April 9, 1968 M. B. THORNTON 3,376,739

HYDRAULIC LOAD LIMITER

Filed Oct. 12, 1965 2 Sheets-Sheet 1

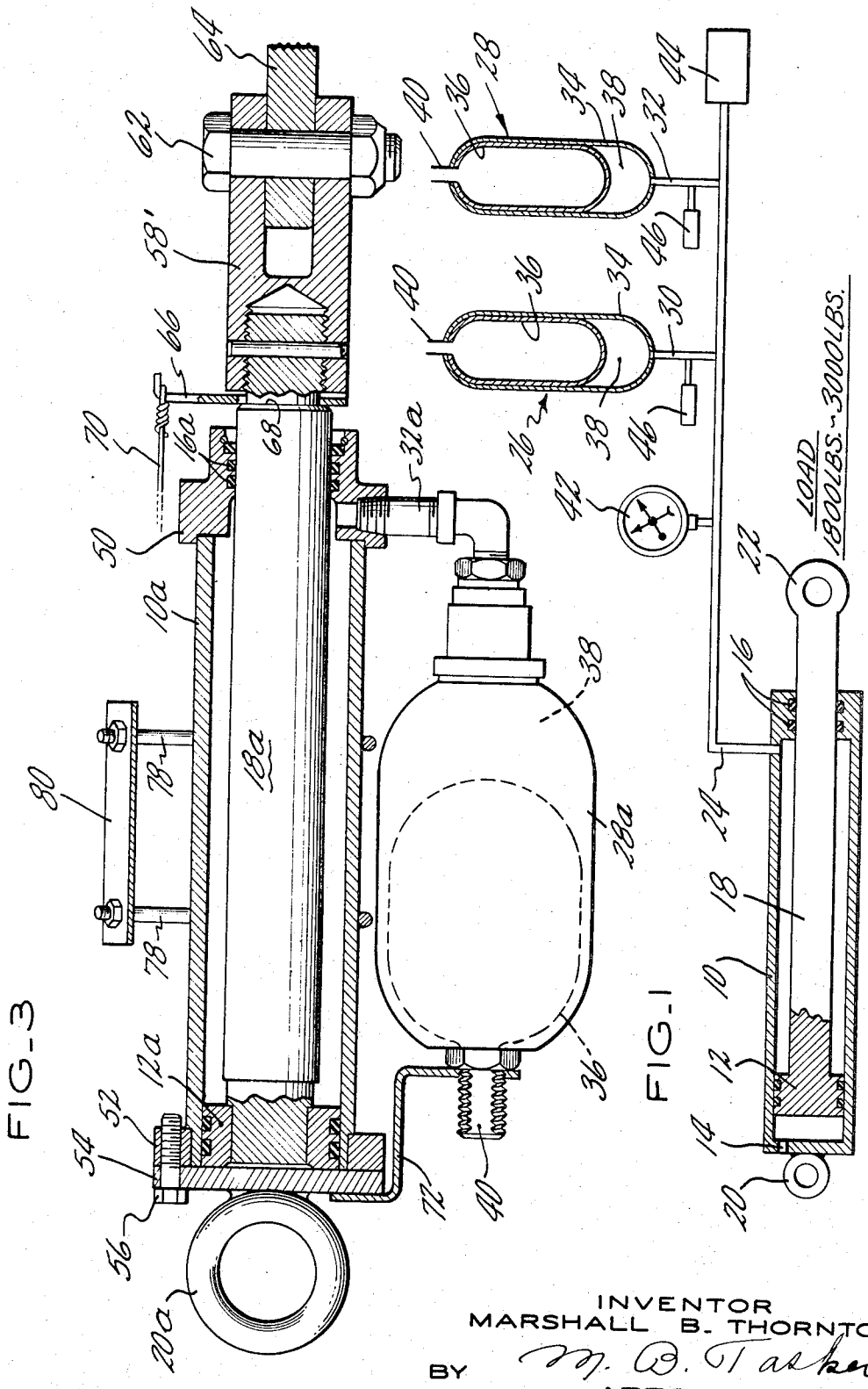


FIG. 3

FIG. 1

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FIG. 2

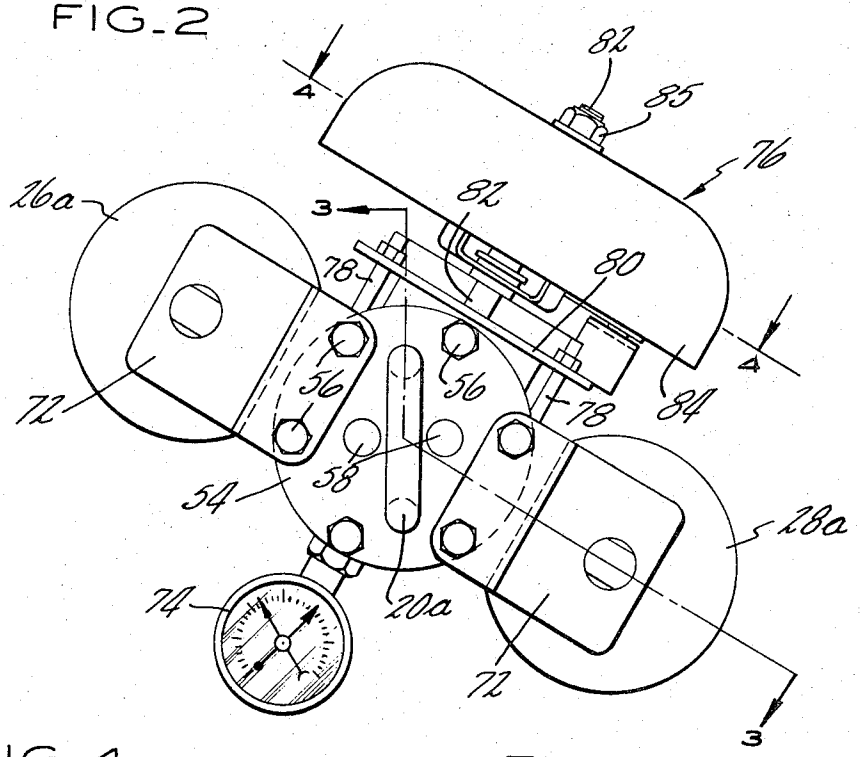


FIG. 4

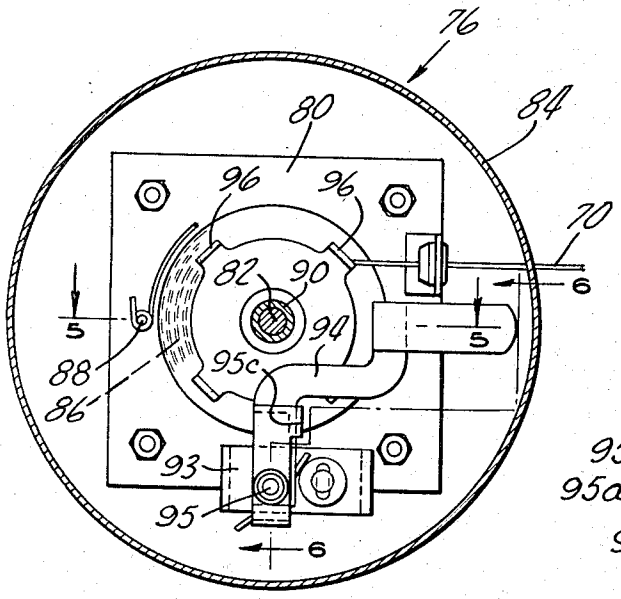


FIG. 5

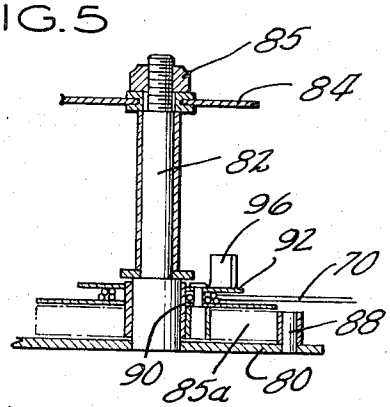
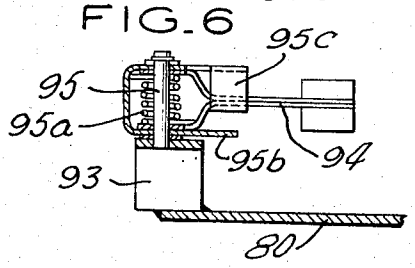


FIG. 6



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HYDRAULIC LOAD LIMITER

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10 Claims. (Cl. 73—141)

This invention relates to load limiters and particularly to a load limiter having special advantages for use in a cable of a hoist for lifting heavy articles. The load limiter of this invention was developed for use in the cable of a hoist used in installing or removing an airplane propeller unit from the engine shaft of an airplane and will be described as used for this purpose, although it will be obvious that the load limiter is readily adaptable for other uses.

In handling a propeller unit for airplanes, the hoist cable is provided with a metal fixture for engaging the propeller hubs so that the propeller unit can be raised into position to be installed on the propeller shaft of the airplane engine. Occasionally it happens, when the propeller has been slipped onto the shaft, a gust of wind acting on the opposite wing of the airplane will result in seriously overloading the hoist mechanism, resulting in damage to the hub engaging fixture or other parts of the hoist mechanism which if not noticed may result in subsequent failure.

It is an object of this invention to provide a load limiter in the cable of a hoist for introducing a limited amount of stroke within a specified range for eliminating destructive overloads in the event of a large extraneous force being applied over a short time period or distance to the object being handled by the hoist.

More specifically it is an object of this invention to provide in series in the hoist cable such a load limiter comprising a hydraulic cylinder communicating with a gas charged accumulator to control pressure exerted by a piston in the cylinder and allow a definite amount of travel of the piston relative to the cylinder upon overload without destructively overloading the hoist equipment.

Another object of this invention is to provide in such a load limiter both a visual warning device for indicating when an overload has occurred and also for recording that the overload has occurred and the extent of the overload.

A further object of the invention is to provide a periodic audible signal of the motion of the load limiter while the hoist is operating within safe limits of overload and warn of impending destructive overloads before they occur.

Briefly the improved load limiter of this invention consists of a single acting hydraulic cylinder and piston sized for the desired load, stroke and pressure. The cylinder, at one side of the piston, is vented to atmosphere while the cylinder at the other side of the piston is filled with hydraulic fluid. This fluid is pressurized by one or more accumulators to provide the initial preload, or no-deflection load capacity. The accumulators, pressurized by gas, act as a load limit spring, any movement of the piston forcing fluid into the accumulator, thereby decreasing volume and increasing pressure of the confined gas. This pressure increase provides the stroke-load ratio, or spring rate, of the system.

A still further object of this invention is generally to improve load limiters of the type described.

These and other objects and advantages of the invention will become apparent or will be pointed out in connection with the following detailed description of a preferred embodiment of the invention shown in the accompanying drawings.

In these drawings:

FIG. 1 is a schematic diagram of a cable hoist load limiter of the hydraulic type embodying the invention;

FIG. 2 is an end view of a preferred construction for such a hydraulic load limiter;

FIG. 3 is a longitudinal sectional view of the load limiter of FIG. 2 taken on lines 3—3 of FIG. 2;

FIG. 4 is a sectional view on line 4—4 of FIG. 2;

FIG. 5 is a sectional view on line 5—5 of FIG. 4;

FIG. 6 is a sectional view on line 6—6 of FIG. 4.

As shown schematically in FIG. 1, the load limiter consists of a single acting cylinder **10** and a piston **12**. The cylinder has a vent **14** to atmosphere at one end and has at its other end suitable seals **16** for a piston rod **18** which is extended through this end of the cylinder. The vented end of the cylinder is provided with a cable attaching eye **20** and the external extended end of the piston rod **18** is provided with a similar cable eye **22**. As will be evident, the remote end of the cylinder and piston rod have their eyes **20** and **22** connected in the cable of a hoist.

A pipe connection is provided at one end of the cylinder remote from the vent **14** for a hydraulic pipe **24** which communicates with two accumulators **26**, **28** through branch pipes **30**, **32**, respectively. Each accumulator consists of a tank **34** and an expansible bag **36** which is shorter than tank **34** but otherwise conforms to the inside dimensions of the tank, leaving a chamber **38** at one end of the tank with which the branch pipes **30** and **32** are in fluid communication. The bags **36** have short necks **40** extended through apertures in the tank, housing valves through which the bags are charged with nitrogen gas. Pipe **24** is provided with a pressure gage **42** and an oil charging valve **44** by which cylinder **10** and the accumulators are initially filled. Air bleed valves **46** are also provided in the branch pipes **30**, **32** to bleed air from the system during filling.

Referring to FIGS. 2 and 3 showing a working embodiment of the load limiter, a cylinder **10***a* has a head **50** welded to it at one end and a cylinder head attaching ring **52** welded to it at its other end to which a cylinder head **54** is removably attached by cap screws **56**. Vents **58** are provided in cylinder head **54** (FIG. 2) and a cable eye **20***a* is also provided. A piston **12***a* has a piston rod **18***a* which extends through packing **16***a* in cylinder head **50** and carries at its extreme end a screw threaded clevis fitting **58'** to which the propeller attaching fitting is secured by a bolt **62**, as indicated (broken away) at **64**. An arm **66** carried by the piston rod between shoulder **68** thereon and fitting **58** carries a cord **70** for a bell alarm subsequently to be described.

Two accumulators **26***a* and **28***a* are mounted on brackets **72** secured by cap screws **56** at one end of the cylinder and on branch pipes **30***a* and **32***a* carried by cylinder head **50** and communicating directly with the interior of cylinder **10***a*. Each accumulator tank contains a bag **36** having a neck **40** through which it is charged with nitrogen gas as in the FIG. 1 showing. A pressure gage **74** is provided which is mounted directly on cylinder head **50** in communication with cylinder **10***a* and which indicates the pressure of hydraulic fluid in cylinder **10***a* and chamber **38** of the tanks **26***a* and **28***a*.

An audible alarm device **76** is carried by cylinder **10***a* midway of its length on brackets **78**. These brackets carry a rectangular plate **80** which supports a fixed, upright post **82** on the upper end of which a gong **84** is fixed by a nut **85**.

At the base of the post a spring well **85***a* is provided housing a clock-type spring **86** attached at its outer end to a pin **88** on plate **80** and at its inner end to a sleeve **90** rotatable about post **82**. Sleeve **90** also provides a reel

92 (FIG. 5) on which cord 70 is found. The other end of the cord is attached to arm 66 on piston rod 18*a* (FIG. 3). As piston 12*a* moves away from cylinder head 54 toward cylinder head 50, cord 70 rotates reel 92 in a clockwise direction (FIG. 4) to wind up spring 86.

Plate 80 also carries a pedestal 93 at one side, but within the confines of the depending rim of gong 84 on which a striker arm 94 is pivotally mounted on a pin 95. A torsion spring 95*a* on pin 95 biases a U-shaped actuator having a lower inwardly directed end 95*b*. The U-shaped actuator carries a depending abutment 95*c* at its other end in position to engage arm 94. The end 95*b* of this actuator is engaged successively by four cams 96 which project upwardly from the upper plate of reel 92 as the latter is rotated in a clockwise direction (FIG. 4) to move arm 94 against the bias of spring 95*a*. It will be evident that as the cams 96 move past the end 95*b* the arm 94 carrying the striker will sound the gong repeatedly to give audible warning of an overload.

While the particular dimensions of the load limiter will vary widely for different applications, the one shown in the drawings for a propeller unit hoist has an effective piston area on its unvented side of 3 square inches and a stroke of 12 inches, giving a total displacement of 36 cubic inches. The accumulator bags are charged at 500 pounds per square inch to insure the proper volume of gas, and the oil in the accumulator tanks is subsequently charged at 600 pounds per square inch, giving a working pressure range of 600–1000 pounds per square inch. These figures are given by way of example, as it will be understood that for a different use the dimensions and pressures chosen may vary considerably.

In the operation of a hoist equipped with the load limiter above described, the 600 pounds per square inch initial preload, or no-deflection load, insures that in the normal operation of the hoist the piston of the load limiter remains at the left-hand end of the cylinder (FIG. 3). If for any reason the load on the hoist cable is increased beyond this normal value by any extraneous force of more than 1800 pounds the piston will move in the cylinder, forcing oil into the accumulator chambers and compressing the gas in the accumulator bags. The resulting increase in the pressure in the accumulators provides the stroke-load increase ratio, or spring rate, of the system. With the load limiter illustrated, an increase from 1800 pounds of load to 3000 pounds of load occurs before the piston has reached the end of its stroke and has seated against cylinder head 50.

During this movement of the piston, the pressure gage 74 gives a visual indication of the amount of overload. A second hand on the gage may be provided which will record, until manually reset, the amount of overload which has occurred after the load has been reduced to normal and the load limiter has been reset by the pressure in the accumulators.

Also, during the movement of the load limiter piston through what may be termed the tolerable overload range, the alarm bell will be periodically struck as the piston moves in the cylinder to give repeated warnings of the overload condition.

When the piston has reached the end of its travel it will engage the cylinder 50 and prevent further compression of the gas in the accumulator bags. Thus damage will be prevented in the event of severe overloads beyond the designed capacity of the load limiter but within the structural capability of the device. However, long before this condition occurs, ample warning will have been given that an overload exists.

It will be evident that as a result of this invention a load limiter has been provided for a hoist which limits the load on the hoist by providing in the hoist cable sufficient motion upon overload which acts to compress an expansible gas in an accumulator, thus relieving the hoist from destructive overload and providing for resetting the load limiter automatically when the overload is relieved.

It will also be evident that the pressure of the compressed gas in the accumulator serves to give a visual indication on a pressure gage so that overload can be instantly detected and its magnitude determined, and that the operation of the load limiter upon overload gives repeated audible warnings that an overload exists.

Further, the initial no-deflection load of the load limiter as indicated on the gage gives immediate indication of a leak in the system.

It will also be noted that the load limiter of this invention can be used in any attitude, vertical or horizontal, and may be adapted for use with either tension or compression loads.

While only one embodiment of the invention has been shown and described, it will be understood that many changes may be made in the construction of the load limiter without exceeding the scope of the invention as defined in the following claims.

I claim:

1. A load limiter for a hoist comprising a cylinder and piston adapted to be connected in series between an object to be lifted and the hoist, means for venting said cylinder to atmosphere on the side of the piston adjacent the hoist, an accumulator communicating with said cylinder on the other side of said piston, means for charging said cylinder on said other side with a hydraulic fluid, and means for charging said accumulator with a compressed gas for pressurizing said hydraulic fluid to provide an initial no-deflection load on said piston.

2. A load limiter for a hoist comprising a cylinder and piston adapted to be connected in series between the object to be lifted and the hoist, means for venting said cylinder on the side of said piston adjacent said hoist, an accumulator having fluid communication with said cylinder on the other side of said piston including a tank and a bag within said tank, means for charging said cylinder on said other side of said piston with a hydraulic fluid, and means for charging said bag with a gas under pressure to pressurize said hydraulic fluid and provide an initial no-deflection load on said piston.

3. In a load limiter for a hoist, a cylinder and piston connected in series between the hoist mechanism and the object to be lifted, said cylinder having means for connecting it at one end to the hoist mechanism and said piston having means at its remote end for connecting it to an object to be lifted, means for venting said cylinder to atmosphere at its connected end, an accumulator including a tank providing a pressure chamber, means providing fluid communication between said chamber and the other end of said cylinder, means for charging said cylinder and said chamber with hydraulic fluid, means for charging said chamber with an expansive gas for providing an initial no-deflection load on said piston during the normal use of said hoist, and means for providing visual and audible indications of overload as said piston moves in said cylinder.

4. A load limiter for a hoist comprising a cylinder and piston adapted to be connected in series between an object to be lifted and the hoist, means for venting said cylinder on the side of said piston adjacent the hoist, an accumulator having fluid communication with said cylinder on the other side of said piston including a tank, said tank and said cylinder adapted to contain hydraulic fluid, and means for charging said tank with an expansible fluid to provide an initial no-deflection load on said piston.

5. The load limiter of claim 4 in which an expansible container is provided in the tank for the expansible fluid, and means is provided for charging the container from outside the tank.

6. The load limiter of claim 4 in which a pressure gage is provided in communication with the hydraulic fluid for normally indicating the initial no-deflection load and for indicating overload pressures as the piston moves in the cylinder.

7. In a load limiter for a cable hoist, a cylinder and

piston adapted to be connected in series in the cable between the hoist mechanism and an object to be lifted, means for venting said cylinder at its end adjacent the hoist, an accumulator mounted on said cylinder including a closed chamber having fluid communication with said cylinder adjacent the other end of said cylinder, means for charging said chamber with a hydraulic fluid, a flexible bag in said chamber, means for charging said bag with an expansible gas to provide an initial no-deflection load on the hydraulic fluid acting on said piston, means for giving a visual indication of the pressure acting on said hydraulic fluid including a pressure gage, and means for giving an audible warning as the piston moves relative to said cylinder.

8. In a load limiter for a hoist, a cylinder and piston connected between the hoist mechanism and the object to be lifted, said cylinder having means for connecting it at one end to the hoist cable and said piston having means at its remote end for connecting it to the object to be lifted, means for venting said cylinder to atmosphere at its connected end, accumulator means carried by said cylinder including a plurality of tanks arranged about

the circumference of said cylinder, said tanks having fluid connections to said cylinder at its other end, and means for providing an initial no-deflection load on said piston including a bag in each tank having means external of said tanks for charging said bags with an expansible fluid under pressure.

9. The load limiter of claim **8** in which a pressure gage is provided to indicate the normal no-deflection load on the piston and also the overload as said piston moves in said cylinder.

10. The load limiter of claim **8** in which a gong is provided having a striker and means for sounding said gong repeatedly as said piston travels in said cylinder under overload conditions.

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