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**PRESSURE OIL FEED CIRCUIT DEVICE FOR HYDRAULIC CYLINDER OF OPERATION MACHINE.**

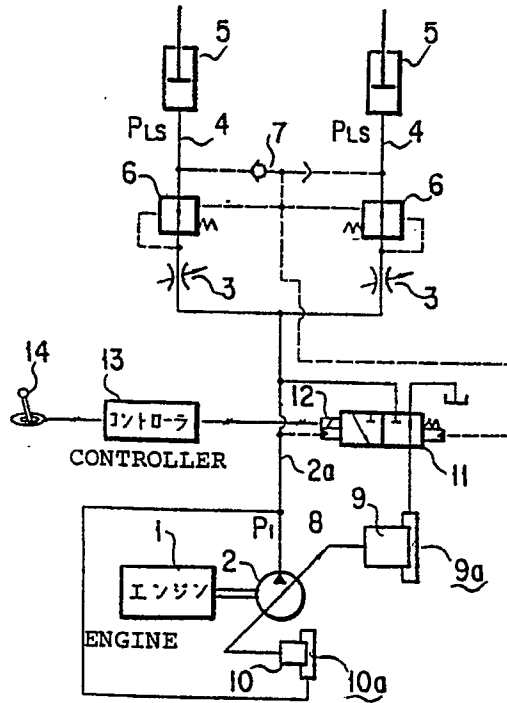
This invention intends to provide a pressure oil feed circuit device for a hydraulic cylinder of an operation machine which can control a pump discharge flow rate so that the difference between a pump discharge pressure and a load pressure becomes constant during the normal operation of the operation machine and can control the discharge flow rate of the pump so to decrease it during the fine operation of the operation machine. The pressure oil feed circuit device includes a larger diameter piston (9) for operating the capacity regulation member (8) of a variable capacity pump (2) in such a direction as to reduce the pump capacity; a small-

er diameter piston (10) for operating the capacity regulation member (8) of the variable capacity pump (2) in such a direction as to increase the pump capacity, the smaller diameter piston (10) having a small diameter piston pressure receiving chamber (10a) connected to the pump discharge passage (2a); a load sensing valve (11) for establishing/cutting off communication between the pressure receiving chamber (9a) of the larger diameter piston and the pump discharge passage; and means (12, 13, 14) for providing the load sensing valve with a push force exerted in the direction of establishing communication between the pump dis-

charge passage (2a) and the larger diameter piston pressure receiving chamber (9a).

FIG. 1

第 1 図



## TECHNICAL FIELD OF THE INVENTION

This invention relates to a hydraulic circuit apparatus for supplying fluid under pressure discharged by a hydraulic pump into hydraulic cylinders for actuating a work implement of a construction vehicle such as a power shovel or the like.

## BACKGROUND ART OF THE INVENTION

A hydraulic circuit apparatus arranged so as to supply fluid under pressure discharged by a hydraulic pump into hydraulic cylinders for a work implement through operating valves is heretofore well known.

In case of conducting earth scraping-off operation and slope correcting operation by a power shovel, it is necessary to perform inching operation of the work implement of the power shovel. This inching operation of the work implement is achieved by supplying extremely small amounts of fluid under pressure discharged by a hydraulic pump into hydraulic cylinders for the work implement.

In the prior art pressurized fluid supplying circuit apparatus, however, to control the amount of fluid under pressure to be supplied into hydraulic cylinders for the work implement, the area of opening between the pump port and the outlet port is controlled finely by minimizing the operational stroke of operating valves. However, it is impossible to control finely the amount of fluid under pressure to be supplied into the hydraulic cylinders for the work implement only by controlling the area of opening finely, and also it is impossible to inch the work implement as desired, and as a result, the operational accuracy in earth scraping-off operation and slope correcting operation becomes low.

## SUMMARY OF THE INVENTION

The present invention has been made in view of the above-mentioned circumstances, and has for its object to provide a hydraulic circuit apparatus for supplying fluid under pressure into hydraulic cylinders for a work implement wherein during normal operation of the work implement the flow rate of fluid under pressure discharged by a hydraulic pump is controlled in such a manner that the difference between the discharge pressure of the pump and the load pressure is always kept constant, whilst during inching operation of the work implement the flow rate of fluid discharged by the pump is reduced.

To achieve the above-mentioned object, according to a first aspect of the present invention, there is provided a hydraulic circuit apparatus for

supplying fluid under pressure into hydraulic cylinders for a work cylinder arranged so as to connect a discharge passage of a variable displacement pump through operating valves with the cylinders for the work implement, the apparatus comprising a large diameter piston for actuating a displacement regulating member of the variable displacement pump in such a direction as to reduce the displacement of the pump; a small diameter piston having a pressure receiving chamber connected with the discharge passage of the pump and adapted to actuate the displacement regulating member of the pump in such a direction as to increase the displacement of the pump; a load sensing valve adapted to connect or disconnect the pressure receiving chamber of the large diameter piston with or from the discharge passage of the pump; and means for applying pushing forces to the load sensing valve so as to push its spool in such a direction as to communicate the discharge passage of the pump with the pressure receiving chamber of the large diameter piston, wherein during normal operation of the work implement the flow rate of fluid discharged by the pump is controlled in such a manner that the difference between the discharge pressure of the pump and the load pressure is always kept constant, whilst during inching operation of the work implement the flow rate of fluid discharged by the pump is reduced.

According to a second aspect of the present invention, there is provided a hydraulic circuit apparatus for supplying fluid under pressure into hydraulic cylinders for a work implement as set forth in the first apparatus, wherein the pushing force applying means comprises: a proportional position action electromagnetic solenoid provided on one side of the load sensing valve; a mode change-over switch for the electromagnetic solenoid; and a controller adapted to receive an inching operation mode signal transmitted by the mode change-over switch and send an electric current to the electromagnetic solenoid.

Further, according to a third aspect of the present invention, there is provided a hydraulic circuit apparatus for supplying fluid under pressure into hydraulic cylinders for a work implement as set forth in the first aspect, wherein the pushing force applying means comprises: a pilot pump; a conduit for introducing pilot fluid under pressure discharged by the pilot pump into a pressure receiving section provided on one side of the load sensing valve; a change-over valve provided in the conduit; a proportional position action electromagnetic solenoid provided on one side of the change-over valve; a mode change-over switch for the electromagnetic solenoid; and a controller adapted to receive an inching operation mode signal transmitted by the mode change-over switch and send

an electric current to the electromagnetic solenoid.

According to the present invention incorporating the above-mentioned aspects, since the flow rate of fluid discharged by the variable displacement pump is controlled in such a manner that the difference between the discharge pressure of the pump and the load pressure is always kept constant, a stable operation of the work implement is ensured, and also during inching operation of the work implement the displacement regulating member of the variable displacement member of the variable displacement pump can be actuated in such a direction as to reduce the displacement of the pump by applying pushing forces to the load sensing valve so as to push its spool in such a direction as to communicate the discharge passage of the pump with the pressure receiving chamber of the large diameter piston. Accordingly, since during inching operation of the work implement the flow rate of fluid discharged by the variable displacement pump can be reduced, the amount of fluid under pressure to be supplied into the hydraulic cylinders for the work implement can be controlled finely to an extremely small amount so that the inching operational characteristic can be enhanced.

The above-mentioned and other objects, aspects and advantages of the present invention will become apparent to those skilled in the art when reference is made to the following description and the accompanying drawings in which preferred embodiments incorporating the principles of the present invention are shown by way of example only.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a hydraulic circuit diagram showing a first embodiment of the present invention;

Fig. 2 is a graph showing the relationship between the flow rate of fluid under pressure supplied into hydraulic cylinders for a work implement and the stroke of an operating valve associated therewith; and

Fig. 3 is a hydraulic circuit diagram showing a second embodiment of the present invention.

#### DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The present invention will now be described in detail below by way of several preferred embodiments thereof with reference to the accompanying drawings.

Referring first to Figs. 1 and 2, the first embodiment of the present invention is described.

A variable displacement pump 2 driven by an engine 1 has a discharge passage 2a connected with inlets of a plurality of operating valves 3, whose outlet sides are connected by their respec-

tive conduits 4 with hydraulic cylinders 5 of work implements, respectively. Each conduit 4 is provided with a pressure compensating valve 6. The load pressures  $P_{LS}$  in the conduits 4 are compared by a shuttle valve 7, and a higher load pressure  $P_{LS}$  detected as a result of the comparison is introduced into spring chambers of the pressure compensating valves 6 so that the valves 6 may be set at a pressure corresponding to the higher load pressure  $P_{LS}$ .

By so doing, the fluid under pressure discharged by one variable displacement pump 2 can be supplied to the hydraulic cylinders 5 for work implement.

The displacement of fluid from the variable displacement pump 2 is controlled so that the difference between the discharge pressure  $P_1$  and the load pressure  $P_{LS}$  is always kept constant.

Stating more specifically, a displacement regulating member 8 of the variable displacement pump 2 is actuated by a large piston 9 in such a direction as to reduce the displacement, and by a small piston 10 in such a direction as to increase the displacement. Further, a pressure receiving chamber 9a of the large piston 9 is controlled to be selectively connected through a load sensing valve 11 either with a fluid tank or with the discharge passage 2a, and a pressure receiving chamber 10a of the small piston 10 is connected with the discharge passage 2a.

The above-mentioned load sensing valve 11 has a spool arranged to be pushed by the pressure in the discharge passage 2a; that is, the discharge pressure  $P_1$  and the thrust created by a proportional position action electromagnetic solenoid 12 in such a direction as to increase the area of its port communicating with the pressure receiving chamber 9a of the large piston 9, and also pushed by the outlet pressure in the operating valves 3; that is, the load pressure  $P_{LS}$  in such a direction as to reduce the area of the port thereof communicating with the pressure receiving chamber 9a. This load sensing valve 11 is arranged to effect control such that where the thrust created by the proportional position action electromagnetic solenoid 12 is zero, and when the difference between the discharge pressure  $P_1$  and the load pressure  $P_{LS}$  ( $P_1 - P_{LS}$ ) is increased, the pressure in the pressure receiving chamber 9a of the large piston 9 is increased so as to actuate the displacement regulating member 8 in such a direction as to reduce the displacement to thereby reduce the discharge flow rate per one revolution to reduce the discharge pressure  $P_1$ . Whilst, where the thrust created by the solenoid 12 is zero, and when the difference between the discharge pressure  $P_1$  and the load pressure  $P_{LS}$  ( $P_1 - P_{LS}$ ) is reduced, the pressure in the pressure receiving chamber 9a of

the large piston 9 is reduced so as to actuate the displacement regulating member 8 in such a direction as to increase the displacement to thereby increase the discharge flow rate per one revolution to increase the discharge pressure  $P_1$ , whereby controlling the displacement of fluid from the variable displacement pump 2 so that the difference between the discharge pressure  $P_1$  and the load pressure  $P_{LS}$  ( $P_1 - P_{LS}$ ) may always be kept constant. Further, when a thrust is created by the proportion position action electromagnetic solenoid 12, the spool of the load sensing valve 11 is pushed in such a direction as to increase the area of the port thereof communicating with the pressure receiving chamber 9a so as to increase the pressure in the chamber 9a of the large piston 9 regardless of the pressure between the discharge pressure  $P_1$  and the load pressure  $P_{LS}$  to move the displacement regulating member 8 in a direction to reduce the displacement, thereby reducing the flow rate of fluid per one revolution.

Stating in brief, the pressure between the discharge pressure  $P_1$  and the load pressure  $P_{LS}$  is reduced by the thrust created by the proportional position action solenoid 12 so as to reduce the discharge flow rate of fluid from the variable displacement pump 12.

The above-mentioned proportional position action electromagnetic solenoid 12 is supplied with electric current from a controller 13, to which a mode signal from a mode change-over switch 14 is inputted. When a normal mode signal is inputted by the mode change-over switch 14 to the controller 13, the proportional position action electromagnetic solenoid 12 is not supplied with electric current, whilst when an inching operation mode signal is inputted by the mode change-over switch 14 to the controller 13, the electromagnetic solenoid 12 is supplied with electric current.

Such being the arrangement, during inching of the work implement, the flow rate of fluid discharged by the variable displacement pump 2 becomes less than that in the normal operation, so that the flow rate of fluid to be supplied into the hydraulic cylinders 5 for work implement changes in proportion to the stroke of the operating valves 3 as shown by a dotted line "A" in Fig. 2 and becomes less than the flow rate of fluid in the normal operation as shown by a solid line B in Fig. 2, thus rendering it possible to effect fine control of the amount of fluid supplied into the hydraulic cylinders 5 for the work implement to improve the inching operation characteristic.

Fig. 3 shows the second embodiment of the present invention. In this embodiment, a pilot pump 15 is driven by an engine 1, and a discharge passage 15a of the pump 15 is connected through a change-over valve 16 with a pressure receiving

section 11a of a load sensing valve 11. The change-over valve 16 is arranged to be kept at its shut-off position I by the resilient force of a spring mounted therein, and also kept at its communicating position II when its solenoid 16 is energized. The solenoid 16 is supplied with electric current from a power supply through a mode change-over switch 14 and the controller 13.

Further, the component parts shown in Fig. 3 with the same reference numerals as those used in the first embodiment shown in Fig. 1 are the same component parts, and therefore description of them is omitted herein to avoid duplication of explanation.

In the second embodiment shown in Fig. 3, when a mode change-over switch 14 is located at its inching operation mode position so as to input an inching operation mode signal from the switch 14 to a controller 13 and send an electric current to a solenoid 16a, thereby energizing the same, a change-over valve 16 is changed over to its communicating position II so that the pilot fluid under pressure from a pilot pump 15 is supplied into a pressure receiving section 11a of a load sensing valve 11, and as a result, its spool is pushed in such a direction as to increase the area of the port thereof communicating with pressure receiving chamber 9a of a large piston 9, thereby reducing the amount of fluid discharged by a variable displacement pump 2.

## Claims

1. A hydraulic circuit apparatus for supplying fluid under pressure into hydraulic cylinders for a work implement arranged so as to connect a discharge passage of a variable displacement pump through operating valves with the cylinders for the work implement, said apparatus comprising a large diameter piston for actuating a displacement regulating member of said variable displacement pump in such a direction as to reduce the displacement of the pump; a small diameter piston having a pressure receiving chamber connected with said discharge passage of the pump and adapted to actuate the displacement regulating member of said pump in such a direction as to increase the displacement of the pump; a load sensing valve adapted to connect or disconnect the pressure receiving chamber of said large diameter piston with or from the discharge passage of said pump; and means for applying pushing forces to the load sensing valve so as to push its spool in such a direction as to communicate the discharge passage of said pump with the pressure receiving chamber of said large diameter piston, wherein during normal operation of

the work implement the flow rate of fluid discharged by the pump is controlled in such a manner that the difference between the discharge pressure of the pump and the load pressure is always kept constant, whilst during inching operation of the work implement the flow rate of fluid discharged by the pump is reduced.

2. A hydraulic circuit apparatus for supplying fluid under pressure into hydraulic cylinders for a work implement as claimed in claim 1, wherein said pushing force applying means comprises: a proportional position action electromagnetic solenoid provided on one side of said load sensing valve; a mode change-over switch for the electromagnetic solenoid; and a controller adapted to receive an inching operation mode signal transmitted by the mode change-over switch and send an electric current to said electromagnetic solenoid.
3. A hydraulic circuit apparatus for supplying fluid under pressure into hydraulic cylinders for a work implement as claimed in claim 1, wherein said pushing force applying means comprises: a pilot pump; a conduit for introducing pilot fluid under pressure discharged by the pilot pump into a pressure receiving section provided on one side of said load sensing valve; a change-over valve provided in the conduit; a proportional position action electromagnetic solenoid provided on one side of the change-over valve; a mode change-over switch for the electromagnetic solenoid; and a controller adapted to receive an inching operation mode signal transmitted by the mode change-over switch and send an electric current to said electromagnetic solenoid.

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FIG. 1

第 1 図

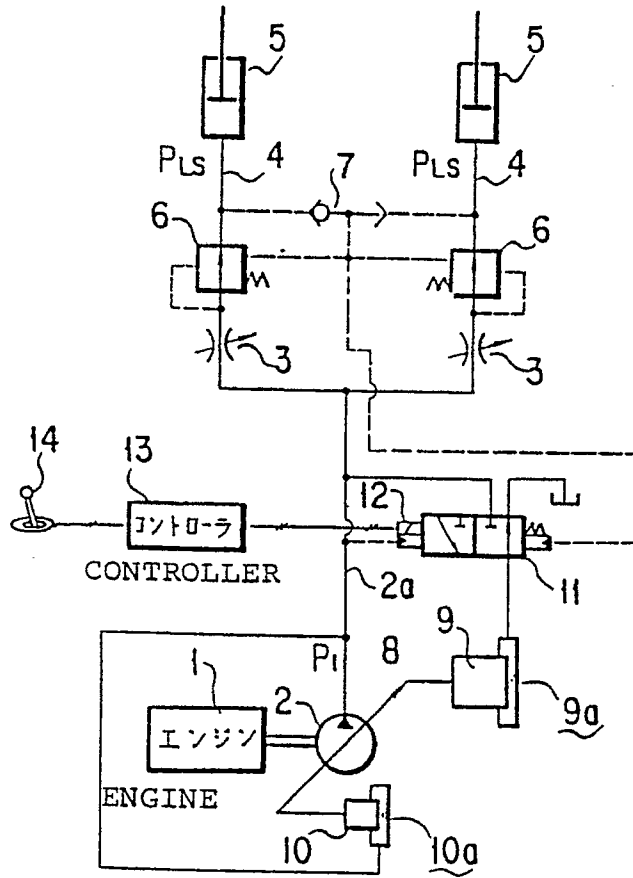
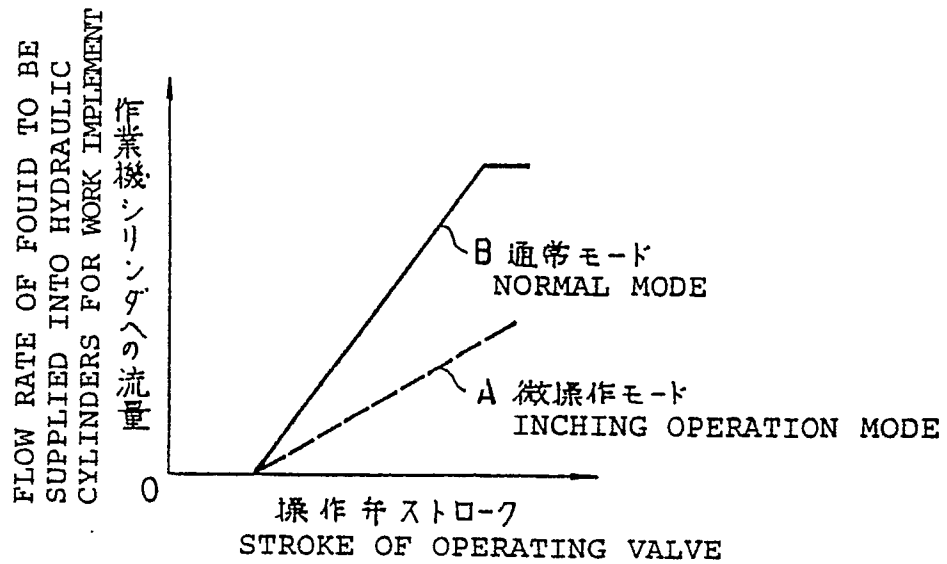


FIG. 2

第 2 図





# INTERNATIONAL SEARCH REPORT

International Application No PCT/JP90/01050

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (if several classification symbols apply, indicate all) <sup>6</sup>				
According to International Patent Classification (IPC) or to both National Classification and IPC				
Int. Cl <sup>5</sup> F15B11/00, E02F9/22, F04B49/00				
<b>II. FIELDS SEARCHED</b>				
Minimum Documentation Searched <sup>7</sup>				
Classification System	Classification Symbols			
IPC	F15B11/00, F15B11/05, E02F9/22, F04B49/00, F15B11/04			
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched <sup>8</sup>				
Jitsuyo Shinan Koho	1926 - 1990			
Kokai Jitsuyo Shinan Koho	1971 - 1990			
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT</b> <sup>9</sup>				
Category <sup>9</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>		
A	JP, A, 59-69505 (Daikin Industries, Ltd.), 19 April 1984 (19. 04. 84), (Family: none)	1 - 3		
<p><sup>10</sup> Special categories of cited documents:</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 50%; border: none;"> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </td> <td style="width: 50%; border: none;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>"&amp;" document member of the same patent family</p> </td> </tr> </table>			<p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p>	<p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>"&amp;" document member of the same patent family</p>
<p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p>	<p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>"&amp;" document member of the same patent family</p>			
<b>IV. CERTIFICATION</b>				
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report			
October 30, 1990 (30. 10. 90)	November 13, 1990 (13. 11. 90)			
International Searching Authority	Signature of Authorized Officer			
Japanese Patent Office				