

19



Europäisches Patentamt  
European Patent Office  
Office européen des brevets



11 Publication number:

**0 667 421 A1**

12

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

21 Application number: **94926381.8**51 Int. Cl.<sup>6</sup>: **E02F 9/22, E02F 3/43**22 Date of filing: **09.09.94**86 International application number:  
**PCT/JP94/01497**87 International publication number:  
**WO 95/07390 (16.03.95 95/12)**30 Priority: **09.09.93 JP 224595/93**43 Date of publication of application:  
**16.08.95 Bulletin 95/33**84 Designated Contracting States:  
**DE FR GB IT NL**71 Applicant: **HITACHI CONSTRUCTION  
MACHINERY CO., LTD.  
6-2, Ohtemachi 2-chome  
Chiyoda-ku  
Tokyo 100 (JP)**72 Inventor: **SATO, Shinichi Chiyoda-house  
7-401  
1828, Niihari  
Chiyodamachi**

**Niihari-gun  
Ibaraki 315 (JP)**  
Inventor: **TAMURA, Seiji 6227-26,  
Ohaza-koibuchi  
Tomobemachi  
Nishiibaraki-gun  
Ibaraki 309-17 (JP)**  
Inventor: **SAEKI, Fumimasa  
25-2, Kandatsuhigashi 2-chome  
Tsuchiura-shi  
Ibaraki 300 (JP)**

74 Representative: **Patentanwälte Beetz - Timpe -  
Siegfried Schmitt-Fumian - Mayr  
Steinsdorfstrasse 10  
D-80538 München (DE)**54 **HYDRAULIC DRIVING DEVICE FOR A CONSTRUCTION.**

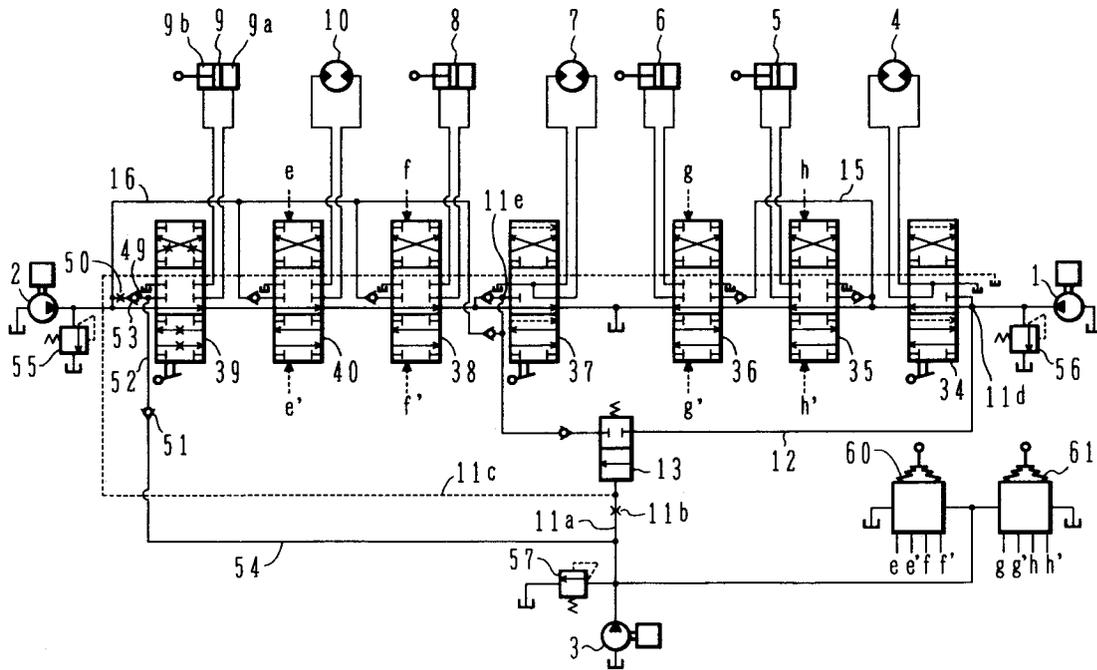
57 A hydraulic driving device for a construction machine comprising a first hydraulic pump (1), a second hydraulic pump (2), a plurality of actuators including at least two running motors (4, 7) driven by virtue of pressure oil discharged from these first and second hydraulic pumps and an earth discharging plate elevating cylinder (9), and a plurality of direction control valves including at least two running direction control valves (34, 37) for controlling the flow of pressure oil supplied from the first and second hydraulic pumps to the plurality of respective actuators and an earth discharging plate elevating direction control valve (39), wherein the earth discharging plate elevating direction control valve (39) has a load check valve (53) provided along a feeder

line (49) thereof to thereby effect a combined operation of an earth discharging plate (25) elevating and running, the hydraulic device being characterized in that one (37) of the two running direction control valves (34, 37) and the earth discharging plate elevating direction control valve (39) are connected to one (2) of the first and second hydraulic pumps (1, 2) in parallel, that a throttle valve (50) is provided on the upstream side of the load check valve (53) provided at a position along the feeder line (49) of the earth discharging plate elevating direction control valve (39), and that refilling means (51, 52, 54, 3) for refilling pressure oil are provided on the downstream side of the load check valve (53) provided along the feeder line (49) of the earth discharging plate elevat-

**EP 0 667 421 A1**

ing direction control valve (39).

FIG.2



## TECHNICAL FIELD

The present invention relates to a hydraulic drive system which is equipped on construction machines such as small-sized hydraulic excavators and is able to perform the combined operation of up-and-down movement of a blade and travel of the machine.

## BACKGROUND ART

Fig. 3 is a circuit diagram showing one example of prior art hydraulic drive systems of the above-mentioned type. The illustrated prior art system includes three primary hydraulic pumps, i.e., a first hydraulic pump 1, a second hydraulic pump 2, and a third hydraulic pump 26. The system also includes a left-hand track motor 4 for driving a left-hand crawler belt which constitutes an undercarriage (not shown), a boom cylinder 5 for driving a boom which constitutes a front attachment (not shown), and a bucket cylinder 6 for driving a bucket which constitutes the front attachment (not shown), as actuators driven by a hydraulic fluid delivered from the first hydraulic pump 1; a right-hand track motor 7 for driving a right-hand crawler belt which constitutes the undercarriage (not shown) and an arm cylinder 8 for driving an arm which constitutes the front attachment (not shown), as actuators driven by a hydraulic fluid delivered from the second hydraulic pump 2; and a blade lifting/lowering cylinder 9 for driving a blade (not shown) and a swing motor 10 for driving an upper structure (not shown) which constitutes a machine body with a cab installed thereon, as actuators driven by a hydraulic fluid delivered from the third hydraulic pump 3. Further, the system includes a left-hand track directional control valve 34, a boom directional control valve 35 and a bucket directional control valve 36 for controlling respective flows of the hydraulic fluid supplied from the first hydraulic pump 1 to the left-hand track motor 4, the boom cylinder 5 and the bucket cylinder 6; a right-hand track directional control valve 37 and an arm directional control valve 38 for controlling respective flows of the hydraulic fluid supplied from the second hydraulic pump 2 to the right-hand track motor 7 and the arm cylinder 8; and a blade lifting/lowering directional control valve 39 and a swing directional control valve 40 for controlling respective flows of the hydraulic fluid supplied from the third hydraulic pump 26 to the blade lifting/lowering cylinder 9 and the swing motor 10.

In the above-described prior art, the combined operation of up-and-down movement of the blade and travel of the machine, for example, is carried out by shifting the left-hand track directional control valve 34, the right-hand track directional control

valve 37 and the blade lifting/lowering directional control valve 39. More specifically, the left-hand track directional control valve 34 is shifted to supply the hydraulic fluid from the first hydraulic pump 1 to the left-hand track motor 4, the right-hand track directional control valve 37 is shifted to supply the hydraulic fluid from the second hydraulic pump 2 to the right-hand track motor 7, and the blade lifting/lowering directional control valve 39 is shifted to supply the hydraulic fluid from the third hydraulic pump 26 to the blade lifting/lowering cylinder 9. As a result, the left-hand crawler belt, the right-hand crawler belt and the blade which constitute the undercarriage (not shown) are driven to carry out the combined operation of up-and-down movement of the blade and travel of the machine.

Fig. 4 is a circuit diagram showing another example of prior art hydraulic drive systems of the above-mentioned type. The illustrated other prior art system includes only two primary hydraulic pumps, i.e., a first hydraulic pump 1 and a second hydraulic pump 2. A left-hand track directional control valve 34 for controlling the driving of a left-hand track motor 4 is connected to the first hydraulic pump 1, and a boom directional control valve 35 for controlling the driving of a boom cylinder 5 and a bucket directional control valve 36 for controlling the driving of a bucket cylinder 6 are connected in parallel downstream of the left-hand track directional control valve 34. On the other hand, a blade lifting/lowering directional control valve 39 for controlling the driving of a blade lifting/lowering cylinder 9, a swing directional control valve 40 for controlling the driving of a swing motor 10, and an arm directional control valve 38 for controlling the driving of an arm cylinder 8 are connected to the second hydraulic pump 2 in parallel. A right-hand track directional control valve 37 for controlling the driving of a right-hand track motor 7 is connected downstream of those directional control valves 39, 40 and 38.

The system also includes a communication line 12 for communicating an inlet port 11d of the left-hand track directional control valve 34 and an inlet port 11e of the right-hand track directional control valve 37 with each other, a switching valve 13 connected in the communication line 12, a hydraulic source 11, a line 11a for communicating the hydraulic source 11 with a drive sector of the switching valve 13, a throttle 11b provided in the line 11a, and a line 11c having one end connected to a portion of the line 11a between the throttle 11b and the drive sector of the switching valve 13 and the other end communicated with a reservoir through the directional control valves 39, 40, 38, 37, 36, 35 and 34.

In the other prior art shown in Fig. 4, when the left-hand track directional control valve 34, the

right-hand track directional control valve 37 and the blade lifting/lowering directional control valve 39 are shifted for the combined operation of up-and-down movement of the blade and travel of the machine, the hydraulic fluid from the second hydraulic pump 2 is supplied to the blade lifting/lowering cylinder 9 upon the shifting of the blade lifting/lowering directional control valve 39, so that the blade (not shown) is moved up or down. At the same time as the shifting of the blade lifting/lowering directional control valve 39, etc., the communication between the line 11c and the reservoir is cut off, whereupon a pressure is applied to the drive sector of the switching valve 13, causing the switching valve 13 to be shifted against the resilient force of a spring into a lower shift position at which the valve 13 is held open. As a result, the left-hand track directional control valve 34 and the right-hand track directional control valve 37 are connected to the first hydraulic pump 1 in parallel, and the hydraulic fluid from the first hydraulic pump 1 is supplied to both the left-hand track motor 4 and the right-hand track motor 7 for driving the left-hand crawler belt and the right-hand crawler belt which constitute the undercarriage (not shown), to thereby travel the machine.

With the other prior art thus arranged, the combined operation of up-and-down movement of the blade and travel of the machine can be realized by providing only the two hydraulic pumps 1, 2, and the hydraulic drive system can be obtained at a lower production cost than with the former prior art shown in Fig. 3. Further, since there is no need of securing a space for installation of the third hydraulic pump, a sufficient space is available for installation of other equipment. Hence, the latter prior art is generally suitable for small-sized hydraulic excavators or the like which are subject to harder restrictions in an available space for installation of equipment, and is superior to the former prior art shown in Fig. 3.

Note that the arrangement similar to the prior art shown in Fig. 4 is disclosed in JP, A, 4-55529.

#### DISCLOSURE OF THE INVENTION

However, the above-mentioned prior art shown in Fig. 4 has the problem as follows. During the sole operation of travel in which the hydraulic fluid from the first hydraulic pump 1 is supplied to the left-hand track motor 4 and the hydraulic fluid from the second hydraulic pump 2 is supplied to the right-hand track motor 7, when the blade lifting/lowering directional control valve 39 is shifted into a lower shift position in Fig. 4 to supply the hydraulic fluid from the second hydraulic pump 2 to the bottom side of the blade lifting/lowering cylinder 9 so that the cylinder 9 is actuated to extend for

operating the blade, e.g., moving the blade down, the hydraulic fluid from the second hydraulic pump 2 fails to be supplied to the right-hand track motor 7 because the load of the blade lifting/lowering cylinder 9 is lighter than that of the right-hand track motor 7. This results in the condition where the right-hand track motor 7 and the left-hand track motor 4 are both driven by the hydraulic fluid from the first hydraulic pump 1 as described before. Accordingly, the traveling speed is abruptly reduced as compared with the speed preceding. Thus, the operability of the combined operation of travel and blade movement is deteriorated, and the working efficiency is reduced remarkably.

The present invention has been made in view of the state of art described above, and its object is to provide a hydraulic drive system for a construction machine which can suppress an abrupt reduction in the traveling speed when a blade is operated with a load lighter than the travel load while the machine is traveling.

To achieve the above object, a hydraulic drive system for a construction machine according to the present invention is arranged below. In a hydraulic drive system for a construction machine comprising a first hydraulic pump, a second hydraulic pump, a plurality of actuators including at least two track motors and a blade lifting/lowering cylinder which are driven by hydraulic fluids delivered from the first and second hydraulic pumps, and a plurality of directional control valves including at least two track directional control valves and a blade lifting/lowering directional control valve for controlling respective flows of the hydraulic fluids supplied from the first and second hydraulic pumps to the plurality of actuators, the blade lifting/lowering directional control valve including a load check valve disposed in its feeder line, the system being capable of performing the combined operation of up-and-down movement of a blade and travel of the machine, one of the two track directional control valves and the blade lifting/lowering directional control valve are connected to one of the first hydraulic pump and the second hydraulic pump in parallel, and a throttle valve is disposed upstream of the load check valve in the feeder line of the blade lifting/lowering directional control valve.

Preferably, additional supply means capable of replenishing a hydraulic fluid is connected downstream of the load check valve in the feeder line of the blade lifting/lowering directional control valve. In this case, preferably, the additional supply means includes a pilot pump as a hydraulic source. Also, preferably, at least some of the plurality of directional control valves are of the hydraulic pilot operated type, and the hydraulic drive system further comprises a pilot operating system including a pilot pump and control lever means which are asso-

ciated with those hydraulic pilot operated directional control valves and produce signal pressures depending on input amounts of the control lever means based on a hydraulic fluid from the pilot pump for shifting the corresponding directional control valves, the hydraulic pump in the pilot operating system doubling as the pilot pump of the additional supply means.

Furthermore, preferably, an opening of the throttle valve is set such that the hydraulic fluid delivered from the one second hydraulic pump is supplied to the one track directional control valve and the blade lifting/lowering directional control valve in a distributed manner during work of moving the blade down.

In the hydraulic drive system of the present invention thus arranged, when the hydraulic fluid is supplied to the bottom side of the blade lifting/lowering cylinder and the hydraulic fluid in the rod side thereof is drained to a return line, the blade lifting/lowering cylinder is extended to carry out work of moving the blade down. When the hydraulic fluid is supplied to the rod side of the blade lifting/lowering cylinder and the hydraulic fluid in the bottom side thereof is drained to the return line, the blade lifting/lowering cylinder is contracted to carry out work of moving the blade up.

When the blade is operated with a load lighter than the travel load to perform the work of moving down, for example, while the machine is traveling, the hydraulic fluid delivered from the one hydraulic pump is distributed by the throttle valve disposed upstream of the load check valve in the feeder line of the blade lifting/lowering directional control valve, and is then supplied to both the one track directional control valve and the blade lifting/lowering directional control valve. Therefore, the hydraulic fluid delivered from the second hydraulic pump can be supplied to the track motor as well through that track directional control valve. It is thus possible to suppress an abrupt reduction in the traveling speed during the combined operation of travel and blade movement.

In addition, to the side of the blade lifting/lowering directional control valve where the hydraulic fluid becomes in short supply due to the distribution through the throttle valve during the combined operation of travel and blade movement, a pilot hydraulic fluid can be replenished by the additional supply means including the pilot pump, for example. When the blade is operated with a light load under situations which require positive supply of the hydraulic fluid, the pilot hydraulic fluid is replenished by the additional supply means so that an abrupt reduction in the traveling speed during the combined operation of travel and blade movement can be suppressed as with the above

case and an reduction in the lifting/lowering speed of the blade can also be suppressed.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a view showing a small-sized hydraulic excavator as one example of construction machines on which a hydraulic drive system of the present invention is equipped.

Fig. 2 is a circuit diagram showing the hydraulic drive system for a construction machine according to one embodiment of the present invention.

Fig. 3 is a circuit diagram showing one example of conventional hydraulic drive systems for construction machines.

Fig. 4 is a circuit diagram showing another example of conventional hydraulic drive systems for construction machines.

#### BEST MODE FOR CARRYING OUT THE INVENTION

Hereinafter, embodiments of a hydraulic drive system for a construction machine according to the present invention will be described with reference to the drawings.

The structure of a small-sized hydraulic excavator shown in Fig. 1 will first be described. The illustrated small-sized hydraulic excavator comprises a left-hand crawler belt 20 constituting an undercarriage, a right-hand crawler belt (not shown), an upper structure 21 constituting a machine body with a cab installed thereon, a boom 22 rotatably mounted in front of the upper structure 21 and driven by a boom cylinder 5, an arm 23 rotatably mounted to the boom 22 and driven by an arm cylinder 8, a bucket 24 rotatably mounted to the arm 23 and driven by a bucket cylinder 6, and a blade 25 rotatably mounted to the undercarriage and driven by a blade lifting/lowering cylinder 9.

As shown in Fig. 2 drawn corresponding to Fig. 4 referred to in connection with the prior art, the hydraulic drive system of this embodiment includes two primary hydraulic pumps, i.e., a first hydraulic pump 1 and a second hydraulic pump 2, and one auxiliary hydraulic pump, i.e., a pilot pump 3. A left-hand track directional control valve 34 for controlling the driving of a left-hand track motor 4 for operating the left-hand crawler belt, a boom directional control valve 35 for controlling the driving of the boom cylinder 5 for turning the boom 22, and a bucket directional control valve 36 for controlling the driving of the bucket cylinder 6 for turning the bucket 24 are connected to the first hydraulic pump 1. The boom directional control valve 35 and the bucket directional control valve 36 are connected downstream of the left-hand track directional control valve 34 in tandem relation to the left-

hand track directional control valve 34 so that a hydraulic fluid delivered from the first hydraulic pump 1 is supplied to the left-hand track directional control valve 34 with priority, and both the valves are connected in parallel to the first hydraulic pump 1 through a parallel line 15. On the other hand, a blade lifting/lowering directional control valve 39 for controlling the driving of the blade lifting/lowering cylinder 9 for turning the blade 25, a swing directional control valve 40 for controlling the driving of a swing motor 10 for swinging the upper structure 21, an arm directional control valve 38 for controlling the driving of the arm cylinder 8 for turning the arm 23, and a right-hand track directional control valve 37 for controlling the driving of a right-hand track motor 7 for operating the right-hand crawler belt (not shown) are connected to the second hydraulic pump 2 in parallel through a parallel line 16.

As with the prior art circuit shown in Fig. 4, the system of this embodiment also includes a communication line 12 for communicating an inlet port 11d of the left-hand track directional control valve 34 and an inlet port 11e of the right-hand track directional control valve 37 with each other, a switching valve 13 connected in the communication line 12, a line 11a for communicating the pilot pump 3 with a drive sector of the switching valve 13, a throttle 11b provided in the line 11a, and a line 11c having one end connected to a portion of the line 11a between the throttle 11b and the drive sector of the switching valve 13 and the other end communicated with a reservoir through the directional control valves 39, 40, 38, 37, 36, 35 and 34. Additionally, the directional control valves 34, 37 are each of the internal structure formed to hold the communication with the line 11c and hence the reservoir when it is in any of a neutral position as shown and upper and lower shift positions, whereas the directional control valves 39, 40, 38, 36 and 35 are each of the internal structure formed to hold the communication with the line 11c and hence the reservoir when it is in a neutral position as shown, but to cut off the communication with the line 11c and hence the reservoir when it is shifted from the neutral position to an upper or lower shift position. The communication line 12, the switching valve 13, the pilot pump 3, the line 11a, the throttle 11b, the line 11c, and the internal structures of the directional control valves 39, 40, 38, 36 and 35 jointly constitute communication means for selectively communicating the inlet port 11d of the left-hand track directional control valve 34 and the inlet port 11e of the right-hand track directional control valve 37 with each other.

Of the directional control valves 34 to 40, at least the directional control valves 35, 36, 38 and 40 are of the hydraulic pilot operated type. A pilot operating system including a pair of control lever

units 60, 61 is associated with those hydraulic pilot operated directional control valves 35, 36, 38 and 40. In the pilot operating system, the control lever unit 60 produces signal pressures e, e'; f, f' depending on the input amount of its control lever based on a hydraulic fluid from the pilot pump 3, thereby shifting the directional control valves 40, 38, and the control lever unit 61 produces signal pressures g, g'; h, h' depending on the input amount of its control lever by utilizing the hydraulic fluid from the pilot pump 3, thereby shifting the directional control valves 36, 35.

Particularly, in this embodiment, a throttle valve 50 is disposed upstream of a load check valve 53 in a feeder line 49 of the blade lifting/lowering directional control valve 39. The throttle valve 50 has its opening set such that the hydraulic fluid delivered from the second hydraulic pump 2 is supplied to the right-hand track directional control valve 37 (the right-hand track motor 7) and the blade lifting/lowering directional control valve 39 (the blade lifting/lowering cylinder 9) in a distributed manner during the combined operation of travel and movement of the blade 25 in which the blade 25 undergoes a lighter load, e.g., during the combined operation of travel and work of moving the blade 25 down.

The system of this embodiment further includes a line 52 having one end connected downstream of the load check valve 53 in the feeder line 49 of the blade lifting/lowering directional control valve 39 for filling up a lack of the hydraulic fluid caused by the above-described distributing function of the throttle valve 50, a check valve 51 connected to the other end of the line 52 for preventing the hydraulic fluid delivered from the second hydraulic pump 2 from being supplied toward the pilot pump 3, and a line 54 having one end connected to the check valve 51 and the other end connected to the line 11a which is communicated with the pilot pump 3. The pilot pump 3, the line 54, the check valve 51 and the line 52 are connected downstream of the load check valve 53 in the feeder line 49 of the blade lifting/lowering directional control valve 39, and jointly constitute additional supply means capable of replenishing the hydraulic fluid. The pilot pump 3 doubles as a hydraulic source for the pilot operating system including the control lever units 60, 61 and a hydraulic source for the additional supply means.

Denoted by reference numeral 56 is a main relief valve for specifying a pressure of the hydraulic fluid delivered from the first hydraulic pump 1, 55 is a main relief valve for specifying a pressure of the hydraulic fluid delivered from the second hydraulic pump 2, and 57 is a pilot relief valve for specifying a pressure of the hydraulic fluid delivered from the pilot pump 3.

In the hydraulic drive system of this embodiment thus arranged, when the hydraulic fluid is supplied to the bottom side 9a of the blade lifting/lowering cylinder 9 and the hydraulic fluid in the rod side 9b thereof is drained to a return line, the blade lifting/lowering cylinder 9 is extended to carry out work of moving the blade 25 down. When the hydraulic fluid is supplied to the rod side 9b of the blade lifting/lowering cylinder 9 and the hydraulic fluid in the bottom side 9a thereof is drained to the return line, the blade lifting/lowering cylinder 9 is contracted to carry out work of moving the blade 25 up.

For the sole operation of travel in this embodiment, the left-hand track directional control valve 34 and the right-hand track directional control valve 37 are shifted, whereupon the hydraulic fluid from the first hydraulic pump 1 is supplied to the left-hand track motor 4 through the left-hand track directional control valve 34 for driving the left-hand track motor 4 to thereby operate the left-hand crawler belt 20 constituting the undercarriage and, simultaneously, the hydraulic fluid from the second hydraulic pump 2 is supplied to the right-hand track motor 7 through the right-hand track directional control valve 37 for driving the right-hand track motor 7 to thereby operate the right-hand crawler belt (not shown) constituting the undercarriage. As a result, the sole operation of travel is carried out.

When the blade lifting/lowering directional control valve 39 is additionally shifted for transition from the above sole operation of travel to the combined operation of travel and blade movement in which the blade undergoes a lighter load, e.g., the combined operation of travel and work of moving the blade down, the communication between the line 11c and the reservoir is cut off in response to the shifting of the blade lifting/lowering directional control valve 39. Therefore, the pressure downstream of the throttle 11b is raised, causing the switching valve 13 to be shifted against the resilient force of a spring into an open position, i.e., a lower shift position in Fig. 2. Correspondingly, the inlet port 11d of the left-hand track directional control valve 34 and the inlet port 11e of the right-hand track directional control valve 37 are communicated with each other through the communication line 12. In this condition, the hydraulic fluid from the first hydraulic pump 1 is supplied to the left-hand track motor 4 through the left-hand track directional control valve 34 for driving the left-hand track motor 4 to thereby operate the left-hand crawler belt 20 constituting the undercarriage, and a part of the hydraulic fluid from the first hydraulic pump 1 is also supplied to the right-hand track directional control valve 37 through the communication line 12. Further, the hydraulic fluid from the second hydraulic pump 2 is distributed and supplied

through the throttle valve 50 to the right-hand track directional control valve 37 and the blade lifting/lowering directional control valve 39. Accordingly, the right-hand track directional control valve 37 is supplied with a part of the hydraulic fluid from the first hydraulic pump 1 introduced through the communication line 12 and a part of the hydraulic fluid from the second hydraulic pump 2 distributed through the throttle valve 50 in a joined manner. The joined hydraulic fluid is then supplied to the right-hand track motor 7, whereupon the right-hand track motor 7 is driven to operate the right-hand crawler belt (not shown) which constitute the undercarriage. On the other hand, the remainder of the hydraulic fluid from the second hydraulic pump 2 distributed through the throttle valve 50 is supplied to the bottom side 9a of the blade lifting/lowering cylinder 9, whereupon the blade lifting/lowering cylinder 9 is extended to carry out the work of moving the blade 25 down. In this way, during the combined operation of travel and blade movement in which the blade undergoes a lighter load, the hydraulic fluids supplied to the left-hand track motor 4 and the right-hand track motor 7 can be prevented from abruptly reducing in their flow rate, and hence an abrupt reduction in the traveling speed can be suppressed.

To the side of the blade lifting/lowering directional control valve 39 where the hydraulic fluid becomes in short supply due to the above-described distribution through the throttle valve 50 during the combined operation of travel and blade movement, the pilot hydraulic fluid from the pilot pump 3 can be replenished through the line 11a, the line 54, the check valve 51 and the line 52. When the blade is operated with a light load under situations which require positive supply of the hydraulic fluid, the pilot hydraulic fluid is additionally supplied to the blade lifting/lowering directional control valve 39 to suppress a reduction in the lifting/lowering speed of the blade while suppressing an abrupt reduction in the traveling speed during the combined operation of travel and blade movement. Particularly, when the combined operation of travel and blade movement is carried out in such a manner as moving the blade 25 up and down to perform light-load operation, e.g., leveling of the ground, while the machine is traveling straightly, the satisfactory lifting/lowering speed of the blade can be ensured with additional supply of the pilot hydraulic fluid delivered from the pilot pump 3 under a relatively low pressure.

During the sole operation of the blade 25, the hydraulic fluid from the second hydraulic pump 2 having a pressure specified by the main relief valve 55 is supplied to the blade lifting/lowering cylinder 9 through the throttle valve 50 and the blade lifting/lowering directional control valve 39 and, there-

fore, the satisfactory lifting/lowering speed of the blade can be ensured.

With this embodiment described above, since a reduction in the traveling speed can be suppressed during the combined operation of travel and blade movement in which the blade undergoes a lighter load, the operability of the combined operation of travel and blade movement can be prevented from deteriorating and the working efficiency can be improved.

Also, since the pilot hydraulic fluid from the pilot pump 3 can be additionally supplied to the blade lifting/lowering directional control valve 39 during the combined operation of travel and blade movement, a reduction in the lifting/lowering speed of the blade 25 can also be suppressed. By so suppressing a reduction in the lifting/lowering speed of the blade 25, the higher operability of the combined operation of travel and blade movement can be achieved and the working efficiency can be further improved correspondingly.

#### INDUSTRIAL AVAILABILITY

According to the hydraulic drive system of the present invention arranged as described hereinabove, an abrupt reduction in the traveling speed can be suppressed when the blade is operated with a load lighter than the travel load while the machine is traveling. This results in an advantage of improving the operability of the combined operation of travel and blade movement and hence ensuring the higher working efficiency than the prior art.

Also, a reduction in the lifting/lowering speed of the blade can also be suppressed with the provision of the additional supply means. In the case of so suppressing a reduction in the lifting/lowering speed of the blade, there can be obtained an advantage of ensuring the higher operability of the combined operation of travel and blade movement and hence further improving the working efficiency.

#### Claims

1. A hydraulic drive system for a construction machine comprising a first hydraulic pump (1), a second hydraulic pump (2), a plurality of actuators including at least two track motors (4, 7) and a blade lifting/lowering cylinder (9) which are driven by hydraulic fluids delivered from said first and second hydraulic pumps, and a plurality of directional control valves including at least two track directional control valves (34, 37) and a blade lifting/lowering directional control valve (39) for controlling respective flows of the hydraulic fluids supplied from said first and second hydraulic pumps to

said plurality of actuators, said blade lifting/lowering directional control valve including a load check valve (53) disposed in its feeder line (49), said system being capable of performing the combined operation of up-and-down movement of a blade (25) and travel of said machine, wherein:

one (37) of said two track directional control valves (34, 37) and said blade lifting/lowering directional control valve (39) are connected to one (2) of said first hydraulic pump (1) and said second hydraulic pump (2) in parallel, and a throttle valve (50) is disposed upstream of said load check valve (53) in the feeder line (49) of said blade lifting/lowering directional control valve.

2. A hydraulic drive system for a construction machine according to Claim 1, wherein additional supply means (51, 52, 54, 3) capable of replenishing a hydraulic fluid is connected downstream of said load check valve (53) in the feeder line (49) of said blade lifting/lowering directional control valve (39).
3. A hydraulic drive system for a construction machine according to Claim 2, wherein said additional supply means includes a pilot pump (3) as a hydraulic source.
4. A hydraulic drive system for a construction machine according to Claim 3, wherein at least some (35, 36, 38, 40) of said plurality of directional control valves are of the hydraulic pilot operated type, and said hydraulic drive system further comprises a pilot operating system including a pilot pump (3) and control lever means (60, 61) which are associated with said hydraulic pilot operated directional control valves and produce signal pressures depending on input amounts of said control lever means based on a hydraulic fluid from said pilot pump for shifting the corresponding directional control valves, said hydraulic pump (3) in said pilot operating system doubling as the pilot pump of said additional supply means.
5. A hydraulic drive system for a construction machine according to Claim 2, wherein an opening of said throttle valve (50) is set such that the hydraulic fluid delivered from said one second hydraulic pump (2) is supplied to said one track directional control valve (37) and said blade lifting/lowering directional control valve (39) in a distributed manner during the combined operation of work of moving said blade (25) down and travel of said machine.

FIG.1

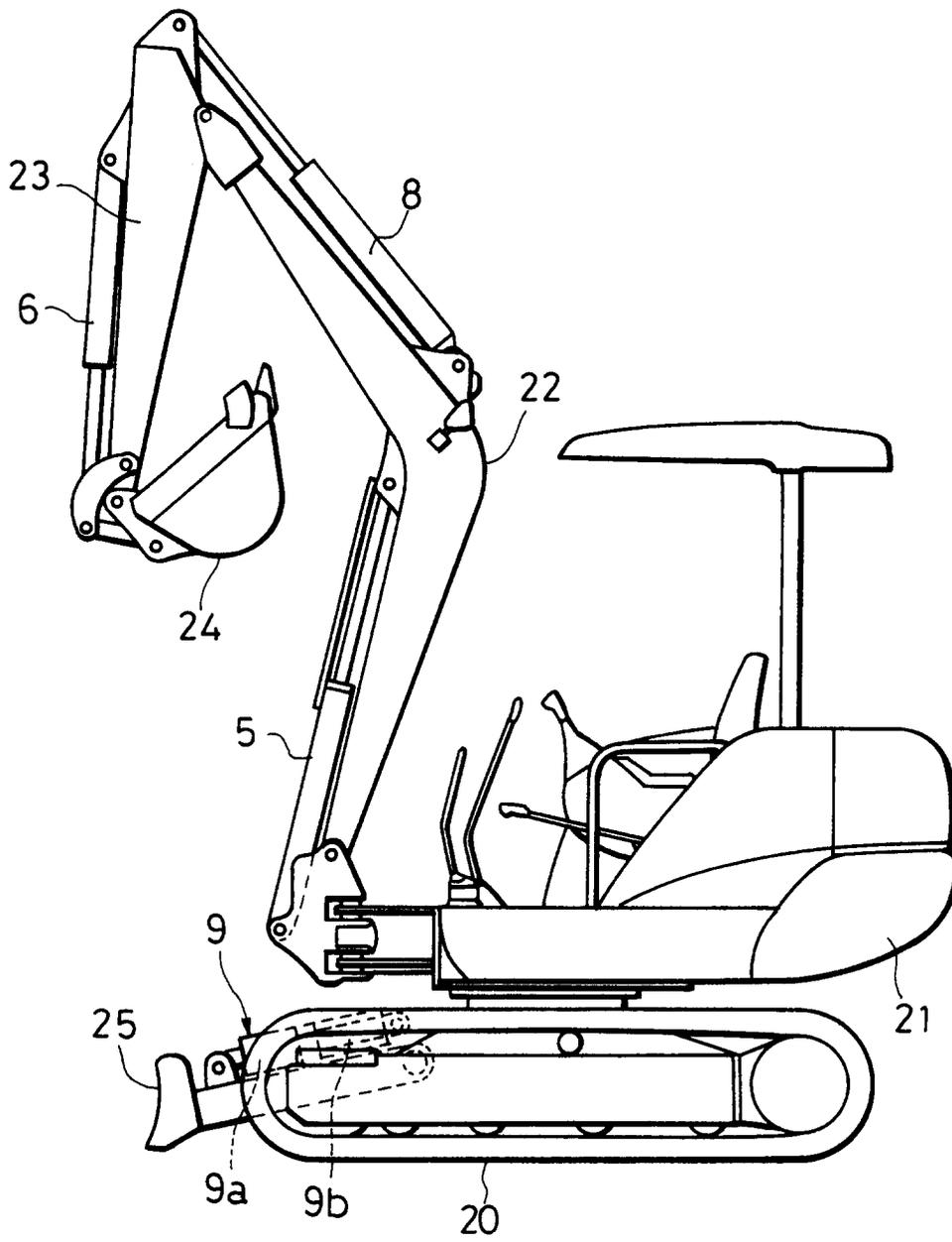




FIG.3  
(PRIOR ART)

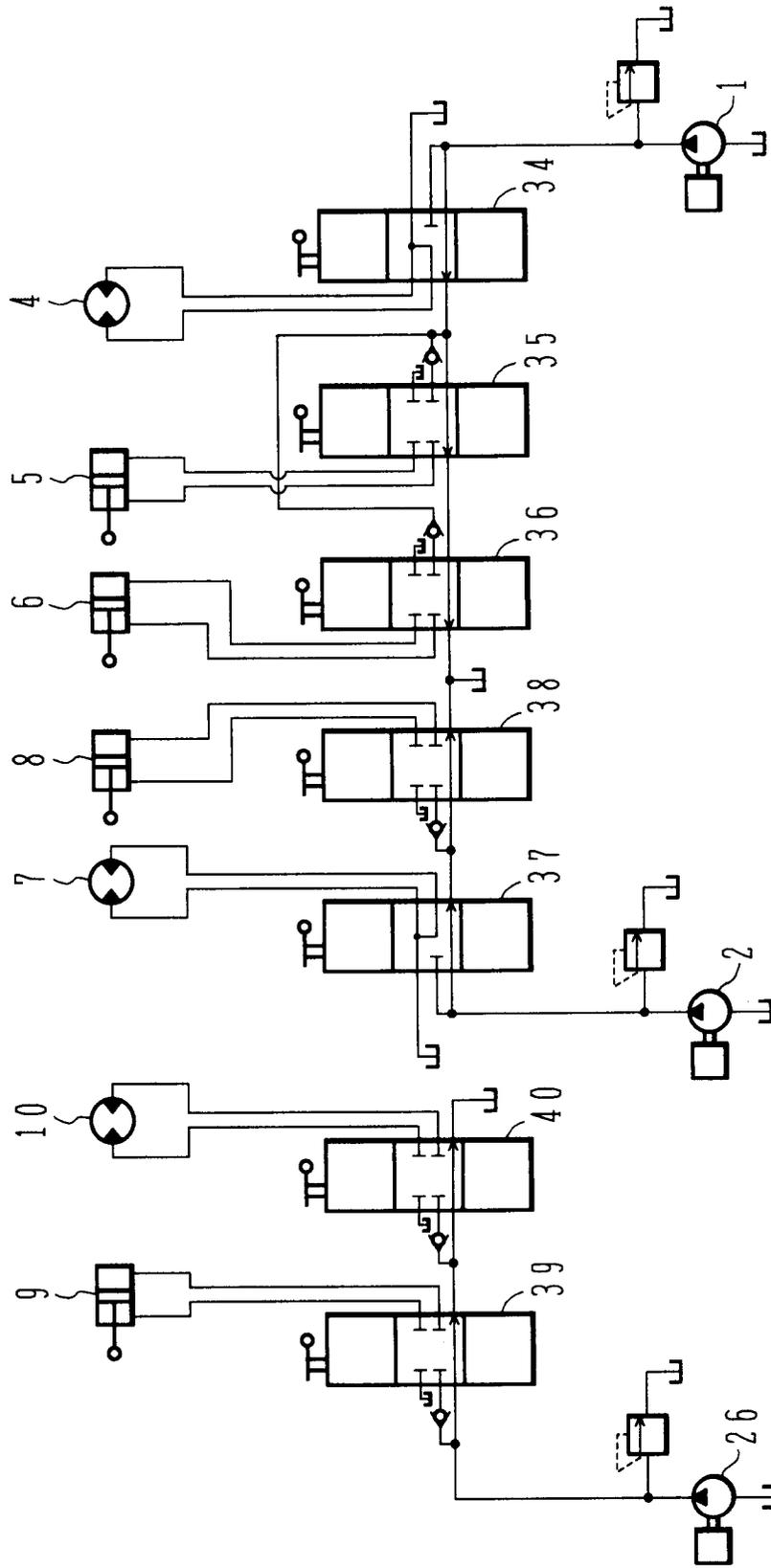
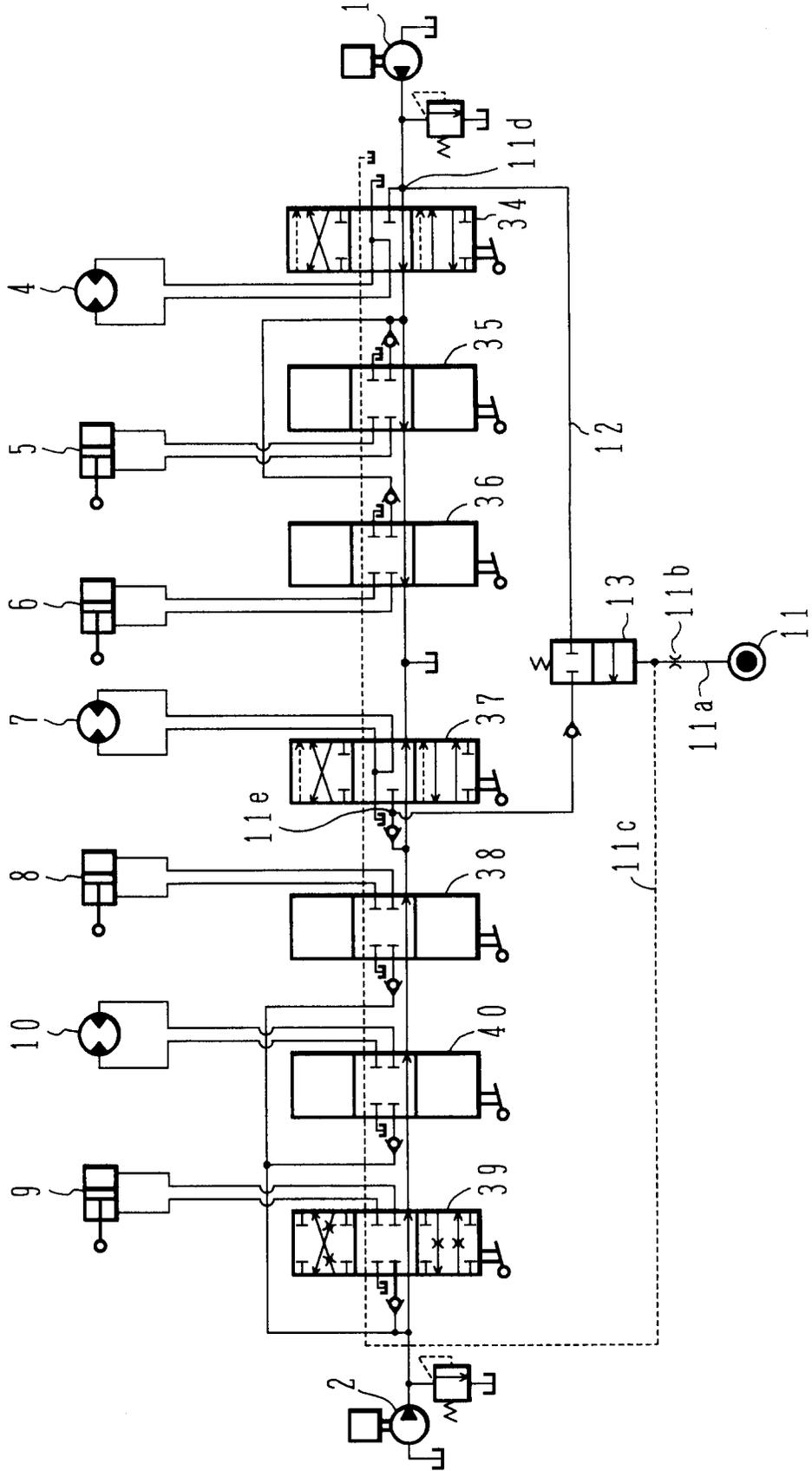


FIG.4  
(PRIOR ART)



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP94/01497

A. CLASSIFICATION OF SUBJECT MATTER Int. Cl <sup>6</sup> E02F9/22, E02F3/43 According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) Int. Cl <sup>5</sup> E02F9/22, E02F3/43 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1926 - 1994 Kokai Jitsuyo Shinan Koho 1971 - 1994 Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Microfilm of the specification and drawings annexed to the written application of Japanese Utility Model Application No. 12947/1988 (Laid-Open No. 120562/1989) (Yutani Juko K.K.), August 15, 1989 (15. 08. 89), Lines 5 to 10, page 10	1, 5
Y	JP, A, 64-90325 (Hitachi Construction Machinery Co., Ltd.), April 6, 1989 (06. 04. 89)	2-4
A	JP, A, 60-144432 (Handorsar Kogyo K.K.), July 30, 1985 (30. 07. 85), (Family: none)	1
A	JP, A, 4-55529 (Hitachi Construction Machinery Co., Ltd.), February 24, 1992 (24. 02. 92), (Family: none)	1
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.		
<p>* Special categories of cited documents:</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 when the document is taken alone</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>		
Date of the actual completion of the international search November 11, 1994 (11. 11. 94)		Date of mailing of the international search report December 27, 1994 (27. 12. 94)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.		Authorized officer  Telephone No.