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European Patent Office  
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Publication number: **0 553 347 A1**

**EUROPEAN PATENT APPLICATION**  
published in accordance with Art.  
158(3) EPC

Application number: **90903215.3**

Int. Cl.<sup>5</sup>: **E02F 9/22**

Date of filing: **20.02.90**

International application number:  
**PCT/JP90/00195**

International publication number:  
**WO 91/13218 (05.09.91 91/21)**

Date of publication of application:  
**04.08.93 Bulletin 93/31**

Designated Contracting States:  
**DE FR GB IT**

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**HYDRAULIC DRIVING DEVICE OF CONSTRUCTION MACHINERY.**

This invention relates to a hydraulic driving device of a travelling machine or working machine in construction machinery such as a power shovel, a shovel bulldozer, a bulldozer, and so forth. The device includes a hydraulic driving mechanism actuated by oil pressure, a means for supplying the oil pressure to an oil pressure piping arrangement system for this hydraulic driving mechanism and a means for controlling this oil pressure supply means and lowering the oil pressure supply speed in the oil pressure piping arrangement system and based on the oil pressure supply in a predetermined zone after a dead zone in which the oil pressure rises. Accordingly, while the delay of the operation of the hydraulic driving mechanism is prevented, the shock

at the start and stop can be prevented.

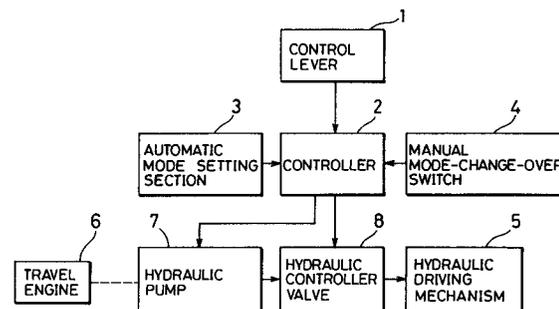


FIG. 1

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## TECHNICAL FIELD

The present invention relates to hydraulically-operated equipment such as travelling equipment and working equipment for use in construction machinery such as a power shovel, shoveldozer and bulldozer. Among the working equipment are buckets, tilting apparatus, slewing apparatus etc.

## BACKGROUND ART

In one known type of hydraulically-operated equipment such as travelling equipment and working equipment which are provided in the aforesaid construction machines according to the needs of various kinds of construction works including travelling and working operations, hydraulic pressure for actuating the hydraulic driving mechanism which is driven by hydraulic pressure in the hydraulically-operated equipment is supplied, at a constant supplying rate, to the pipeline system of the hydraulic driving mechanism, by means of hydraulic controller valves, hydraulic pumps and similar devices. In other words, the hydraulic driving mechanism is driven by hydraulic pressure, the pressure being supplied at such a constant supplying rate that it rises and drops rectilinearly.

Such hydraulically-operated equipment, however, has the following disadvantages: since hydraulic pressure is supplied at a constant supplying rate, when a high supplying rate is adopted, the hydraulic driving mechanism driven by hydraulic pressure abruptly starts or stops its operation immediately after the dead zone period in which hydraulic pressure starts to rise. As a result of this, the mechanism receives a great shock at the time of start-up and shut-down. On the other hand, when the supplying rate is low, the operation of the hydraulic driving mechanism driven by hydraulic pressure becomes sluggish so that there occurs a lag in the operation even though the mechanism can be free from a shock at the time of its start-up and shut-down.

This is a serious problem, particularly in the use of hydraulically-operated equipment in which more than two operation speed modes, e.g., a high travelling-speed mode, and low travelling-speed mode; and digging mode (i.e., normal speed mode) and moderating mode (i.e., half speed mode) can be selected. Because a great shock is caused at the time of start-up and shut-down with one mode whilst with the other mode, an operational lag occurs.

It is therefore a prime object of the invention to provide hydraulically-operated equipment for use in construction machinery, which is capable of overcoming the foregoing disadvantages by eliminating a shock at the time of start-up and shut-down and

preventing a lag in the operation.

## DISCLOSURE OF INVENTION

In order to accomplish the above object, the hydraulically-operated equipment according to the invention comprises:

- 5 (a) a hydraulic driving mechanism actuated by hydraulic pressure;
- 10 (b) hydraulic pressure supplying means for supplying hydraulic pressure to a hydraulic pipeline system for the hydraulic driving mechanism; and
- 15 (c) controlling means for controlling the hydraulic pressure supplying means such that the supplying rate at which hydraulic pressure is supplied to the hydraulic pipeline system, the rate being based on the supply of hydraulic pressure, is decreased during a specified period after a dead zone period in which hydraulic pressure starts to rise.

In the above arrangement, the controlling means may include a plurality of control modulation patterns of the hydraulic pressure supplying means for determining the supplying rate at which hydraulic pressure is supplied to the hydraulic pipeline system and may control the hydraulic pressure supplying means according to one of the control modulation patterns which has been selected in compliance with an operation mode. The hydraulic pressure supplying means may be a hydraulic controller valve and/or hydraulic pump.

According to the invention, the hydraulic pressure supplying rate at the hydraulic pipeline system, namely, the rising and dropping rates of hydraulic pressure are decreased during a specified period (represented by the period between I and II in Fig. 2) in the operating zone period, the specified period succeeding the dead zone period in which hydraulic pressure starts to rise. In other words, the motion of the hydraulic driving mechanism is made sluggish by decreasing the hydraulic pressure supplying rate in the specified period in which great momentum is imparted to the hydraulic driving mechanism. On the other hand, the motion of the hydraulic driving mechanism is made fast by maintaining the hydraulic pressure supplying rate to be high in the dead zone period and the operating zone period excluding the above specified period. During those periods, great momentum is not imparted to the hydraulic driving mechanism. The above arrangement makes it possible to prevent such an undesirable situation that the working state of the hydraulic driving mechanism is abruptly changed. Therefore, the entire operation of the hydraulic driving mechanism is carried out so smoothly that a shock which may occur at the time of start-up and shut-down is prevented. Further, a delay in the operation can be positively avoided

since the operation of the hydraulic driving mechanism is kept at a high speed in the dead zone period and in the operating zone period excluding the specified period. In the case the equipment has more than two operation modes having different operation speeds, such an unfavourable situation that there occurs a shock with one mode at the time of start-up and shut-down whilst an operational lag occurs with the other mode will no longer happen.

#### BRIEF DESCRIPTION OF DRAWINGS

Figs. 1 and 2 illustrate a preferable embodiment of hydraulically-operated equipment for construction machinery according to the invention. Fig. 1 is a block diagram of a hydraulic system and Fig. 2 graphically shows control modulation patterns.

#### BEST MODE FOR CARRYING OUT THE INVENTION

Reference is now made to the drawings for explaining an embodiment of hydraulically-operated equipment for construction machinery according to the invention.

A construction machine with crawler belts which moves back and forth and slews freely such as a power shovel, for example, is provided with working equipment such as a bucket, tilting apparatus or slewing apparatus which is hydraulically-operated equipment. Such working equipment has a hydraulic system as shown in Fig. 1.

In Fig. 1, an operation signal generated according to the operating conditions of a control lever 1 consisting of an electric lever is supplied to a controller 2. The above operating conditions are, concretely, rapid operation (represented by the dashed line a in Fig. 2), normal operation (the dashed line b), slow operation (the dashed line c) and reverse operation (the dashed line z). Those operations are carried out at control speeds in the range from the minimum value "0" to the maximum value "full stroke" and will be described later in detail. The controller 2 is also provided with set mode signals from an automatic mode setting section 3 and a manual mode-change-over switch 4. The set mode signals are each based on one of operation modes such as an digging mode, moderating mode etc., the operation mode being specified by the automatic mode setting section 3 or the manual mode-change-over switch 4. The automatic mode setting section 3 is for automatically selecting one operation mode according to operational requirements for the construction machine and particularly the working equipment. The manual mode-change-over switch 4 is operated by the operator to select one of the above operation

5 modes in accordance with the working state of the machine. In accordance with the operation signal from the control lever 1 and the set mode signals from the automatic mode setting section 3 and the manual mode-change-over switch 4, the controller 2 controls the rate at which hydraulic pressure is supplied to the hydraulic pipeline system of a hydraulic driving system 5 provided in a bucket, tilting apparatus or slewing apparatus, by selecting one of preset control modulation patterns (in this embodiment, three patterns are preset). More specifically, the pumping rate of a hydraulic pump 7 actuated by a travel engine 6 for driving the construction machine to travel back and forth and slew and the spool drive of a hydraulic controller valve 8 for determining the flow path and flow rate of hydraulic oil pressurised by the hydraulic pump 7 are increased or decreased whereby the controller 2 controls the hydraulic pressure supplying rate according to selected one of the control modulation patterns.

When the operator specifies a setting which allows the operation modes to be selectively changed by the manual mode-change-over switch 4, the controller 2 processes the set mode signal sent from the manual mode-change-over switch 4 in preference to the set mode signal from the automatic mode setting section 3.

Now there will be given an explanation on the relationship between the operation modes to be selected by the automatic mode setting section 3 or the manual mode-change-over switch 4 and the three control modulation patterns installed in the controller 2 whilst making reference to Fig. 2. The continuous lines A, B and Z represent the three types of control modulation patterns.

As shown in Fig. 2, except for the dead zone period (the initial period) in which hydraulic pressure starts to rise and the latter operating zone period (the closing period) during which great momentum is not imparted to the hydraulic driving mechanism 5, each of the control modulation patterns A, B and Z achieves satisfactory operational effects after the rise of hydraulic pressure. In the former operating zone period (the middle period from I to II) during which great momentum is imparted to the hydraulic driving mechanism 5, this period being at the middle of the stroke and accounting for about 30% of it in this embodiment, the hydraulic pressure supplying rate is set less than those of the other periods. In short, in the former operating zone period during which great momentum is imparted to the hydraulic driving mechanism 5, the movement of the hydraulic driving mechanism 5 is restrained thereby preventing a shock caused at the time of start-up and shut-down. On the other hand, in the dead zone period and the latter operating zone period during which

the hydraulic driving mechanism 5 is not subject to great momentum, the hydraulic pressure supplying rate is not decreased but maintained to be high so that an operational lag is prevented. Decreasing the hydraulic pressure supplying rate in the former operating zone period can prevent not only a shock but also cavitation which may be caused in the hydraulic pipeline system by the hydraulic pump 7.

The controller 2 selects, in the following manner, one of the control modulation patterns A, B and Z in accordance with the operation mode specified by the automatic mode setting section 3 or the manual mode-change-over switch 4.

Taking working equipment for a power shovel for instance, with the digging mode, the control modulation pattern B is selected so that no great shock will occur and the operation will be carried out in a smooth and gentle manner in the course of heavy digging operation. With the moderating mode on the other hand, the control modulation pattern A is selected so that there will occur no operational lag. Regarding travelling equipment, when the high travelling-speed mode is set, the control modulation pattern B causing less shocks is selected to reduce the influence of inertia, and when the low travelling-speed mode is selected, the control modulation pattern A causing no operational lag is selected. When the control lever 1 is reversely operated such that the control speed drops from a "full stroke" value to "0", the control modulation pattern Z is always selected regardless of the operation mode that has been set or specified.

Referring to Fig. 2, the control operation of the hydraulic pressure supplying rate will be explained in connection with the relationship between the control modulation patterns A, B and Z to be selected and the operating conditions of the control lever 1.

In Fig. 2, the dashed line a represents the rapid operating condition in which the control lever 1 is operated such that the speed at which hydraulic pressure is controlled increases from its minimum value (i.e., "0") to its maximum value (i.e., "full stroke" value) in an instant, thereby instantaneously increasing the hydraulic pressure supplying rate. The dashed line c represents the slow operating condition in which the control lever 1 is operated such that the control speed increases slowly from "0" to the "full stroke" value, thereby gradually increasing the hydraulic pressure supplying rate. The dashed line b represents the normal operating condition in which the control speed is intermediate between those of the rapid operating condition and the slow operating condition. The dashed line z represents the reverse operating condition in which the control speed decreases with a profile similar to that of the rapid operating condition when it is

inverted. In the rapid operating condition represented by the dashed line a, the normal operating condition represented by the dashed line b and the reverse operating condition represented by the dashed line z, if hydraulic pressure is supplied at a constant supplying rate as indicated by the respective straight dashed lines a, b and z, a shock will inevitably occur at the time of the start-up and shut-down of the hydraulic driving mechanism 5. The shock is considerably great especially in the rapid and reverse operating conditions since the control speed of the control lever 1 instantaneously reaches the "full stroke" value or "0".

If the control modulation pattern A is selected on the basis of a selected operation mode when the control lever 1 is in the rapid operating condition indicated by the dashed line a, the hydraulic pressure supplying rate will be controlled in compliance with the control modulation pattern A. If the control modulation pattern A is selected when the control lever 1 is in the normal operating condition or slow operating condition indicated by the dashed lines b and c respectively, the hydraulic pressure supplying rate will continue to be controlled in compliance with the pattern of the respective operating conditions. This arrangement enables the operational lag of the hydraulic driving mechanism 5 and the occurrence of a shock to be prevented at least in the rapid operating condition.

If the control modulation pattern B is selected when the control lever 1 is in the rapid operating condition or normal operation condition indicated by the dashed lines a and b respectively, the supplying rate will be controlled in compliance with the control modulation pattern B. If the control modulation pattern B is selected when the control lever 1 is in the slow operating condition indicated by the dashed line c, the supplying rate will continue to be controlled in compliance with the pattern of the slow operating condition. With the above arrangement, the operational lag of the hydraulic driving mechanism 5 and the occurrence of a shock can be prevented both in the rapid and normal operating conditions.

Similarly, if the control modulation pattern Z is selected when the control lever 1 is in the reverse operating condition represented by the dashed line z, the hydraulic pressure supplying rate will be controlled in compliance with the control modulation pattern Z so that the operational lag and the occurrence of a shock can be prevented.

In the above embodiment, the rate at which hydraulic pressure is supplied to the hydraulic pipeline system is decreased in a specified period after the dead zone period in which hydraulic pressure starts to rise, according to the preset control modulation patterns A, B and Z, however the invention is not necessarily limited to this arrangement.

For example, the supplying rate may be decreased in a specified period under the calculation directly from the respective patterns of the operating conditions of the control lever 1 whereby an operational lag and the occurrence of a shock are prevented. 5

#### INDUSTRIAL APPLICABILITY

The arrangement disclosed in the invention is capable of preventing a shock which may occur at the time of the start-up and shut-down of the hydraulic driving mechanism as well as an operational lag, and therefore it is most suitably applied not only to working equipment for construction machinery such as a bucket, tilting apparatus, slewing apparatus but also to travelling equipment for construction machinery. 10  
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#### Claims 20

1. Hydraulically-operated equipment for construction machinery comprising:
  - (a) a hydraulic driving mechanism actuated by hydraulic pressure; 25
  - (b) hydraulic pressure supplying means for supplying hydraulic pressure to a hydraulic pipeline system for the hydraulic driving mechanism; and
  - (c) controlling means for controlling the hydraulic pressure supplying means such that the supplying rate at which hydraulic pressure is supplied to the hydraulic pipeline system, the rate being based on the supply of hydraulic pressure, is decreased in a specified period after a dead zone period in which hydraulic pressure starts to rise. 30  
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2. The hydraulically-operated equipment for construction machinery as claimed in Claim 1, wherein said controlling means includes a plurality of control modulation patterns of the hydraulic pressure supplying means for determining the supplying rate at which hydraulic pressure is supplied to the hydraulic pipeline system and controls the hydraulic pressure supplying means according to one of the control modulation patterns which has been selected in compliance with an operation mode. 40  
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3. The hydraulically-operated equipment for construction machinery as claimed in Claim 1 or 2, wherein said hydraulic pressure supplying means is a hydraulic controller valve and/or hydraulic pump. 55

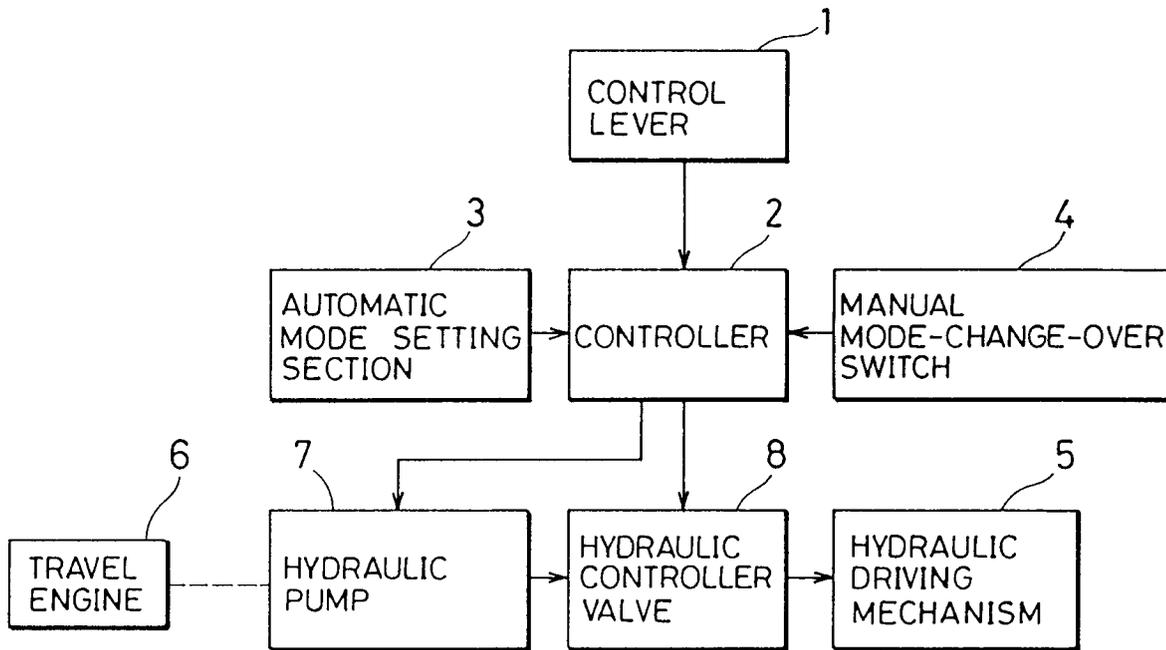


FIG. 1

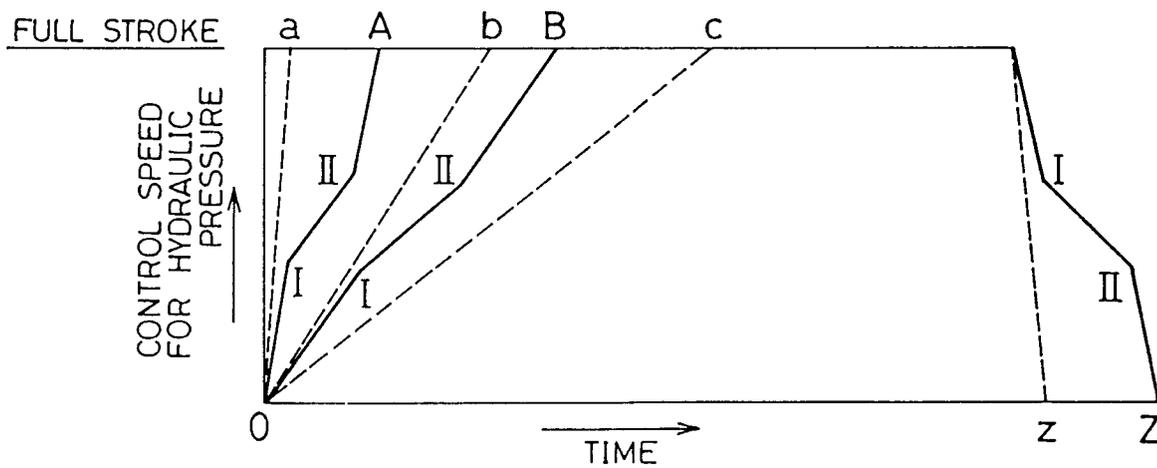


FIG. 2

## INTERNATIONAL SEARCH REPORT

International Application No PCT/JP90/00195

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (if several classification symbols apply, indicate all)	
According to International Patent Classification (IPC) or to both National Classification and IPC	
Int. Cl <sup>5</sup>	E02F9/22
<b>II. FIELDS SEARCHED</b>	
Minimum Documentation Searched	
Classification System	Classification Symbols
IPC	E02F3/42, 3/43, 3/84, 3/85, 9/20, 9/22
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched	
Jitsuyo Shinan Koho	1965 - 1990
Kokai Jitsuyo Shinan Koho	1972 - 1990
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT</b>	
Category *	Citation of Document, ** with indication, where appropriate, of the relevant passages **
Relevant to Claim No. **	
Y	JP, A, 58-213927 (Daikin Industries, Ltd.), 13 December 1983 (13. 12. 83), (Family: none)
1 - 3	
Y	JP, A, 62-160331 (Hitachi Construction Machinery Co., Ltd.), 16 July 1987 (16. 07. 87), & US, A, 4,697,418 & EP, A1, 214,633
1 - 3	
Y	JP, A, 55-78805 (The Japan Steel Works, Ltd.), 13 June 1980 (13. 06. 80), (Family: none)
1 - 3	
* Special categories of cited documents:	
"A" document defining the general state of the art which is not considered to be of particular relevance	"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
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"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)	"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
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P" document published prior to the international filing date but later than the priority date claimed	
<b>IV. CERTIFICATION</b>	
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
May 2, 1990 (02. 05. 90)	May 21, 1990 (21. 05. 90)
International Searching Authority	Signature of Authorized Officer
Japanese Patent Office	