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LOAD BALANCING SYSTEM FOR HYDRAULIC JACK

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2 Sheets-Sheet 1

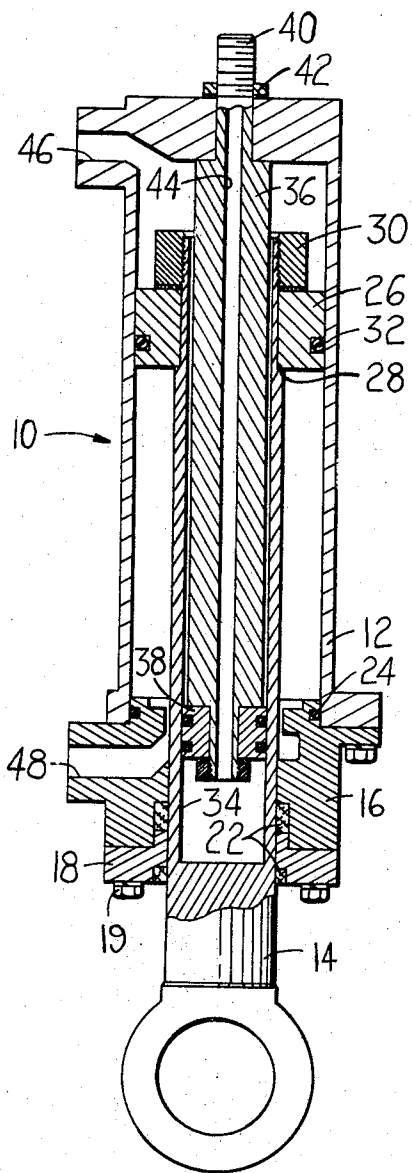


Fig. 1.

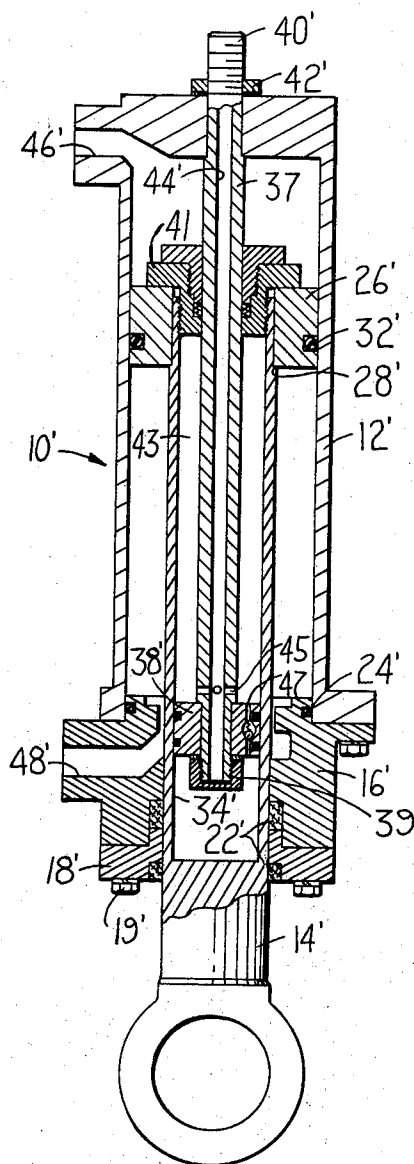


Fig. 2.

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2 Sheets-Sheet 2

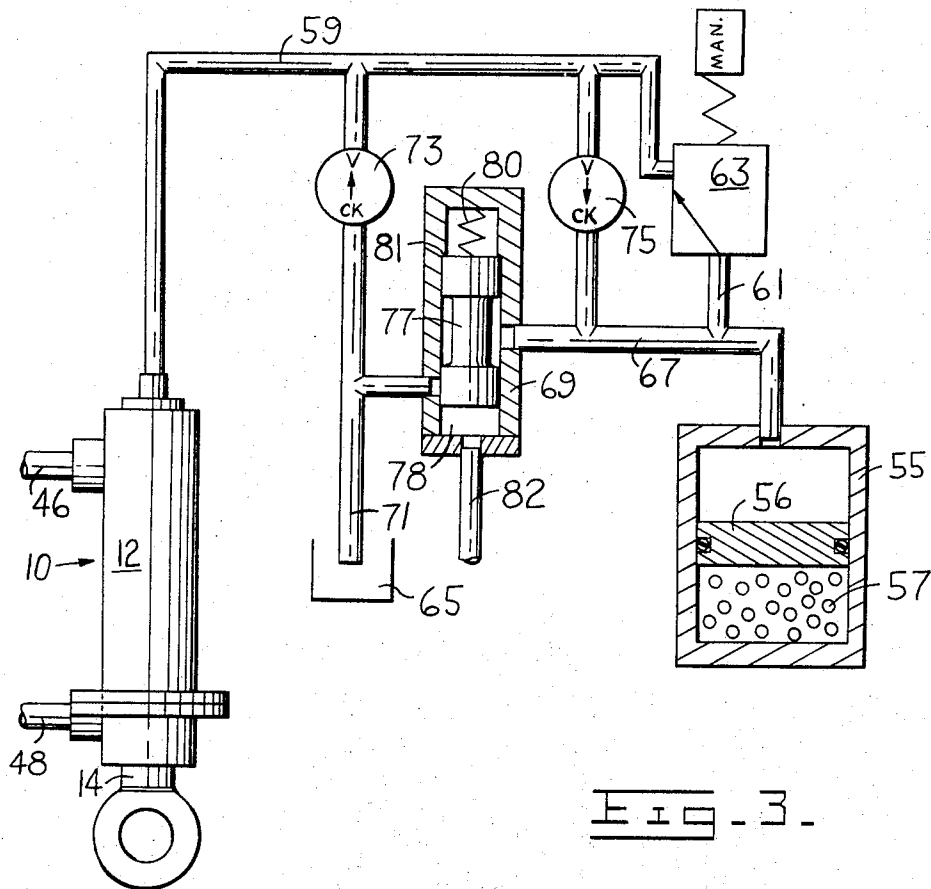


Fig. 3.

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LOAD BALANCING SYSTEM FOR HYDRAULIC JACK

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ABSTRACT OF THE DISCLOSURE

A fluid operated system for balancing at least a portion of the weight of a machine component wherein the system includes a fluid control circuit for supplying fluid under pressure to an internal expansible chamber located in the rod member of a double acting hydraulic jack which jack is used to actuate said machine component and whereby during normal operation said expansible chamber is supplied with sufficient pressure fluid to balance or offset at least a portion of the weight of said machine component.

This invention relates to a load balancing or booster system for a hydraulic jack to offset or compensate for a certain portion of the load on the jack cylinder. The invention is particularly suited for use with a double acting hydraulic jack wherein the load balancing system comprises a single acting hydraulic cylinder associated with the regular double acting cylinder.

Many modern machines or vehicles, such for example as bulldozers, scrapers, wheel loaders, etc., are equipped with hydraulically actuated components or attachments. The force or energy required to manipulate the various hydraulic attachments or tools is generally derived from a single engine, which engine is also used to propel the vehicle. Frequently the weight of individual hydraulically actuated components runs to several tons and the power required to move such components, even in an unloaded condition, often exceeds ten percent of the rated engine output. In many cases, machines are underpowered because the engine is of insufficient power to actuate the various components while simultaneously powering the vehicle. For example, in earthmoving machines the earth engaging portion is extremely heavy and requires substantial force to manipulate it, such as in raising a bulldozer blade or loader bucket. The force required for manipulating such attachments must be produced by the engine and when this manipulation takes place at the same time the entire vehicle is maneuvered, the engine is overtaxed.

The invention is directed to a system wherein the aforementioned deficiencies are eliminated without the use of extra-large power units. Thus, the invention is directed to a system whereby otherwise wasted horsepower is converted to useful output by the use of a novel and simply constructed means for balancing the weight of hydraulically actuated components carried by the machine.

It is an object of this invention to provide a hydraulic jack for actuating components with a load balancing means for supporting at least a portion of the weight of said components.

Another object of this invention is to provide a double acting hydraulic jack with a self-contained single acting hydraulic cylinder operated by fluid from an accumulator

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to supply a load balancing force for components actuated by said jack.

Yet another object of this invention is to provide a vehicle having a double acting hydraulic jack for actuating components with an auxiliary booster chamber located in the rod member of said jack, which booster chamber is provided with hydraulic pressure from an accumulator to offset the weight of said components and thereby relieve the vehicle power plant of extra load when power is required for maneuvering the vehicle.

The manner in which the foregoing and other objects and advantages are obtained is set forth in the following specification wherein reference is made to the accompanying drawing illustrating preferred embodiments of the invention.

FIG. 1 is a longitudinal view, partially in section, of one embodiment of a hydraulic jack constructed in accordance with the invention;

FIG. 2 is a longitudinal view, partially in section, of a second embodiment of a hydraulic jack constructed in accordance with the invention; and,

FIG. 3 is a schematic view illustrating a hydraulic circuit for use in conjunction with either of the embodiments shown in FIGS. 1 and 2.

Referring to FIG. 1 there is shown a double acting hydraulic jack 10 having a main cylinder 12 from which a slidable rod 14 is extended to raise or manipulate a load. The rod end of the cylinder 12 is provided with a removable block 16 which has a packing gland 18 secured thereto as by fastening means 19. Both the block 16 and the gland 18 are provided with a central bore which slidably receives the rod 14. Suitable packing 22 is provided to insure that the system is fluid-tight. Similarly, an O-ring seal 24 provides a fluid-tight connection between the block 16 and the main cylinder 12.

The terminal end of rod 14 which is received within cylinder 12 is provided with an external annular piston 26 which is held in place against an external circumferential rod shoulder 28 by means of a threaded nut 30. Piston 26 is slidably received against the inner wall of cylinder 12; an O-ring seal 32 preventing fluid passage therebetween. A large bore 34 extends longitudinally from the inner end of rod 14 to a point near the outer end of said rod. The purpose of bore 34 will become apparent from the discussion infra.

A tube 36 extends downwardly from the head end of cylinder 12 in a manner such that it is received within the bore 34 of rod 14 whether the rod is in an extended or retracted position. The inner end of tube 36 is provided with an enlarged ring member 38 which engages the wall of bore 34 in slidable and fluid-tight relation. The outer end of tube 36 is provided with a reduced diameter portion 40 which protrudes through an aperture in the head of cylinder 12 and is rigidly fastened thereto by suitable means such as the nut 42. A fluid passageway 44 extends throughout the length of tube 36 and is adapted to communicate at its upper end with a hydraulic circuit which will be described with respect to FIG. 3, infra.

Normal operation of the double acting jack 10 is provided by a conventional hydraulic circuit (not shown) which selectively directs fluid under pressure through either port 46 or port 48 to the head and rod ends of the cylinder, respectively, to thereby extend or retract the

od 14. The jack is connected between the vehicle and a component to be adjusted by conventional means. When fluid pressure is directed through the central passage 44 from an external source such as an accumulator, sufficient pressure may be introduced into bore 34 to compensate or offset the weight of the component. With such an arrangement, the fluid pressure introduced through port 46 is utilized entirely for the manipulation of the net payload moved upon extension of the jack.

FIG. 2 illustrates a modified embodiment of a double acting jack wherein the jack is retracted rather than extended to manipulate a load. Many components of the jack 10' shown in FIG. 2 are identical with components previously described with reference to jack 10 of FIG. 1. Accordingly, prime numerals have been assigned to those components in FIG. 2 which correspond to like components in FIG. 1.

The tube 37 of FIG. 2 has a considerably smaller outer diameter than the tube 36 of FIG. 1 and the lower end of passageway 44' is closed as by a cap member 39. In addition, the upper end of rod bore 34' is provided with an annular plug 41 adapted for slidable sealed engagement with tube 37. Thus, a variable sized annular chamber 43 is formed having upper and lower walls defined by members 41 and 38', respectively. A plurality of radial ports 45 permit fluid communication between tube passageway 44' and chamber 43.

When fluid pressure is directed to chamber 43, the rod 14' will tend to retract into main cylinder 12'. Since retraction of jack 10' actuates a component and its load, sufficient pressure may be introduced into chamber 43 to balance or offset the weight of the component and pressure introduced at port 48' is utilized entirely for manipulation of the net payload carried by said component. A small oneway bleed valve 47 is provided in member 38' to permit draining back to chamber 43 any fluid which might leak into the lower end of rod bore 34'.

FIG. 3 illustrates a hydraulic circuit which is adapted to supply fluid pressure to the load balancing chambers of either of the embodiments shown in FIGS. 1 and 2. However, for purposes of illustration, the hydraulic jack 10 of FIG. 1 is shown connected to the circuit of FIG. 3. In FIG. 3 a conventional accumulator 55 having a piston 56 and a supply of compressible fluid 57 is connected to conduit 59 via conduit 61 and a suitable pressure control valve 63. Accumulator 55 is also connected to a fluid tank or reservoir 65 via conduit 67, a safety valve 69 and conduit 71.

The accumulator 55 is initially charged in a conventional manner by alternately directing fluid from a hydraulic jack circuit (not shown) to ports 46 and 48. Thus, extension of rod 14 will initially draw fluid from reservoir 65, through a check valve 73, conduit 59 and into rod bore chamber 34 (see FIG. 1), while reverse movement of rod 14 will direct such fluid back through line 59 and a check valve 75 into the accumulator 55. Successive cycles of jack 10 will eventually charge the accumulator 55 to a predetermined pressure which will open the pressure control valve 63 and further strokes of rod 14 will have no effect on check valves 73 and 75 due to the pressure which has built up in lines 59 and 67. It should be apparent that successive strokes of the rod 14' of the jack embodiment shown in FIG. 2 would serve to initially charge the accumulator 55 in like fashion.

When the pressure in the accumulator 55 is in the operative range, the pressure control valve 63 will remain open to permit flow of fluid through line 59 in both directions. In this manner as the load balancing chamber in rod bore 34 (see FIG. 1) expands, fluid flows from the accumulator 55 to the said chamber and as the chamber contracts, the fluid flow is in a direction back to the accumulator. Should leakage in the system result in a reduction of pressure in the accumulator 55 below a predetermined minimum, control valve 63 will close and as the rod 14 is extended and retracted, the circuit will be re-

charged by flow of oil through the check valves 73 and 75, as previously described.

The safety valve 69 is provided with a spool 77 which is normally urged to open the valve under the action of spring 80. However, when the engine of the vehicle is running, lubricating oil pressure therefrom enters through conduit 82 to force spool 77 against an internal circumferential shoulder 81 as shown and thus prevent fluid communication between accumulator 55 and the reservoir 65. When the engine is shutdown or the engine oil pressure is lost for some other reason, the valve spool 77 is spring biased to a position establishing communication between accumulator 55 and reservoir 65. Such an arrangement allows the hydraulic jack components to be brought to rest in a lowered or inoperative position during extended shutdown periods as a safety precaution.

Although a specific embodiment of safety valve 69 is illustrated, it should be recognized that any suitable alternate form could be used. For example, the valve 69 could be responsive to any signal which indicates when the vehicle engine is operative. In addition to engine oil pressure the valve could be controlled by transmission control pressure or by pressure from the main implement control system pump which is operative any time the engine is running. On an electric drive vehicle the valve could be solenoid controlled in response to opening or closing of the main power switch.

I claim:

1. In an engine driven vehicle having a machine component actuated by a hydraulic jack, apparatus for balancing at least a portion of the weight of said machine component, said apparatus comprising in combination, a hydraulic jack having the usual cylinder, piston and rod, said rod having a bore opening at its inner end, a tube having a first end fixedly secured to and extending through the head end of said cylinder, said tube having a second end portion extending into said rod bore, a stationary wall member fixedly secured to the tube and slidably fitting the rod bore to define one end of an internal expansible chamber within said rod bore, hydraulic fluid means for extending and retracting said jack, and a hydraulic circuit for directing fluid from a pressure fluid reservoir through said tube and into said expansible chamber, said hydraulic circuit comprising an accumulator chargeable to a predetermined pressure by extending and retracting said jack, a pressure control valve located in said hydraulic circuit between said accumulator and said expansible chamber for preventing fluid flow between said expansible chamber and said accumulator when the pressure in the hydraulic circuit drops below said predetermined pressure, check valve means located in said hydraulic circuit between said expansible chamber and said reservoir to communicate pressure fluid from said reservoir to said expansible chamber when the pressure in the hydraulic circuit drops below said predetermined pressure, whereby during normal operation said expansible chamber is supplied with pressure fluid which is sufficient to balance or offset at least a portion of the weight of said machine component, and a safety valve situated between said pressure fluid reservoir and said accumulator, means responsive to operation of said engine to normally close said safety valve and prevent fluid flow from said accumulator to said reservoir, said safety valve further having means operable to open said safety valve to allow fluid to flow from said accumulator to said reservoir when said engine is shut down.

2. Apparatus as set forth in claim 1 wherein said expansible chamber is located in said rod so that admission of pressure fluid to said chamber tends to extend said rod from said cylinder.

3. Apparatus as set forth in claim 1 wherein said expansible chamber is located in said rod so that admission of pressure fluid to said chamber tends to retract said rod into said cylinder.

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