of the interengaging threads. A locking plug **72** serves to secure the adjustment plug in its position of desired adjustment. Non-circular openings **74** in the plugs serve to receive a tool, such as a conventional Allen wrench, by which to turn the plugs. The adjustment plug serves to vary the compression of the spring **68** and hence the resistance to opening of the safety valve.

Within the hollow safety valve is a hollow relief valve **76** axially movable freely therein. The forward end of the safety valve forms a tapered seat **78** which matches the taper of the adjacent face **80** of the relief valve. Sealing engagement of these services is enhanced by the O-ring **82** carried by the relief valve. Radially projecting fins **84** on the relief valve serve to guide the latter in its longitudinal movement relative to the safety valve, while providing openings between the fins for the passage of hydraulic fluid.

The inner end of the safety valve **64** supports a removable annular throttle valve seat **86**, confined by the keeper ring **88** mounted removably in an annular groove in the safety valve. The taper **90** of this valve seat matches the taper of the valve surface **92** on the adjacent, inner end of the relief valve. A coil spring **94** encircles the relief valve and abuts at one end against a shoulder adjacent the radial fins **84** and at the opposite and against the removable valve seat **86**. The spring thus urges the relief valve resiliently outward for sealing engagement of the tapered surfaces **78** and **80**.

The inner end of the hollow relief valve **76** is provided with a tapered seat **96** matching the taper of the metering valve head **98**. A stem **100** extends forwardly from this head and is encircled by a coil spring **102**. The inner end of the spring abuts an internal shoulder on the relief valve **76** and its outer end abuts a keeper ring **104** mounted removably in an annular groove in the stem. Thus, the spring urges the metering valve resliently to its closed position, as illustrated.

A plurality of circumferentially spaced openings **106** are provided in the valve seat member **38** inwardly of the seat **44**, to permit the passage of hydraulic fluid from the inner tube **10** to the outer tube **12** when the back flow valve **48** is open. Circumferentially elongated openings **108** also are provided in the sleeve for communication with circumferentially spaced, axially elongated openings **110** in the stem, for passage of hydraulic fluid from the outer tube to the inner tube through the safety, relief and metering valves **64**, **76** and **98**, respectively.

The boom snubbing device is filled with hydraulic fluid by lowering the boom to its maximum limit, at which the inner tube **10** is extended from the outer tube **12** to its maximum limit. The outer tube then is filled to capacity with hydraulic fluid, by removing the filler plug **32**, after which the latter is replaced.

The operation of the boom snubbing device and the associated valve assembly is as follows: Assuming the boom is being raised slowly from its lowered position, retracting the inner tube **10** into the outer tube **12**, the hydraulic fluid in front of the piston **36** forces the metering valve **98** open. Hydraulic fluid thus passes through the metering valve and thence through the openings **108** and **110** in the stem and sleeve and the openings **74** in the plugs, into the inner tube behind the piston.

In the event the boom is elevated at a rate faster than the metering valve can accommodate, the relief valve **76** is moved inward against the resistance of the spring **94** sufficiently to unseat the valve surface **80** from the seat **78**, but insufficient to move the throttle valve **92** at the inner end of the relief valve into sealing engagement with the seat **90**. Thus, additional hydraulic fluid may be transferred to the inner tube through the spaces between the fins **84** and out through the open inner end of the safety valve.

If elevation of the boom exceeds a predetermined rate, the relief valve **76** moves inward still further until the throttle valve **92** seals against the seat **90**. The transfer of hydraulic fluid to the inner tube thus is restricted, since it may pass only through the open metering valve. Accordingly, the speed of boom elevation is throttled back to a safe limit.

In the event of accidental loss of a load being lifted by the boom, as by failure of the hoisting cable, or on the occurrence of a gust of wind, or other circumstance which tends to whip the boom rapidly upward in an uncontrolled manner, the excessive increase in pressure within the outer tube **12** is relieved by inward movement of the safety valve **64** against the resistance of the spring **68**. The resulting unseating of the safety valve from its seat **62** allows a further quantity of hydraulic fluid to transfer to the inner tube and thus relieves a rupturing pressure in the outer tube.

At a predetermined upper limit of elevation of the boom the piston **36** abuts the adjacent end of the coil buffer spring **112** (FIG. 1) the opposite end of which bears against the closed outer end of the outer tube.

When the boom is lowered from an elevated position the partial vacuum created in the outer tube **12** causes the back flow valve **48** to open against the resistance of spring **56**, allowing hydraulic fluid to transfer quickly from the inner tube to the outer tube.

In the event any component of the control valve assembly requires replacement or repair, the entire assembly is removed with speed and facility merely by removing the keeper ring. A replacement assembly may be just as quickly and easily installed, thus restoring the boom apparatus to productive use with a minimum of down time, after which the defective assembly may be repaired at leisure.

It will be apparent to those skilled in the art that various changes may be made in the size, shape, number and arrangement of parts described hereinbefore. For example, the piston **36** and valve seat member **38** may be made of one piece and secured removably to the inner end of the inner tube **10** by such means as set screws.

Having now described my invention and the manner in which it may be used, I claim:

1. A hydraulic control valve comprising

(a) a hollow back flow valve seat member,

(b) a hollow back flow valve member mounted for movement relative to the back flow valve seat member for releasably preventing hydraulic fluid flow in the direction of seating movement of said back flow valve member,

(c) a safety valve seat on the back flow valve member,

(d) a hollow safety valve member mounted for movement relative to the back flow valve member for releasably preventing hydraulic fluid flow in the direction opposite the seating movement of said back flow valve member,

(e) a relief valve seat on the safety valve member,

(f) a hollow relief valve member mounted for movement relative to the safety valve member for releasably preventing hydraulic fluid flow in the direction opposite the seating movement of said back flow valve member,

(g) a metering valve seat on the relief valve member,

(h) a metering valve member mounted for movement relative to the relief valve member for releasably preventing hydraulic fluid flow in the direction opposite the seating movement of said back flow valve member,

(i) a throttle valve seat on the end of the safety valve member opposite the relief valve seat, and

(j) a throttle valve member on the end of the relief valve member adjacent the throttle valve seat.

2. The hydraulic control valve of claim **1** wherein the safety valve member, relief valve member and metering valve member are of progressively decreasing size and are arranged substantially concentrically each within the

next larger valve member, the safety valve member being arranged within the back flow valve member.

3. The hydraulic control valve of claim 1 including

(a) resilient means interengaging the back flow seat member and back flow valve member and urging the latter to closed position,

(b) resilient means interengaging the back flow valve member and safety valve member and urging the latter to closed position,

(c) resilient means interengaging the safety valve member and relief valve member and urging the latter to closed position and the throttle valve member to open position, and

(d) resilient means interengaging the relief valve member and metering valve member and urging the latter to closed position.

4. The hydraulic control valve of claim 1 including

(a) inner and outer elongated telescoping tubular members closed at their outer ends and forming an extensible hydraulic boom snubbing fluid cylinder,

(b) the hollow back flow valve seat member being secured to the inner end of the inner tubular member for movement therewith.

5. The combination of claim 4 including

(a) a hollow piston member secured to the inner end of the inner tubular member,

(b) the back flow valve seat member being removably secured to the piston member.

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