

Feb. 24, 1970

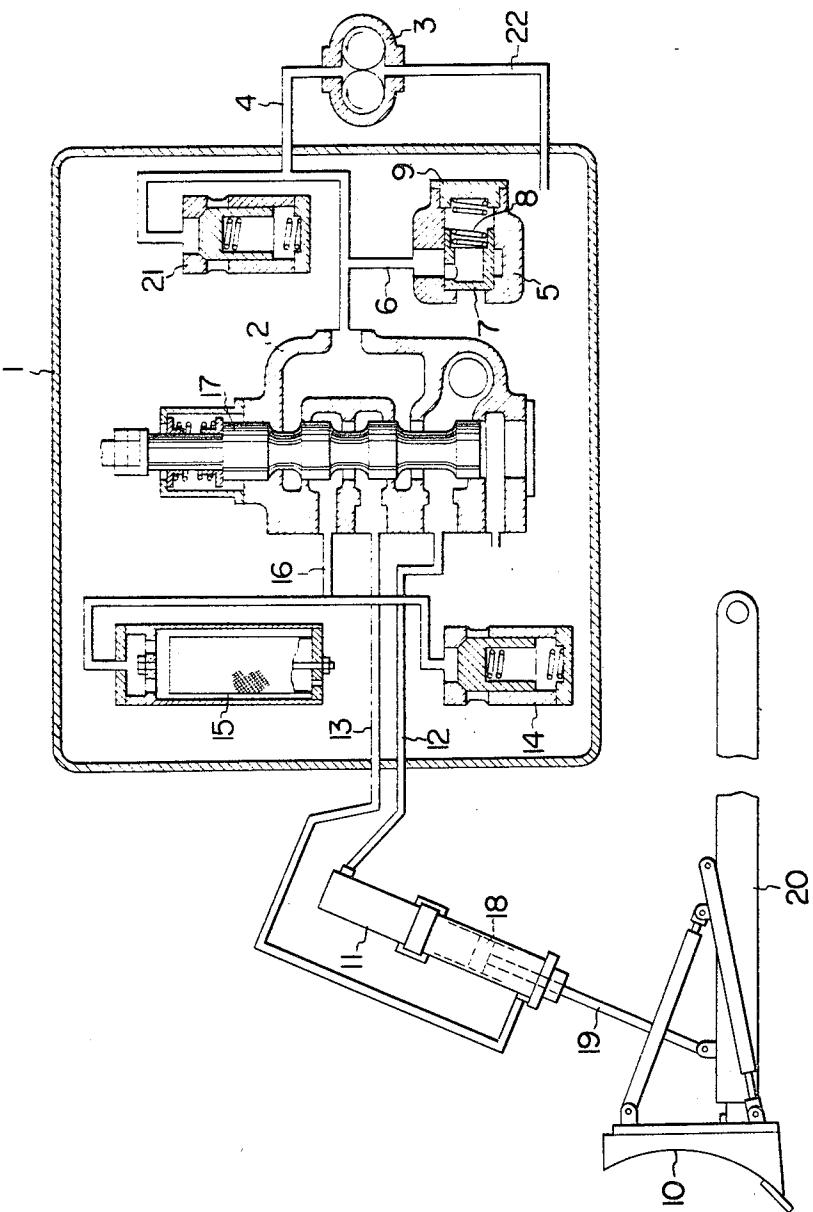
MITSUO TAKEDA ET AL
HYDRAULIC PRESSURE CONTROL DEVICE

3,496,723

Original Filed Dec. 8, 1966

2 Sheets-Sheet 1

FIG. 1



BY

INVENTORS
MITSUO TAKEDA
TOMOKI MURAKAMI
TERUHIRO KOKAJI

H. Edward Marten

Feb. 24, 1970

MITSUO TAKEDA ET AL

3,496,723

HYDRAULIC PRESSURE CONTROL DEVICE

Original Filed Dec. 8, 1966

2 Sheets-Sheet 2

FIG. 2

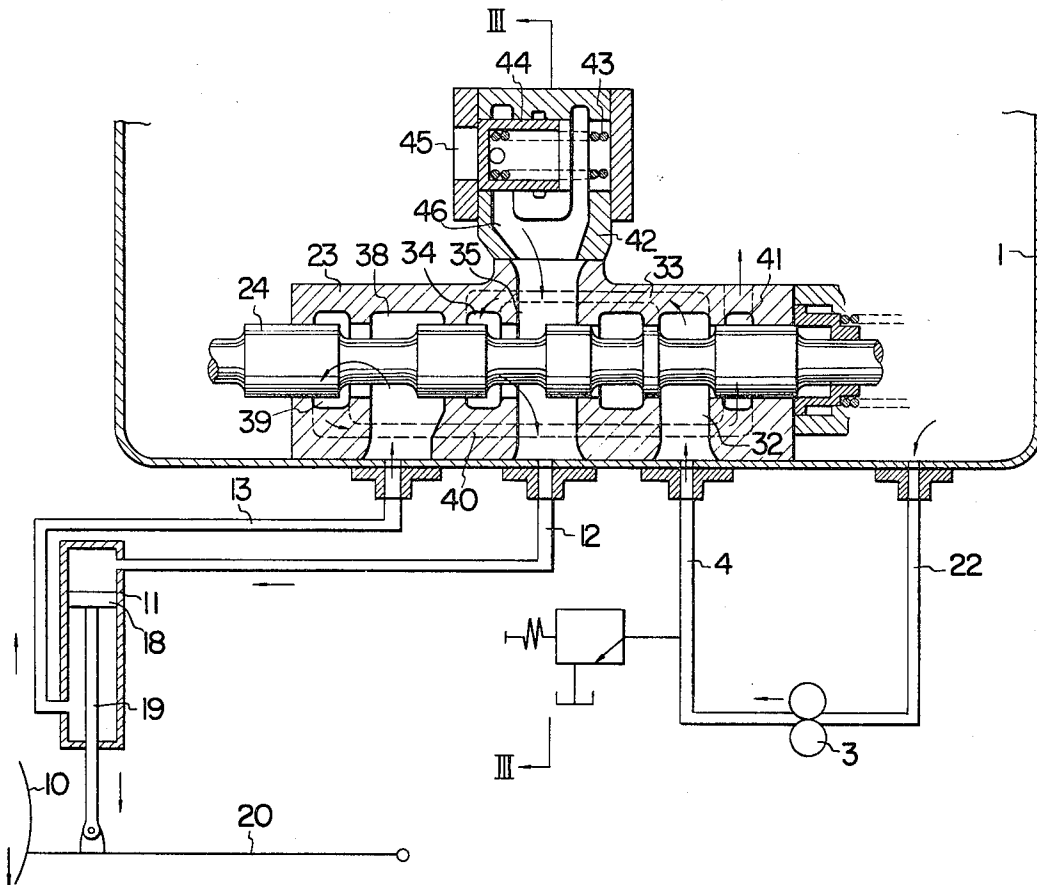
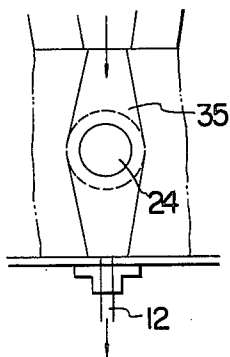


FIG. 3



BY

INVENTORS
MITSUO TAKEDA
TOMOKI MURAKAMI
TERUHISA KOKAJI

H. Edward Meston

1

3,496,723

HYDRAULIC PRESSURE CONTROL DEVICE

Mitsuo Takeda, Tokyo-to, Tomoaki Murakami, Fujisawa-shi, and Teruhisa Kokaji, Tokyo-to, Japan, assignors to Kabushiki Kaisha Komatsu Seisakusho, Tokyo-to, Japan, a joint-stock company of Japan

Continuation of application Ser. No. 600,079, Dec. 8, 1966. This application Feb. 5, 1969, Ser. No. 820,030

Claims priority, application Japan, Dec. 28, 1965,

40/80,618

Int. Cl. F15b 15/18, 1/06; F16h 41/04

U.S. Cl. 60—52

2 Claims

ABSTRACT OF THE DISCLOSURE

A hydraulic pressure control device has a pressure equalizing check valve in the hydraulic flow path between the delivery side of a hydraulic pump and a control valve and operates to direct hydraulic fluid from a fluid collecting reservoir to pass into the flow path upstream of the control valve when the pressure within the reservoir exceeds the pressure within the flow path.

This application is a streamlined continuation of Ser. No. 600,079, filed Dec. 8, 1966 and now abandoned.

This invention relates to fluid-pressure power transmission systems generally referred to as hydraulic systems and relates more particularly to a new and improved hydraulic pressure control device for operating in cooperation with a control valve for directing hydraulic fluid under pressure to one or more double-acting hydraulic motors or cylinders in a hydraulic system.

Heretofore, a hydraulic system or circuit for controlling the movements of a work implement or attachment such as a bulldozer attachment mounted on a tractor, in general, has comprised, essentially, one or more double-acting hydraulic cylinders, a fluid reservoir, a power-driven hydraulic pump, and a control valve for controlling the flow of the working fluid flowing in and out of the hydraulic cylinder or cylinders.

The control valve in such a case ordinarily has four positions as, for example, "hold," "raise," "lower," and "float." While a bulldozer mold board or shovel bucket (hereinafter referred to as "bowl") in the "float" position is capable of being freely moved in accordance with an outside force, difficulties such as the following arise when a bowl is used in connection with a hydraulic system of this general type.

Under certain operational conditions, the bowl in some cases is moved at a higher speed by its load than the speed corresponding to the rate at which the pump can supply the working fluid to the hydraulic cylinder. As a result, the fluid discharged from the hydraulic cylinder is returned to the fluid reservoir at a higher rate than the fluid delivered by the pump, and the quantity of fluid within the reservoir increases. Particularly in the case of a closed type reservoir, excessive pressure may develop and give rise to damage such as bursting of the reservoir vessel, whereby the hydraulic system is damaged and rendered inoperative.

Another inconvenience which arises in some cases is that, when it is desired to move the bowl in a certain direction under an outside force, the movement of the bowl is retarded by the delivery output of the pump. This occurrence is particularly undesirable at the time when the bowl is to be lowered, it being desirable to lower the bowl to the working position in the shortest time.

In an ordinary hydraulic circuit, it is possible for the work implement (e.g., bulldozer mechanism) to move in advance of the pump output, and a partial vacuum is pro-

2

duced in the pressure end of the hydraulic cylinder. As a result, the bowl does not descend rapidly to the work position, or, even if it does descend, the downward force of the bowl is not applied until the hydraulic cylinder is filled with the working fluid by the pump.

It is an object of the present invention to overcome the above described difficulties encountered heretofore in hydraulic mechanisms of the type with which the invention is concerned.

More specifically, an object of the invention is to provide simple and inexpensive improvements in hydraulic systems of the above stated character whereby excessive pressures are prevented from being applied to the hydraulic circuit parts, and, at the same time, the work implement (e.g., the bowl) can be caused to move very rapidly under the effect of outside forces.

Another object of the invention is to achieve the above stated objects through the use of a single aspiration valve in each hydraulic system irrespective of the number of hydraulic cylinders in the system.

According to the present invention, briefly stated, an aspiration valve is provided in the hydraulic flow path between the delivery side of the hydraulic pump and the control valve and operates to permit hydraulic fluid from the reservoir to pass directly into said hydraulic flow path when the pressure within the reservoir exceeds the pressure within said flow path.

According to the present invention, more specifically, there is provided, in a hydraulic system of the type referred to above, a hydraulic pressure control device comprising an aspiration valve provided in an intermediate point in the hydraulic flow path between the pump and the control valve and operating to aspirate fluid from the reservoir into said delivery flow path when the flowrate of fluid displaced by the piston of a hydraulic cylinder under an outside force and thereby returning to the reservoir exceeds the delivery flowrate of the pump.

The nature, principle, and details of the invention will be more clearly apparent from the following detailed description with respect to preferred embodiments of the invention when read in conjunction with the accompanying drawings, in which like parts are designated by like reference numerals.

In the drawings:

FIG. 1 is a schematic diagram, with some parts shown in disproportionately reduced scale, showing an example of a hydraulic mechanism in which the hydraulic pressure control device of the invention is utilized;

FIG. 2 is a similar schematic diagram showing a hydraulic mechanism in which another embodiment of the invention is utilized; and

FIG. 3 is a partial sectional view taken along the plane indicated by line III—III in FIG. 2.

Referring to FIG. 1, the hydraulic mechanism shown therein is provided with a fluid reservoir 1 of closed type, in the interior of which a control valve 2 is installed and connected on one side thereof to a fluid line 4 communicating with the delivery side of a hydraulic pump 3 driven by means not shown. A fluid line 6 branching from the line 4 is connected to a pressure equalizing valve or aspiration valve 5, which is installed within the reservoir 1, and within which there is fitted a slidable valve body 7 pressed against an inlet port at one end of the valve casing by a coil spring 8, which is retained in compressed state by a spring retainer 9 secured to the valve casing.

On the other side of the control valve 2, there are connected a fluid line 12 communicating with the rear end of a hydraulic cylinder 11 and a fluid line 13 communicating with the front end of the cylinder 11 for lowering and respectively raising a bowl 10, and a fluid line 16 communicating by way of branches respectively with a

3

fluid pressure regulating valve 14 and a fluid filter 15 both installed within the reservoir 1.

A spool type valve 17 is fitted within the control valve 2 and is freely operable to accomplish changeover operation whereby the fluid sent under pressure from the pump 3 can be introduced selectively into the fluid lines 12, 13, and 16.

The hydraulic cylinder 11 contains a double-acting piston 18 connected to a piston rod 19, which is coupled at its outer end to the upper part of a bulldozer frame 20. The base or rear end of this frame 20 is pivoted on the frame of a vehicle (not shown), and the front end thereof is coupled to and supports the bowl 10.

A pressure regulating valve 21 installed within the reservoir 1 is connected to another branch from the fluid line 4 between the pump 3 and the control valve 2. The interior of the reservoir 1 is communicated with the suction side of the pump through a fluid line 22.

The hydraulic mechanism of the above described composition and arrangement of parts according to the invention operates in the following manner.

Throughout the operation of the hydraulic mechanism, the pump 3 continually operates to draw the working fluid from the reservoir 1 through the fluid line 22 and to deliver the fluid through the fluid line 4 to inlet of the control valve 2.

FIG. 1 illustrates the operational state wherein the piston 18 is in its position for lowering the bowl 10, and the fluid sent under pressure from the pump 3 is being passed by the control valve 2 through the fluid line 12 to enter the rear port of the hydraulic cylinder 11 and thereby to apply pressure on the upper or rear surface of the piston 18.

In the case of an ordinary hydraulic mechanism in the above described operational state, the bowl and parts connected thereto are urged by their own weights to descend, whereby a partial vacuum is readily formed above the upper or rear surface of the piston 18, especially when the pump 3 is rotating at low speed. At the same time, the pressure on the front or lower surface of the piston 18 becomes high, and this high pressure is transmitted through the fluid lines 13 and 16 and filter 15 and into the reservoir 1, whereupon the reservoir 1 and fluid lines 12 and 16 are subjected to an abnormally high pressure and, heretofore, have been damaged in many instances.

In accordance with the present invention, the above described problem is solved in the following manner. A rapid descent of the bowl 10 causes the fluid below the lower surface of the piston 18 to flow rapidly through the fluid line 13, through the control valve 2, and into the interior of the reservoir 1 to cause the pressure within the reservoir 1 to increase. Simultaneously, however, the pressure above the upper surface of the piston 18 and in the fluid lines 12, 4, and 6 becomes lower than the pressure within the reservoir 1. Consequently, the fluid within the reservoir 1 imparts a force on the valve body 7 of the aspiration valve 5, overcoming the force of the spring 8, to open the valve 7 and flows through the fluid line 6, control valve 2, and fluid line 12 to enter the rear end of the cylinder 11. Accordingly, development of excessively high pressure on the reservoir side is prevented, and, at the same time, the development of a partial vacuum above the upper surface of the piston 18, that is, in the rear end of the cylinder 11, is prevented, whereby the above described problem is overcome.

In the case when the bowl is raised rapidly, the reverse operation occurs. That is, the fluid above the upper surface of the piston 18 flows rapidly through the fluid line 12 into the reservoir side, and the fluid within the reservoir 1 simultaneously flows through the aspiration valve 5 into the fluid lines on the fluid delivery side and is compensatingly supplied to the cylinder below the lower surface of the piston 18, whereby the bowl 10 is permitted to rise rapidly, and, at the same time, damage to the parts on the reservoir side is fully prevented.

4

In another embodiment of the invention as illustrated in FIGS. 2 and 3, all exposed fluid lines within the reservoir 1 have been eliminated by mounting a control valve provided with built-in communicating passages directly against an inner surface of the wall of the reservoir 1, the ports for communication with the components of the hydraulic system outside of the reservoir 1 being disposed flush against the wall and connected directly with corresponding outside fluid lines, and mounting an aspiration valve directly on the control valve.

In FIGS. 2 and 3, reference numerals 1 through 22, inclusive, designate the same or equivalent parts as in FIG. 1. The other reference numerals and parts designated thereby (all within the reservoir 1 and constituting parts of the control valve and pressure equalizing valve) are as follows:

Control valve 23; spool valve 24; built-in fluid passages 33 and 40; hydraulic chambers 32, 34, 35, 38, 39, 41, and 46; and aspiration valve 42 with spring 43, valve 44, and inlet 45.

The hydraulic mechanism illustrated in FIGS. 2 and 3 operates in the following manner, which is similar to the manner in which the mechanism shown in FIG. 1 operates.

The pump 3 draws the working fluid from within the reservoir 1 through the fluid line 22 and delivers the fluid through the fluid line 4 and fluid passage 33 into the hydraulic chamber 34. The fluid so delivered is then caused to flow in a path as determined by the control position of the spool valve 24.

FIGS. 2 and 3 show the operational state of the hydraulic mechanism wherein the piston 18 is being forced downward. The fluid delivered from the pumps 3 flows through the chambers 34 and 35 and the fluid line 12 and enters the upper or rear end of the cylinder 11 to act downwardly on the upper surface of the piston 18.

As described hereinbefore, the bowl 10 ordinarily tends to descend under the force of gravity at a speed higher than that corresponding to the supply of fluid by the pump 3, whereby a partial vacuum readily develops above the piston 18, especially when the pump 3 is operating at low speed. At the same time, the pressure of the fluid on the opposite or lower side of the piston 18 becomes high, and this fluid passes through the fluid line 13, chambers 38 and 39, fluid passage 40, and chamber 41 and flows out into the reservoir 1. As a result, an abnormally high pressure develops in the reservoir 1 and in the circuit from the lower surface of the piston 18 to the reservoir 1, whereby these parts are subject to damage. Moreover, the descent of the bowl 10 is retarded.

In accordance with this embodiment of the invention, the above described problem is overcome by mounting an aspiration valve 42 in direct communication with the hydraulic chamber 35 of the control valve 23. More specifically, when a rapid descent of the bowl 10 causes the pressure in the cylinder above the upper surface of the piston 18, fluid line 12, chambers 35, 34, and 32, fluid passage 33, and fluid line 4 to become lower than the pressure within the reservoir 1, the valve 44 of the pressure equalizing valve 42 is forced inward, overcoming the force of the spring 43, whereupon the fluid in the reservoir 1 enters through the inlet 45 and, passing through the chambers 46 and 35 and fluid line 12, compensatingly nullifies the partial vacuum above the upper surface of the piston 18 of the cylinder 11. Accordingly, the above described problem is overcome.

Thus, according to the present invention, a single aspiration valve is provided between the hydraulic pump and control valve in a hydraulic system for actuating mechanisms such as a bulldozer attachment, whereby damage to the hydraulic fluid reservoir and various hydraulic lines and passages is completely prevented. At the same time, moreover, retardation of the movements of the actuated mechanism can be prevented, whereby work efficiency is increased.

Furthermore, these advantageous features can be at-

5

tained by the use of a single aspiration valve even in the case where a plurality of hydraulic cylinders are employed. Accordingly, there is no necessity of installing a pressure relieving valve for each hydraulic cylinder in accordance with a known practice.

While the present invention has been described with respect to its application to particular examples of hydraulic systems for actuating a bulldozer attachment, it will be apparent to those skilled in the art that the teachings of this invention can be applied to many other hydraulic systems including those for tractor shovels, fork lifts, powered loaders, and other work equipment.

What we claim is:

1. A hydraulic power transmission system comprising: at least one double-acting cylinder; a closed reservoir for hydraulic fluid; a power-driven hydraulic pump provided outside of said fluid reservoir and having at its flow inlet a flow path communicating with said reservoir; a control valve disposed within said reservoir and having an inlet and a plurality of outlets, the inlet being communicated through a fluid path with a discharge outlet of said pump and the outlets being communicated through fluid paths with both ends of said double-acting cylinder to selectively direct hydraulic fluid under pressure fed from said pump through either of said fluid paths to an end of said cylinder; and a hydraulic pressure control device provided com-

6

municatively between said pump and said control valve and composed of a spring biased check valve communicating with said reservoir and with said flow paths of the hydraulic fluid through said control valve and the hydraulic cylinder, said hydraulic pressure control device operating to pass fluid from said reservoir into said control valve by way of the flow path when the pressure within the reservoir exceeds the pressure within said flow path, thereby equalizing the pressure within the reservoir and the fluid flow paths.

2. A hydraulic power transmission system according to claim 1, wherein said hydraulic pressure control device is directly communicated with the control valve at the inlet thereof.

References Cited

UNITED STATES PATENTS

2,543,989	3/1951	Rockwell.	
2,650,473	9/1953	Bridwell et al.	
2,986,166	5/1961	Hoen.	
3,366,015	1/1968	Haas et al.	60—53 XR
3,369,360	2/1968	De Biasi	60—53 XR

EDGAR W. GEOGHEGAN, Primary Examiner

U.S. Cl. X.R.

91—436