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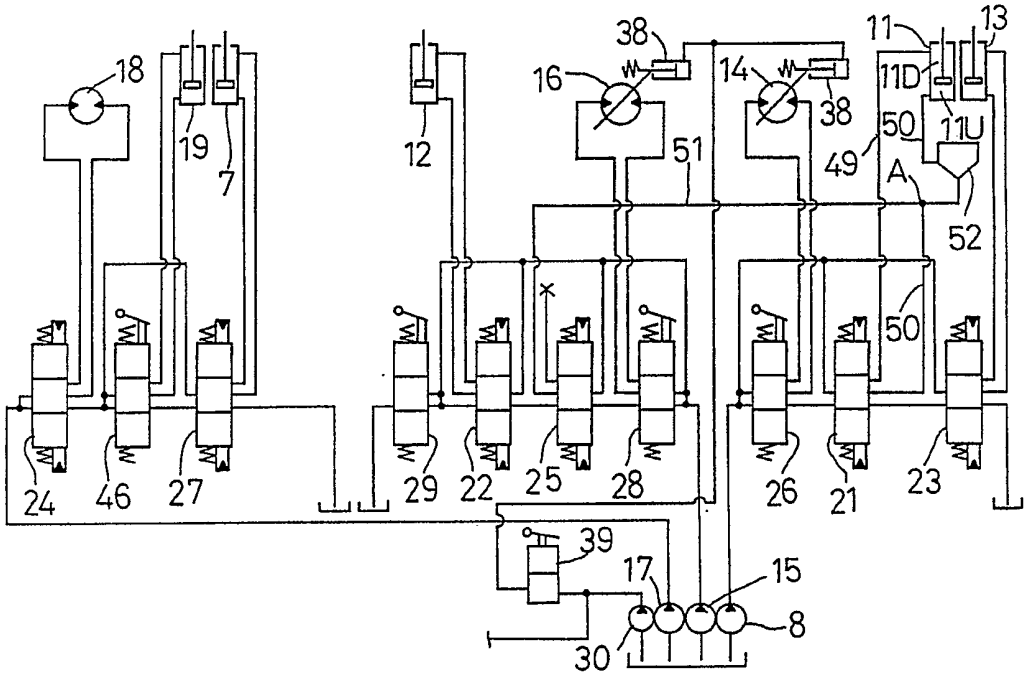
(54) Hydraulic circuit

(57) A hydraulic circuit for vertically driving a boom of a backhoe implement, in which pressure oil from a first pump (8) and pressure oil from a second pump (15) is supplied through a control valve (21) and an auxiliary control valve (25) confluently to a hydraulic cylinder (11) for actuating the boom. This circuit structure includes a single pilot check valve (52) for preventing lowering of the boom due to oil leakage from the control valve and auxiliary control valve when the boom suspending a load is locked by operating the control valve and auxiliary control valve to neutral. The pilot check valve is disposed between the boom actuating hydraulic cylinder and a connecting point for joining the pressure oil from the first pump and pressure oil from the second pump. Control means are provided to close the check valve when the control valve (21) is in its raising or neutral positions and to open the check valve when the control valve is in its lowering position.

Fig. 1



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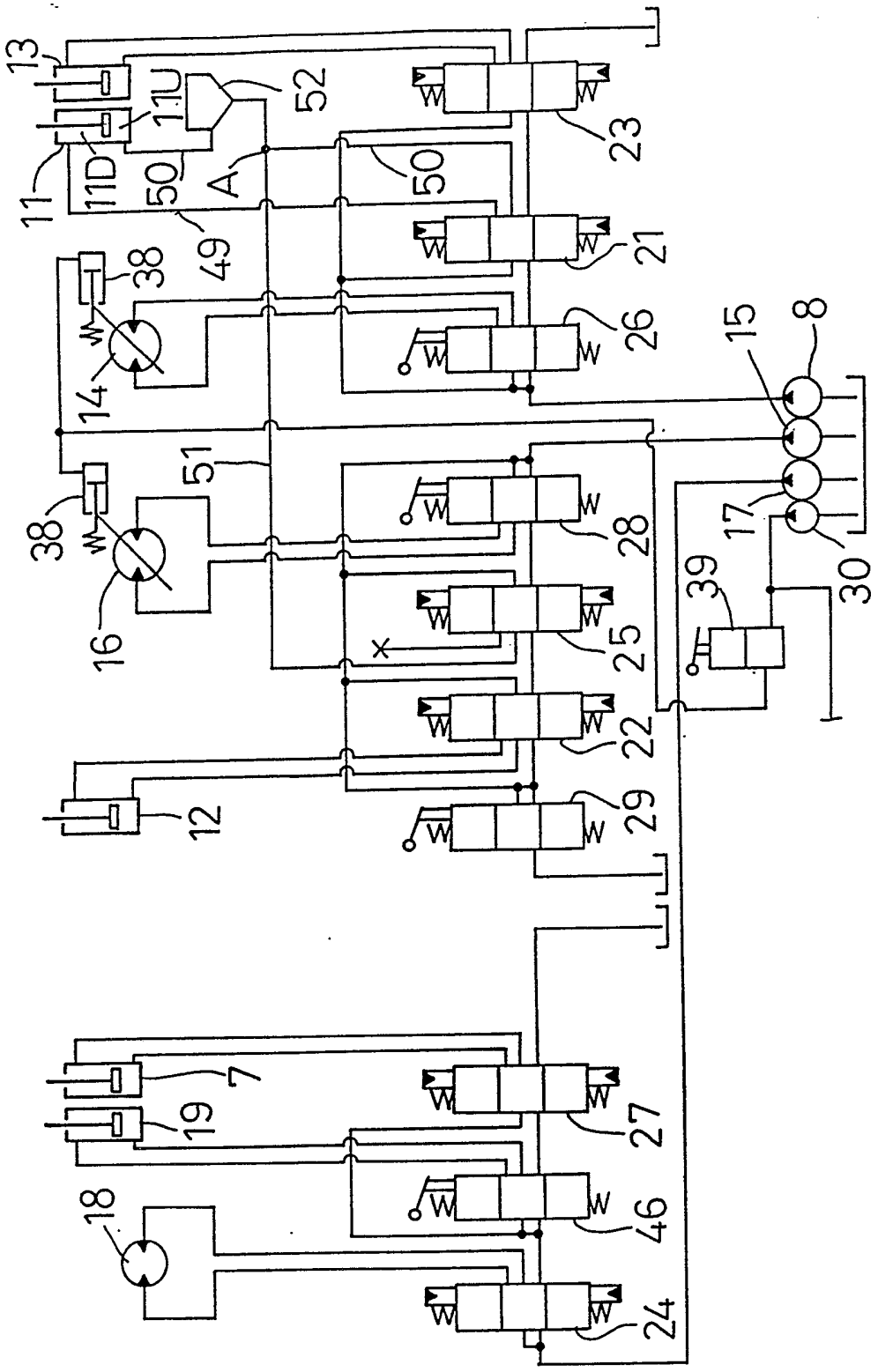
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Fig. 1

Fig. 2

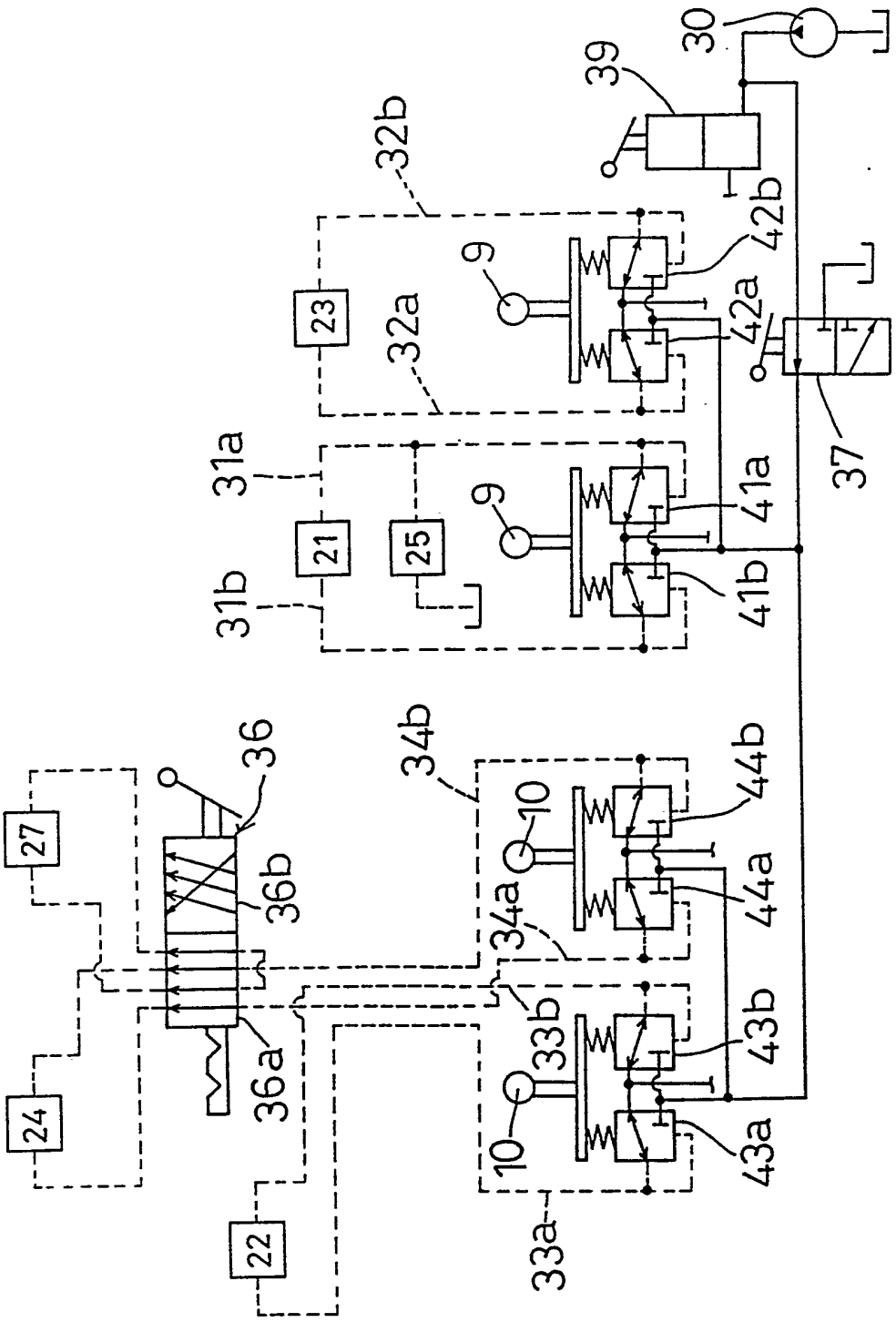
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Fig. 3

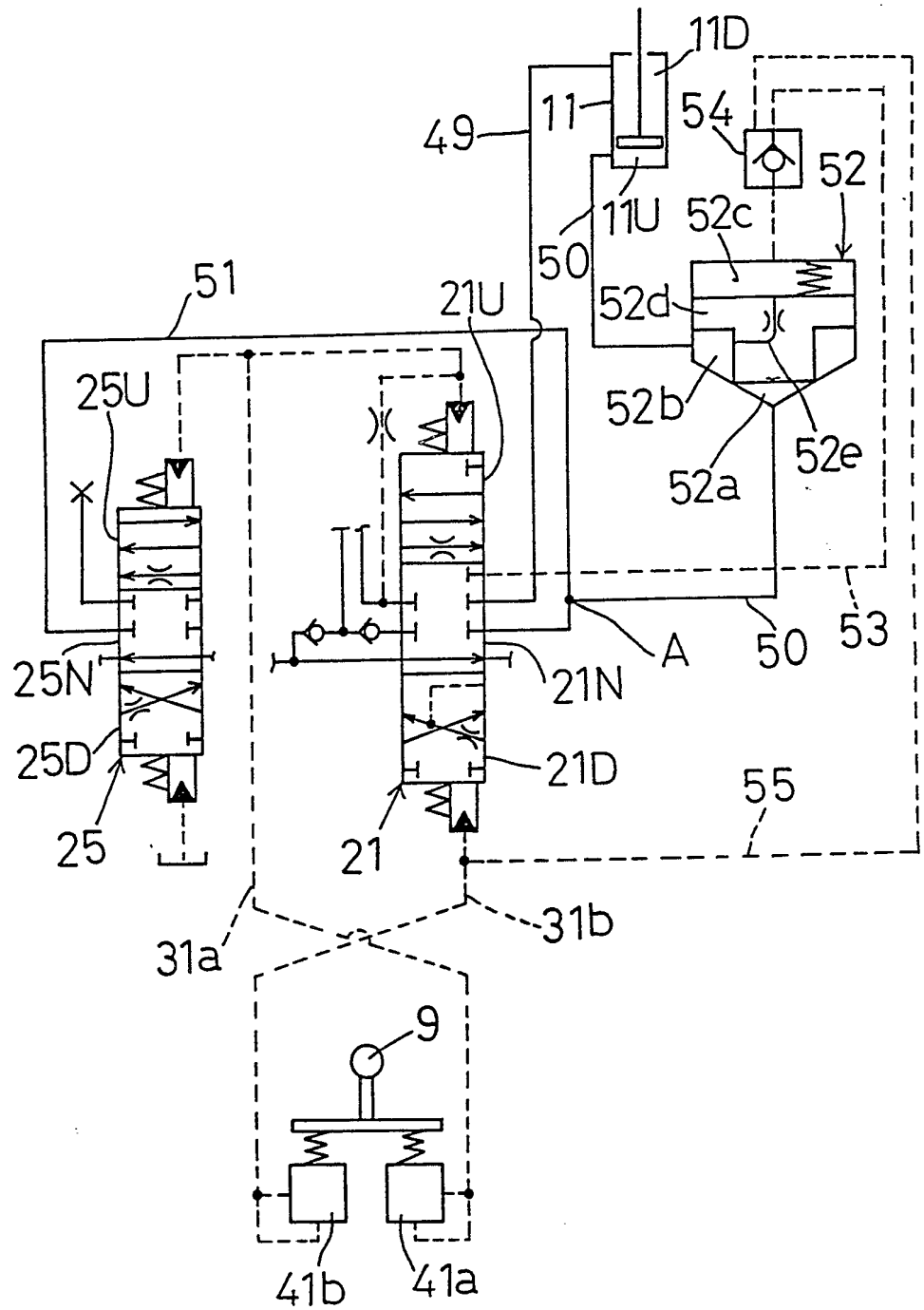
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Fig. 4

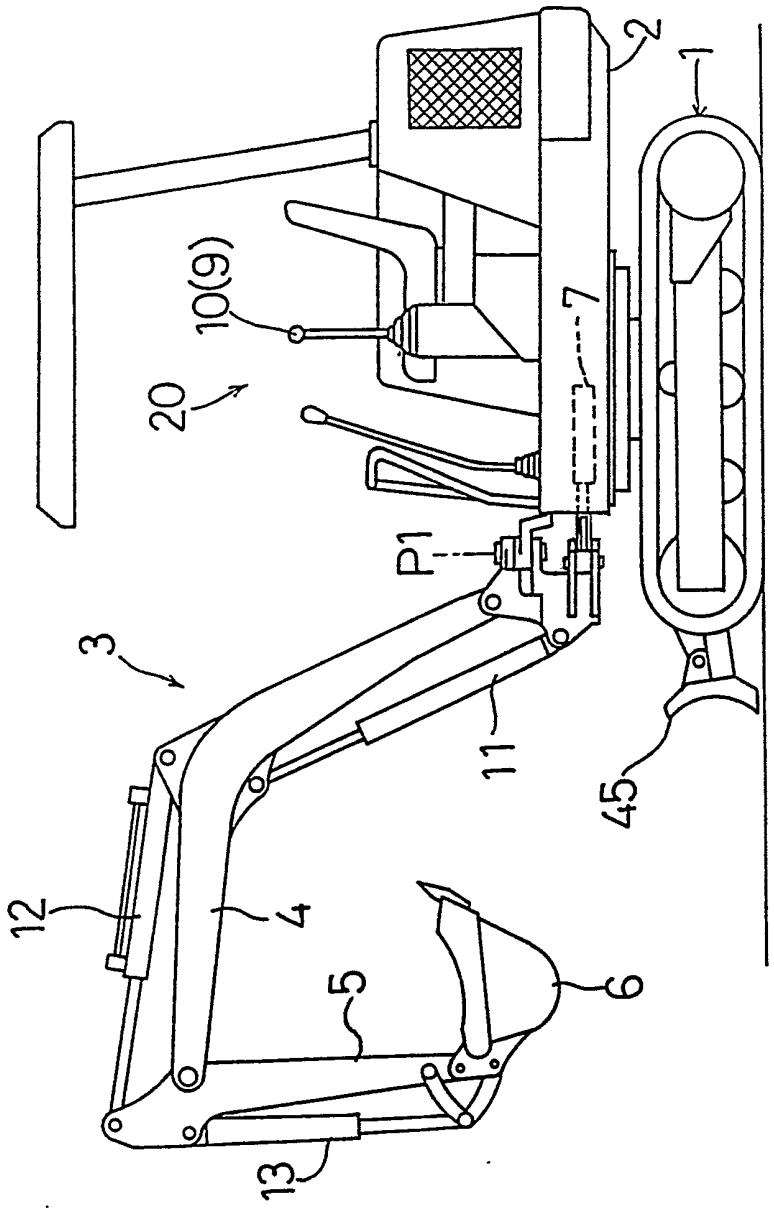
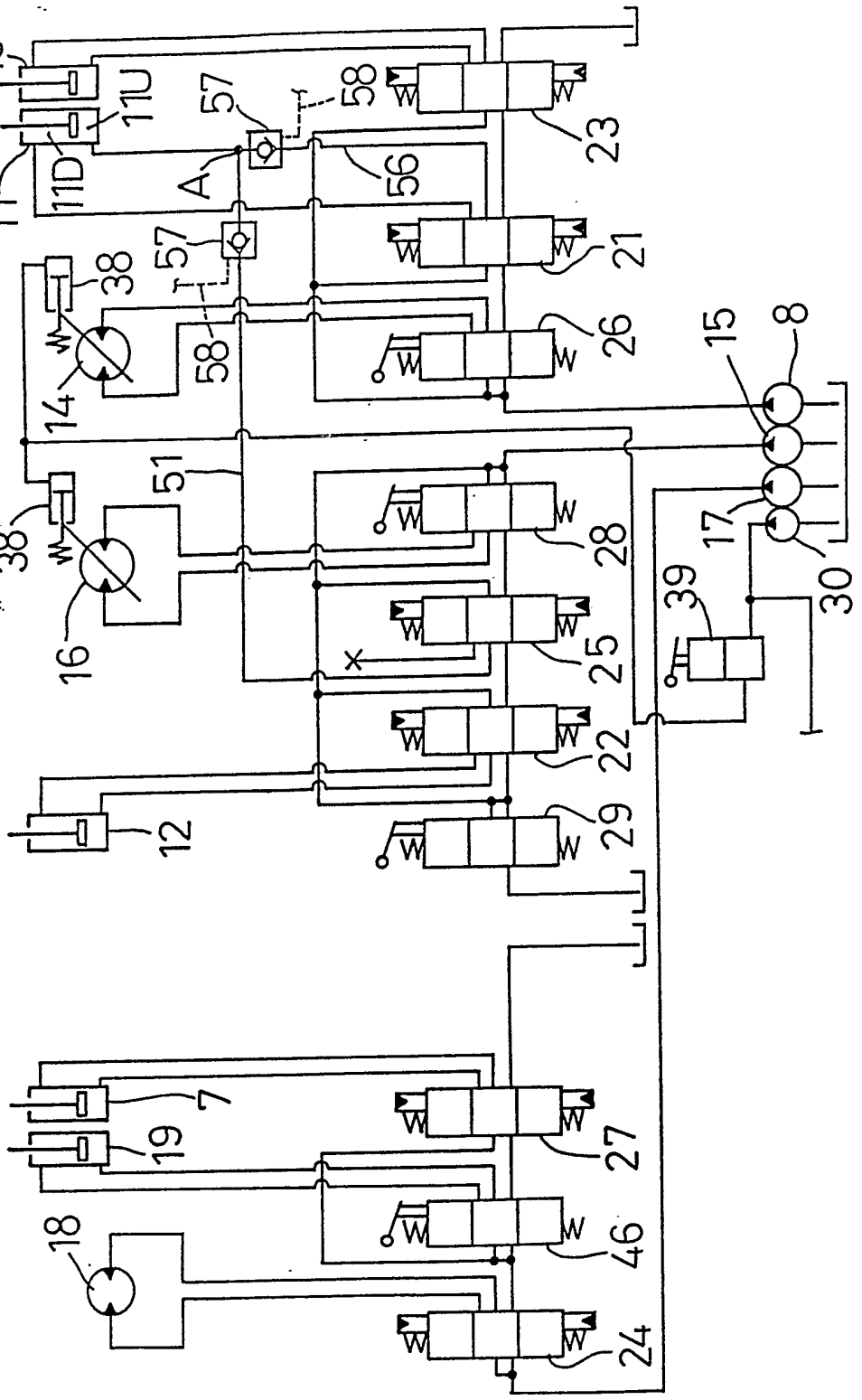


Fig. 5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HYDRAULIC CIRCUIT STRUCTURE FOR A BACKHOE IMPLEMENT

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

The present invention relates to a hydraulic circuit structure for driving a boom system of a backhoe digging implement attached to a front position of a swivel deck of a backhoe machine or to a rear position of a wheel loader or an agricultural tractor.

DESCRIPTION OF THE RELATED ART

An example of hydraulic circuit structure for a backhoe implement is disclosed in Japanese Utility Model Publication Kokai No. 2-139948.

In this structure, a hydraulic cylinder for vertically moving a boom and a first pump are interconnected through a control valve having three control positions, i.e. raising, neutral and lowering positions. The hydraulic cylinder has a raising oil chamber connected to the control valve through a raising oil line. This raising oil line is connected to a second pump through an auxiliary control valve having a raising position and a neutral position. Pressure oil from the first pump and pressure oil from the second pump are supplied through the control valve and auxiliary control valve confluently to the raising oil chamber of the hydraulic cylinder.

By supplying pressure oil from the two pumps confluently to the raising oil chamber of the hydraulic cylinder as above, the boom of the backhoe implement is raised with a strong force, thereby to increase digging power of the backhoe implement.

In the backhoe implement described above, a hook is sometimes fixed to the forward end of the boom or arm to suspend a load.

The boom with a load suspended therefrom may be locked by operating the boom control valve and auxiliary control valve to neutral. However, oil leakage inevitably occurs with the three-position switching type control valve. Consequently, the boom suspending the load tends to lower gradually due to such oil leakage even though the control valve and auxiliary control valve are in neutral.

It is conceivable to provide pilot check valves on the oil lines extending from the control valve and auxiliary control valve to the hydraulic cylinder for driving the boom, respectively. These pilot check valves allow the pressure oil to flow to the raising oil chamber of the hydraulic cylinder, but prevent the pressure oil from flowing back to the control valve and auxiliary control valve. The pair of pilot check valves are capable of preventing lowering of the boom suspending a load. Each pilot check valve is opened by a pilot pressure supplied through a pilot oil line when the control valve is operated to the lowering position.

However, the hydraulic circuit structure including the pair of pilot check valves has room for improvement from the viewpoint of structural simplicity.

SUMMARY OF THE INVENTION

The object of the present invention is to provide a simple circuit structure capable of preventing lowering of a boom while a control valve and an auxiliary control valve are placed in neutral.

To fulfill the above object, the present invention provides the following hydraulic circuit structure for a backhoe implement.

A hydraulic cylinder for vertically driving a boom is connected to a first pump through a control valve having three positions, i.e. raising,

neutral and lowering positions. The hydraulic cylinder has a raising oil chamber connected to the control valve through a raising oil line. The raising oil line is connected to a second pump through an auxiliary control valve having a raising position and a neutral position. Pressure oil from the first pump and pressure oil from the second pump are supplied through the control valve and auxiliary control valve confluently to the raising oil chamber of the hydraulic cylinder. A pilot check valve is disposed on a portion of the raising oil line between the hydraulic cylinder and a connecting point for joining the raising oil line and an oil line extending from the auxiliary control valve. The pilot check valve allows the pressure oil to flow from the connecting point to the raising oil chamber but prohibits a reversed flow from the raising oil chamber to the connecting point. Further, a pilot control device is provided to open the pilot check valve in response to operation of the control valve to the lowering position.

With the above construction, when raising the boom, the pressure oil from the first pump and pressure oil from the second pump flow through the control valve and auxiliary control valve, and join at the connecting point to flow confluently through the pilot check valve to the raising oil chamber of the hydraulic cylinder. This operates the hydraulic cylinder to raise the boom.

For lowering the boom, pressure oil is supplied from only the control valve or from both the control valve and auxiliary control valve to a lowering oil chamber of the hydraulic cylinder. At this time, the pilot check valve is opened by the pilot control device whereby the pressure oil in the raising oil chamber of the hydraulic cylinder is smoothly drained through the pilot check valve. Consequently, the hydraulic cylinder is operated to lower the boom.

Next, assume that the control valve and auxiliary control valve are operated to neutral in order to lock the boom to a desired position. In this state, the weight of the backhoe implement itself and the weight of a load suspended from the backhoe implement exert a force to lower the boom and drain the pressure oil from the raising oil chamber of the hydraulic cylinder. The pressure oil is initially driven from the oil chamber of the hydraulic cylinder to the pilot check valve which is disposed between the oil chamber and the connecting point. Since the pilot check valve is closed at this time, the pressure oil from the oil chamber cannot pass through the pilot check valve. Thus, the boom is locked against lowering from the desired position.

Two pilot check valves, instead of one, would be required for the control valve and auxiliary control valve, respectively, if the pilot check valve position were between the connecting point and the control valve/auxiliary control valve.

According to the present invention, however, the control valve position is between the connecting point and the oil chamber of the hydraulic cylinder. This structure requires only one pilot check valve instead of two.

Thus, in the backhoe implement having the control valve and auxiliary control valve for controlling the boom, the pilot check valve is provided to prevent lowering of the boom. This improves the efficiency of a load suspending operation.

One pilot check valve is sufficient although two control valves are provided for the boom. This structure is advantageous in terms of manufacturing cost also.

The foregoing and other objects, features and advantages of the

invention will be apparent from the following more particular description of a preferred embodiment of the invention, as illustrated in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a diagram of overall hydraulic circuitry of a backhoe according to the present invention;

Fig. 2 is a diagram of hydraulic circuitry of pilot pressure systems of right and left control levers;

Fig. 3 is a diagram of hydraulic circuitry of a boom control valve, an auxiliary boom control valve and a pilot check valve;

Fig. 4 is a side elevation of the backhoe; and

Fig. 5 is a diagram of overall hydraulic circuitry of a backhoe for use in comparison with the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

An embodiment of the present invention will be described hereinafter with reference to the drawings.

Fig. 4 is a side elevation of a backhoe having rubber crawlers 1, a swivel deck 2 supported thereon, and a backhoe implement 3 attached to a front position of the swivel deck 2. The backhoe implement 3 includes a boom 4 vertically pivotable by a hydraulic cylinder 11, an arm 5 pivotable back and forth by a hydraulic cylinder 12, and a bucket 6 operable by a hydraulic cylinder 13 to take shoveling action. The entire backhoe implement 3 is pivotable by a hydraulic cylinder 7 about a vertical axis P1 in the front position of the swivel deck 2.

A hydraulic circuit structure for controlling the backhoe will be

described next. As shown in Fig. 1, the circuit structure includes control valves 26, 21 and 23 connected to a first pump 8 in parallel with one another. The control valve 26 controls a hydraulic motor 14 for driving the right crawler 1. The control valve 21 controls the hydraulic cylinder 11 for actuating the boom 4. The control valve 23 controls the hydraulic cylinder 13 for actuating the bucket 6. The circuit structure further includes a control valve 28, an auxiliary control valve 25, a control valve 22 and a control valve 29 connected to a second pump 15 in parallel with one another. The control valve 28 controls a hydraulic motor 16 for driving the left crawler 1. The auxiliary control valve 25 controls the hydraulic cylinder 11 for actuating the boom 4. The control valve 22 controls the hydraulic cylinder 12 for actuating the arm 5. The control valve 29 controls a service port (not shown). Further, control valves 24, 46 and 27 are connected to a third pump 17 in parallel to one another. The control valve 24 controls a hydraulic motor 18 for driving the swivel deck 2. The control valve 46 controls a hydraulic cylinder 19 for raising and lowering a bulldozer blade 45 shown in Fig. 4. The control valve 27 controls the hydraulic cylinder 7 for horizontally swinging the backhoe implement 3.

The control valves 21, 22, 23, 24, 26, 27, 28, 29 and 46 and auxiliary control valve 25 are the center bypass type. The control valve 26 and 28, the control valve 29 of the service port, and the control valve 46 of the bulldozer blade 45 are the mechanically operable, neutral returning type operable by control levers (not shown). The control valve 21 and auxiliary control valve 25 of the boom 4, the control valve 22 of the arm 5, the control valve 23 of the bucket 6, the control valve 24 of the swivel deck 2, and the control valve 27 for swinging the backhoe implement 3 are the pilot operable, neutral returning type.

A system that operates the control valves 21, 22, 23 and 27 and auxiliary control valve 25 of the backhoe implement 3 and the control valve 24 of the swivel deck 2 will be described next.

Referring to Figs. 2 and 4, a right control lever 9 and a left control lever 10 are provided in a driver's section 20 on the swivel deck 2 to be operable fore and aft and right and left. A pair of pilot valves 41a and 41b are connected to the right control lever 9 to produce pilot pressures with fore and aft operation of the control lever 9. A pair of pilot valves 42a and 42b are connected to the right control lever 9 to produce pilot pressures with sideways operation of the control lever 9. A pair of pilot valves 43a and 43b are connected to the left control lever 10 to produce pilot pressures with fore and aft operation of the control lever 10. A pair of pilot valves 44a and 44b are connected to the left control lever 10 to produce pilot pressures with sideways operation of the control lever 10. A pilot pump 30 is provided to supply a pilot pressure to the respective pilot valves 41a-44b.

As shown in Fig. 2, pilot oil lines 31a and 31b extend from the pilot valves 41a and 41b of the right control lever 9 to the control valve 21 and auxiliary control valve 25 of the boom 4. Pilot oil lines 32a and 32b extend from the pilot valves 42a and 42b of the right control lever 9 to the control valve 23 of the bucket 6. With this structure, when the right control lever 9 is operated fore and aft, the pilot pressures from the pilot valves 41a and 41b operate the control valve 21 and auxiliary control valve 25 to swing the boom 4 vertically. The auxiliary control valve 25 is operable only when raising the boom 4. When the right control lever 9 is operated sideways, the pilot pressures from the pilot valves 42a and 42b operate the control valve 23 to swing the bucket 6 fore and aft.

Pilot oil lines 33a and 33b extend from the pilot valves 43a and 43b of the left control lever 10 to the control valve 22 of the arm 5. Pilot oil lines 34a and 34b extend from the pilot valves 44a and 44b of the left control lever 10 to a changeover valve 36. The changeover valve 36 is connected to the control valve 24 of the swivel deck 2 and the control valve 27 for swinging the backhoe implement 3.

Fig. 2 shows the changeover valve 36 in a first position 36a to connect the pilot valves 44a and 44b to the control valve 24 of the swivel deck 2.

When, in this state, the left control lever 10 is operated fore and aft, the pilot pressures from the pilot valves 43a and 43b operate the control valve 22 to swing the arm 5 fore and aft. When the left control lever 10 is operated sideways, the pilot pressures from the pilot valves 44a and 44b operate the control valve 24 to turn the swivel deck 2 right and left. At this time, the control valve 27 for swinging the backhoe implement 3 is maintained neutral by the changeover valve 36.

When, in the state shown in Fig. 2, the changeover valve 36 is operated to a second position 36, the pilot valves 44a and 44b are connected to the control valve 27 for swinging the backhoe implement 3. With sideways operation of the left control lever 10, the pilot valves 44a and 44b operate the control valve 27 to swing the backhoe implement 3 horizontally. At this time, the control valve 24 of the swivel deck 2 is maintained neutral by the changeover valve 36.

In the above operating states, to the greater extent the right and left control levers 9 and 10 are operated from neutral positions, the greater pilot pressures are produced by the pilot valves 41a-44b. Consequently, to the greater extent the right and left control levers 9 and 10 are operated from the neutral positions, the greater pilot pressures from the pilot valves

41a-44b operate the control valves 21-24 and 27 and auxiliary control valve 25 to positions of the greater oil flow. That is, to the greater extent the right and left control levers 9 and 10 are operated, the faster become operations of the hydraulic cylinders 11-13 and 7 and hydraulic motor 18.

When an unload valve 37 shown in Fig. 2 is operated to an unload position, no pilot pressure is supplied from the pilot pump 30 to the pilot valves 41a-44b. Even if the right and left control lever 9 and 10 are operated in this state, no pilot pressure is produced and the backhoe implement 3 and swivel deck 2 remain still.

As shown in Fig. 2, the hydraulic motors 14 and 16 of the crawlers 1 are the variable output type, and switchable by hydraulic cylinders 38 between two, high and low, speeds, respectively. A changeover valve 39 is connected to the pilot pump 30, which is operable to extend and contract the hydraulic cylinders 38, thereby to switch the hydraulic motors 14 and 16 between the two, high and low, speeds.

The control valve 21 and auxiliary control valve 25 of the boom 4 will be described next. As shown in Figs. 1 and 3, the control valve 21 and auxiliary control valve 25 are three-position, pilot operable and neutral returning type valves having raising or upward positions 21U and 25U, neutral positions 21N and 25N, and lowering or downward positions 21D and 25D, respectively. The pilot oil line 31a extending from the pilot valve 41a of the right control lever 9 is connected in parallel to the upward positions 21U and 25U of the control valve 21 and auxiliary control valve 25. The pilot oil line 31b extending from the pilot valve 41b of the right control lever 9 is connected to the downward position 21D of the control valve 21. The downward position 25D of the auxiliary control valve 25 is in an unload condition.

The hydraulic cylinder 11 includes a lowering or downward oil chamber 11D and a raising or upward oil chamber 11U connected to the control valve 21 through a lowering oil line 49 and a raising oil line 50, respectively. A raising oil line 51 extending from the auxiliary control valve 25 is connected to the raising oil line 50.

A pilot check valve 52 is mounted on a portion of the raising oil line 50 between the hydraulic cylinder 11 and a connecting point A of the two raising oil lines 50 and 51. The pilot check valve 52 includes three oil chambers 52a, 52b and 52c partitioned by a valve closure member 52d. The raising oil line 50 is connected to the oil chambers 52a and 52b. The oil chamber 52c of the pilot check valve 52 is connected to the control valve 21 through a pilot oil line 53 and pilot check valve 54. A pilot oil line 55 extends from the pilot oil line 31b to the pilot check valve 54 to operate the latter. The pilot check valve 54 and the pilot oil line 55 for operating the pilot check valve 54 constitute a pilot control device.

With the above structure, when the right control lever 9 is operated to a position to raise the boom 4, producing the pilot pressure from the pilot valve 41a, both the control valve 21 and auxiliary control valve 25 are operated to the upward positions 21U and 25U. As a result, the pressure oil from the first pump 8 and pressure oil from the second pump 15 flow through the control valve 21 and auxiliary control valve 25, join at the connecting point A, and flow confluently to the oil chamber 52a of the pilot check valve 52.

The pilot check valve 54 is closed at this time. Thus, the oil pressure in the oil chamber 52a biases the valve closure member 52d upward in Fig. 3. Since the pilot check valve 54 is closed, the pilot pressure in the oil chamber 52c cannot flow toward the check valve 54 and, therefore, flows

into the oil chamber 52b through a constricted oil passage 52e formed in the valve closure member 52d. As a result, the valve closure member 52d moves upward in Fig. 3, intercommunicating the oil chamber 52b and oil chamber 52a. The lower oil chamber 52a of the pilot check valve 52 now communicates with the raising oil chamber 11U of the hydraulic cylinder 11. The confluent flow of pressure oil is thereby supplied to the oil chamber 11U to extend the hydraulic cylinder 11 and raise the boom 4.

When the right control lever 9 is operated to a position to lower the boom 4, producing the pilot pressure from the pilot valve 41b, only the control valve 21 is operated to the downward position 21D, with the auxiliary control valve 25 retained in the neutral position 25N. As a result, the pressure oil from the first pump 8 is supplied to the lowering oil chamber 11D, and the pressure oil in the raising oil chamber 11U is supplied to the oil chamber 52b of the pilot check valve 52.

At this time, the pilot pressure through the pilot oil line 31 is supplied to the pilot check valve 54 by way of the pilot oil line 55, to open the pilot check valve 54. The valve closure member 52d is biased upward by the oil pressure in the oil chamber 52b. Since the pilot check valve 54 is open, the pressure oil in the oil chamber 52c can flow toward the pilot check valve 54, which allows the valve closure member 52d to move upward in Fig. 3. Consequently, the oil chamber 52a and oil chamber 52b of the pilot check valve 52 communicate with each other. The pressure oil in the raising oil chamber 11U returns to the control valve 21, whereupon the hydraulic cylinder 11 contracts to lower the boom 4.

When the right control lever 9 is placed in the neutral position, both the control valve 21 and auxiliary control valve 25 are operated to the neutral positions 21N and 25N. The pilot oil line 55 has no pilot pressure when

the control valve 21 and auxiliary control valve 25 are in the neutral positions 21N and 25N. The control valve 21 in the neutral position 21N blocks the pilot oil line 53 to close the pilot check valve 54.

Consequently, the valve closure member 52d does not move upward from the position shown in Fig. 3 even if the pressure oil flows from the raising oil chamber 11U of the hydraulic cylinder 11 into the oil chamber 52b of the pilot check valve 52. The valve closure member 52d maintains the oil chamber 52a and oil chamber 52b out of communication with each other. This prevents lowering of the boom 4.

In the foregoing embodiment, the auxiliary control valve 25 has the upward position 25U, neutral position 25N and downward position 25D. Instead, the auxiliary control valve 25 may have two positions only, i.e. the upward position 25U and neutral position 25N. The control valve 21 and auxiliary control valve 25 of the boom 4 may be mechanically operable or electromagnetically operable instead of being pilot operable.

The present invention is applicable not only to a backhoe, but a backhoe implement attached to a rear position of a wheel loader or an agricultural tractor.

Although the claims include reference numerals for convenience in comparison to the drawings, such inclusion in no way limits the present invention to the illustrated structure.

What is claimed is:

1. A hydraulic circuit structure for controlling vertical movement of a boom system in a backhoe implement, comprising:

a hydraulic cylinder (11) including a raising oil chamber (11U) and a lowering oil chamber (11D) for vertically driving a boom (4);

a first hydraulic pump (8) and a second hydraulic pump (15) for supplying pressure oil to hydraulic circuitry;

a first control valve (21) disposed on a first oil line connecting said first pump (8) to said hydraulic cylinder (11), said first control valve (21) being switchable among a first position, a second position and a third position corresponding to raising, neutral and lowering of said boom;

a raising oil line (50) included in said first oil line to connect said first control valve (21) to said raising oil chamber (11U);

a second control valve (25) disposed on a second oil line connecting said second pump (15) to said hydraulic cylinder (11), said second line having a connecting point (A) for connection to said raising oil line (50);

a pilot check valve (52) disposed on said raising oil line (50) between said connecting point (A) and said hydraulic cylinder (11), said pilot check valve (52) being switchable between a closed position for allowing pressure oil to flow from said connecting point (A) to said raising oil chamber (11U) but prohibiting a reversed flow thereof, and an open position for allowing the pressure oil to flow from said raising oil chamber (11U) to said connecting point (A); and

pilot control means for controlling said pilot check valve (52) such that said pilot check valve (52) is placed in said closed position when said first control valve (21) is operated to one of said first and second positions, and

in said open position in response to operation of said first control valve (21) to said third position.

2. A hydraulic circuit structure as defined in claim 1, wherein said pilot check valve (52) is operable by a check valve (54) operatively connected to said first control valve (21).

3. A hydraulic circuit structure as defined in claim 2, wherein said pilot control means includes said check valve (54) and a pilot oil line (55) for supplying pressure oil to said check valve (54).

4. A hydraulic circuit structure as defined in claim 3, wherein said the pressure oil is supplied through said pilot oil line (55) to open said check valve (54) in response to the operation of said first control valve (21) to said third position, thereby placing said pilot check valve (52) in said open position.

5. A hydraulic circuit structure as defined in claim 3, wherein said check valve (54) is closed when said first control valve (21) is operated to one of said first and second positions, thereby placing said pilot check valve (52) in said closed position.

6. A hydraulic circuit structure as defined in claim 1, wherein said pilot check valve (52) includes a housing, and a valve closure member (52d) slidably mounted therein to define a first oil chamber (52a), a second oil chamber (52b) and a third oil chamber (52c), said valve closure member (52d) having a constricted oil passage (52e) formed therein to

intercommunicate said second oil chamber (52b) and said third oil chamber (52c).

7. A hydraulic circuit structure as defined in claim 6, wherein, when said first oil chamber is in communication with a portion of said first oil line (50) extending from said first control valve (21), said second oil chamber is in communication with a portion of said first oil line (50) extending from said hydraulic cylinder (11), and said third oil chamber is in communication with said pilot control means.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

Application number

GB 9313021.9

Relevant Technical fields

(i) UK Cl (Edition L) F1P

(ii) Int Cl (Edition 5) F15B

Search Examiner

J GRAHAM

Databases (see over)

(i) UK Patent Office

(ii)

Date of Search

4 AUGUST 1993

Documents considered relevant following a search in respect of claims 1-7

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
	NONE	1

Category	Identity of document and relevant passage	Relevant to claim(s)

Categories of documents

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E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

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