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(54) HYDRAULIC SYSTEM FOR IMPROVING FLATTING WORKABILITY IN AN EXCAVATOR

HYDRAULISCHES SYSTEM ZUR ERHÖHUNG DER STRECKFÄHIGKEIT IN EINEM BAGGER
SYSTÈME HYDRAULIQUE AMÉLIORANT MANIABILITÉ D'UN EXCAVATEUR POUR
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Description

[0001] The present invention relates to a hydraulic system according to the preamble of claim 1 which is known from EP 0 436 740 A1.

[0002] US 3 604 313 discloses a hydraulic circuit for the operation of a boom of a construction machine which includes a four-position boom control valve for controlling the position that the boom hydraulic actuator may assume during operations.

[0003] US 2003/230082 A1 discloses a hydraulic system comprising a first and second pump, a boom cylinder which drives a boom, first and second control valves including boom-up side ports hydraulically connected to a boom-up pilot line, the hydraulic operating fluid passing through the first and second boom control valves being joined and supplied to the boom cylinder when the boom is lifted.

[Background Art]

[0004] Among the works using an excavator, the flattening work of a plain or inclined ground is completely dependent on experience and skill of an operator of the excavator, and is known to be difficult by a beginner who is not skilled in the operation of equipment.

[0005] The flattening work of a plain or inclined ground, sometimes called ironing, is carried out as a part of compacting work after the ground is leveled. In the flattening work, a bucket of the excavator is pulled, while pressing the ground in the state in which a flat part of the bucket is in contact with the ground, thereby pressing and simultaneously flattening the ground, similarly ironing clothes with iron.

[0006] The flattening work is carried out by combined operation of a boom, an arm and a bucket with pressing the ground and simultaneously pulling the arm in the state in which the flat part of the bucket is in contact with the ground, which is essential work for making a flatly pressed surface in the plain or inclined ground

[0007] At this time, the force pressing the ground must be uniform to some extent. Meanwhile, if the ground is pressed with excessive or non-uniform force, the pressing work causes a problem with uniformity in flatness of the ground.

[0008] The force pressing the ground is determined by mechanical force applied to the bucket through the combined operation of the boom, the arm and the bucket. However, it is not easy to properly apply the mechanical force to the ground. This can be realized only by skilled operation of a joystick of the excavator. Further, in addition to the application of the uniform force, the flat part of the bucket must be continuously in contact with the ground.

[0009] In general, the boom, the arm and the bucket of the excavator are operated by the joystick. As illustrated in FIG. 5, the typical joystick of the excavator is provided with a swing lever for swinging a body of the exca-

vator and an arm lever for dump/crowd operation of the arm, which are installed on one side within driver's reach, and a lever for up/down operation of the boom and a lever for dump/crowd operation of the bucket, which are installed on the other side within driver's reach. In this excavator, the results of the work are dependent on how properly the joystick is operated.

[0010] However, in the conventional excavator, it is not easy to operate the joystick to carry out the flattening work properly. The up/down operation of the boom, the dump/crowd operation of the arm, and the dump/crowd operation of the bucket should be properly balanced by the control of the joystick to operate the boom, arm and bucket. As such, unskilled operators have a great difficulty in controlling the joystick taking into consideration of the operations of all the three parts.

[Disclosure]

20 [Technical Problem]

[0011] Accordingly, the present invention has been made in an effort to solve the problems occurring in the related art, and an object of the present invention is to provide a hydraulic system for an excavator, which enables even an unskilled operator, who is short of skill or technique of the operation of equipment, to easily perform flattening work on a plain or inclined ground.

30 [Technical Solution]

[0012] In order to achieve the above object, the present invention provides a hydraulic system for an excavator according to independent claim 1.

35 **[0013]** According to an example of the present invention, the fourth position of the boom control valve is located at one outermost port of the boom control valve, and the stopper is connected to the other outermost port of the boom control valve and supplies a predetermined hydraulic pressure to the other outermost port so as to restrict the boom control valve from being switched to the fourth position.

40 **[0014]** The first position of the directional control switch corresponds to a position that is indicated by Mode 1 in FIGS. 3 and 4, which is for the excavating work. Further, the second position of the directional control switch corresponds to a position that is indicated by Mode 2 in FIGS. 3 and 4, which is for the flattening work.

45 **[0015]** Meanwhile, according to the present invention, in order to allow the ordinary excavating work to be carried out even if the directional control switch is switched so as to select the flattening work position, the boom control valve is switched up to the fourth position only when the boom-up side port thereof has pressure equal to or greater than a preset reference pressure, and is switched only to one of the first, second and third positions when the pressure of the boom-up side port is less than the reference pressure. Thereby, the boom-up/down operation

required for the excavating work can be controlled. In this case, the reference pressure is set to pressure occurring at the boom-up side port when an operator operates an operating lever beyond a predetermined displacement or angle in a direction where the boom is lifted.

[0016] The hydraulic system for the excavator, which is structurally improved so as to easily perform flattening work, can be applied to a two-pump hydraulic system having two pumps.

[0017] Further, the hydraulic system of the present invention further comprises means for interrupting the connection of the boom-up pilot line and the second boom control valve. One example of the interrupting means includes a second directional control valve, which can be switched between a first position where the boom-up pilot line is connected with the second boom control valve and a second position where the boom-up pilot line is disconnected from the second boom control valve.

[0018] Further, the hydraulic system according to an example of the present invention further comprises a directional control switch for switching the first directional control valve and the second directional control valve.

[0019] Meanwhile, the two-pump hydraulic system can be also designed so that, in order to allow the ordinary excavating work to be carried out even if the directional control switch is switched so as to select the flattening work position, when the directional control switch is switched to a first position, the first boom control valve is switched up to the fourth position only when the boom-up side port thereof has pressure equal to or greater than a preset reference pressure, and is switched only to one of the first, second and third positions when the pressure of the boom-up side port is less than the reference pressure.

[Advantageous Effects]

[0020] With use of the excavator having the hydraulic system according to the present invention, even an unskilled operator, who is short of skill or technique of the operation of equipment, can naturally perform the flattening work on the plain or inclined ground with ease.

[Description of Drawings]

[0021]

FIG. 1 is a schematic view illustrating configuration of a boom control valve 22 and its peripheral attachments in a known excavator;

FIG. 2 is a schematic view illustrating configuration of a boom control valve 22 and its peripheral attachments in an excavator according to an embodiment of the present invention;

FIG. 3 is a hydraulic circuit diagram illustrating a two-pump hydraulic system having two pumps, which improves flattening workability, according to an example of the present invention;

FIG. 4 schematically illustrates the first boom control

valve 1 and its peripheral attachments in the hydraulic circuit diagram of FIG. 3;

FIG. 5 is a hydraulic circuit diagram illustrating a joystick that is an operating device of the excavator;

FIG. 6 is a graph showing hydraulic characteristics of a pilot valve;

FIG. 7 illustrates the state in which an excavator carries out flattening work on a plain ground; and

FIG. 8 illustrates the state in which an excavator carries out flattening work on an inclined ground.

<Description of Symbols of the Main Parts in the Drawings>

15 [0022]

2: first boom control valve

3: second boom control valve

4: first arm control valve

20 5: second arm control valve

6: bucket control valve

8: first directional control valve

9: gear pump

10: second directional control valve

25 11: stopper

20: directional control switch

21: control valve section

22: boom control valve

23: boom cylinder

30 24: boom

[Mode for Invention]

[0023] Reference will now be made in greater detail to an exemplary embodiment of the invention, an example of which is illustrated in the accompanying drawings.

[0024] Wherever possible, the same reference numerals will be used throughout the drawings and the description to refer to the same or like parts.

[0025] First, FIG. 1 is a schematic view illustrating configuration of a boom control valve 22 and its peripheral attachments in an ordinary excavator having a boom, an arm and a bucket. As can be seen from FIG. 1, such a boom control valve can be switched to one of three positions: one for lifting a boom 24, one for maintaining neutrality of the boom 24, and one for lowering the boom 24, when viewed from the left side.

[0026] FIG. 2 is a schematic view illustrating configuration of a boom control valve 22 and its peripheral attachments in an excavator according to an embodiment of the present invention. As can be seen from FIG. 2, the boom control valve 22 has a first position for maintaining neutrality of a boom 24, a second position for lifting the boom 24, a third position for lowering the boom 24, and a fourth position for allowing the boom 24 to be lifted and lowered by self-weight or external force. The boom control valve 22 can be switched to one of the four positions.

[0027] According to the present invention, the boom

control valve 22 can be operated by a boom-up pilot signal Pi and a boom down pilot signal, which are generated by manipulation of a joystick of an excavator operator (see FIG. 5).

[0028] When the boom control valve 22 is switched to the fourth position, a channel, through which hydraulic operating fluid is supplied from a pump to a boom cylinder, is blocked. At this time, since a head-side hydraulic operating fluid chamber and a rod-side hydraulic operating fluid chamber communicate with each other to form a closed loop, the boom cylinder can be not only freely lowered by self-weight, but also freely lift by external force (a geographical problem). In this state, flattening work can be carried out by force resulting from the self-weight of the boom. In this case, since the force applied to the ground by the self-weight of the boom may be said to be relatively constant, it is not necessary to separately control the force for lowering the boom during the flattening work. Thus, the operator does not require to carry out boom-up or boom-down operation.

[0029] As a result, the flattening work can be done by operating only the bucket and arm in the state in which the boom control valve is fixed to a preset position, i.e. the fourth position.

[0030] More specifically, after the boom control valve is fixed to the fourth position, the arm is stretched to the maximum extent, and thereby the bucket is located at a place remotest from a body of the excavator, as illustrated in FIGS. 7 and 8. At this time, a flat outer surface of the bucket is controlled to be parallel to the ground. Then, in order to pull the arm, an arm controlling joystick is controlled toward a crowd side, so that the flattening work is naturally carried out while the arm is pulled. At this time, the bucket must be controlled such that the flat outer surface thereof is parallel to the ground. In this case, since the flat outer surface of the bucket has only to be minutely controlled while performing simple operation of pulling the arm (arm crowd operation), the flattening work can be easily carried out.

[0031] Meanwhile, if the boom control valve 22 is switched to the fourth position in spite of out carrying out the flattening work, the boom abruptly makes free motion during another work, and thus is lowered. This abrupt lowering of the boom causes an accident. In order to prevent this accident, it is necessary to prevent the boom control valve 22 from being switched to the fourth position while the excavator carries out the work, such as the excavating work, other than the flattening work.

[0032] To this end, according to an example of the present invention, the hydraulic system comprises a stopper 11, which controls the boom control valve 22 to prevent from being arbitrarily switched to the fourth position.

[0033] It can be apparent from FIG. 2 that the boom control valve 22 is further provided with the stopper 11 on one side thereof which restricts the boom control valve 22 from being switched to the fourth position so as to allow the boom control valve 22 to be switched only to

one of the first, second and third positions.

[0034] According to an example of the present invention which has the configuration as in FIG. 2, the boom control valve 22 has the fourth position adjacent to a boom-up side port thereof, that is, one outermost port thereof, and the stopper 11 is connected to another outermost port, that is, a boom-down side port. The application of a predetermined hydraulic pressure to the stopper restricts the boom control valve 22 from being switched to the fourth position.

[0035] Further, referring to FIG. 2, the hydraulic system of the present invention can further comprise a first directional control valve 8 for controlling the stopper. To control the stopper using the first directional control valve 8, the hydraulic system further comprises a gear pump 9, and a pilot line Pi2 connecting the stopper 11 and the gear pump 9. The first directional control valve can be installed on the pilot line Pi2.

[0036] Further, the hydraulic system of the present invention can further comprise a directional control switch 20. A work mode is determined by the directional control switch. In the case of the flattening work, the boom control valve 22 can be adapted to be switched to the fourth position. In the other cases, the boom control valve 22 can be adapted to be not switched to the fourth position.

[0037] In detail, according to an example of the present invention, the directional control switch 20 can be selectively switched to one of a first position (Mode 1) and a second position (Mode 2) by manipulation of an operator. In this embodiment, the directional control switch is provided in a knob shape at a predetermined position within a cab (not shown), and is electrically connected with the solenoid-type first directional control valve 8 as described below as well as a second directional control valve 10 in the next embodiment, which will be described below. Here, the first position of the directional control switch 20 refers to a position where the first directional control valve 8 is switched to the first position so as to allow the stopper 11 to communicate with the gear pump 9 through the pilot line Pi2. With this configuration, the stopper 11 is operated, so that the boom control valve 22 can be prevented from being switched to the fourth position. The second position of the directional control switch 20 refers to a position where the first directional control valve 8 is switched to the second position so as to allow the pilot line Pi2 to communicate with a tank T. Thus, the stopper 11 releases its function, so that the boom control valve 22 can be switched to the fourth position.

[0038] Here, the first position of the directional control switch 20 corresponds to a position that is indicated by Mode 1 in FIGS. 3 and 4, which is for the excavating work. Further, the second position of the directional control switch 20 corresponds to a position that is indicated by Mode 2 in FIGS. 3 and 4, which is for the flattening work.

[0039] Meanwhile, even if the directional control switch 20 is manipulated so as to select the flattening work, it may be adapted to carry out the ordinary excavating work.

[0040] As illustrated in FIG. 6, only when a boom-up

side hydraulic line Pi of the boom control valve 22 has pressure equal to and greater than a preset reference pressure, for instance 26k, the boom control valve 22 can be adapted to be switched to the fourth position. Thereby, in the case in which the joystick is controlled such that the pressure of the boom-up side hydraulic line is less than the reference pressure, a first boom control valve is adapted to be switched only to one of the first, second and third positions so as to be able to carry out the ordinary excavating work. According to the configuration of FIG. 6, the pressure occurring when the operator pulls the operation lever of the joystick at a displacement of 10 mm in the direction where the boom is lifted can be set to become the preset reference pressure of the hydraulic line. In the case in which the operator pulls the operation lever of the joystick at a displacement of 10 mm or less in the direction where the boom is lifted, the first boom control valve can be adapted to be switched only to one of the first, second and third positions. In contrast, in the case in which the operator pulls the operation lever of the joystick at a displacement of 10 mm or more in the direction where the boom is lifted, the first boom control valve can be adapted to be switched to one of the first through fourth positions.

[0041] Meanwhile, FIG. 3 is a hydraulic circuit diagram illustrating a two-pump hydraulic system having two pumps according to an example of the present invention. FIG. 4 schematically illustrates the first boom control valve 1 and its peripheral attachments in the hydraulic circuit diagram of FIG. 3. Further, FIG. 5 is a hydraulic circuit diagram illustrating a joystick that is an operating device of the excavator.

[0042] The hydraulic system illustrated in FIG. 3 comprises first and second pumps P1 and P2, a control valve section 21, an arm crowd pilot line Pac, a boom-up pilot line Pi, a first directional control valve 8, and a second directional control valve 10.

[0043] First, the control valve section 21 includes first and second boom control valves 2 and 3, first and second arm control valves 4 and 5, and other valves such as a straight traveling control valve, a left/right turning control valve, an option control valve and a swing control valve. Here, the detailed description associated with functions of the straight traveling control valve, the left/right turning control valve, the option control valve and the swing control valve will be omitted, and so their numbering will be omitted.

[0044] In FIG. 3, the first boom control valve 2 and the second arm control valve 5 communicate with the first pump P1 through a center parallel line Ps. The second boom control valve 3 and the first arm control valve 4 communicate with the second pump P2 through another center parallel line Ps. Hydraulic operating fluid passing through the second boom control valve 3 joins that passing through the first boom control valve 2 via a predetermined path A8', and then is supplied to a boom cylinder.

[0045] Further, the boom-up side ports of the first and second boom control valves 2 and 3 are hydraulically

connected to each other through the boom-up pilot line Pi. Further, it can be found that the boom-up side ports of the first and second boom control valves 2 and 3 are hydraulically connected to each other such that the hydraulic operating fluids passing through the first and second boom control valves 2 and 3 can be joined when the boom is lifted.

[0046] In the two-pump hydraulic system as in FIG. 3, the first boom control valve 2 has a first position for maintaining neutrality of the boom, a second position for lifting the boom, a third position for lowering the boom, and a fourth position for allowing the boom 24 to be freely lifted and lowered by self-weight or external force. The first boom control valve 2 can be switched to one of the four positions.

[0047] Here, when the first boom control valve 2 is switched to the fourth position, the excavator has a flatting work mode. For reference, a neutral position is a position where inlet and outlet of the boom cylinder are closed.

[0048] It can be apparent from FIG. 3 that the hydraulic system comprises a stopper 11, which restricts the first boom control valve 2 from being switched to the fourth position so as to allow the first boom control valve 2 to be switched only to one of the first, second and third positions. More specifically, the first boom control valve 2 has the fourth position adjacent to one outermost port thereof, and the stopper 11 is connected to the other outermost port. The application of a predetermined hydraulic pressure to the other port of the first boom control valve restricts the first boom control valve from being switched to the fourth position. In FIG. 3, the stopper 11 is installed on the boom-down side port of the first boom control valve 2.

[0049] In conjunction with the control of the stopper 11, the hydraulic system illustrated in FIGS. 3 and 4 can further comprise a gear pump 9, a pilot line Pi2 connecting the stopper 11 and the gear pump 9, and a first directional control valve 8, which is installed on the pilot line Pi2 and is switched between a first position where the pilot line Pi2 communicates with the gear pump 9 and a second position where the pilot line Pi2 communicates with a tank.

[0050] The stopper functions to prevent the first boom control valve from being switched to the fourth position when the first directional control valve 8 is switched to the first position, the communicating position.

[0051] Meanwhile, in the case in which the function of the stopper 11 is released by the switching of the first directional control valve 8, the first boom control valve 2 can be switched to the fourth position.

[0052] Meanwhile, in the case of the two-pump hydraulic system, in spite of the flatting work where the first boom control valve 2 is switched to the fourth position, the hydraulic operating fluid can be supplied to the boom cylinder through the second boom control valve 3. Particularly, when the hydraulic operating fluid is supplied to the boom cylinder in the direction where the second boom

control valve 3 lifts the boom, the flattening work based on the self-weight is not properly performed, and the boom may make irregular motion, which is dangerous. In order to prevent this danger, it is necessary to fix the second boom control valve 3 so as not to be switched while the flattening work is being performed. To this end, a control signal sent to the second boom control valve 3 can be interrupted. According to an example of the present invention, the hydraulic system can employ a method of blocking the boom-up pilot line Pi applied to the second boom control valve 3 during the flattening work.

[0053] To this end, the two-pump hydraulic system can further comprise means for interrupting the connection of the boom-up pilot line Pi and the second boom control valve 3. One example of this interrupting means includes the second directional control valve 10. The second directional control valve 10 can be adapted to be switched between a first position where the boom-up pilot line Pi is connected with the second boom control valve 3 and a second position where the boom-up pilot line Pi is disconnected from the second boom control valve 3.

[0054] According to an example of the present invention, the hydraulic system can further comprise a directional control switch 20, which switches the first directional control valve 8 and the second directional control valve 10. More specifically, the directional control switch 20 can be adapted to be selectively switched to one of: a first position where it switches the first directional control valve 8 to the first position and causes the stopper 11 to communicate with the gear pump 9 through the pilot line Pi2 such that the stopper 11 is functionally activated to restrict the first boom control valve 2 from being switched to the fourth position, and where it switches the second directional control valve 10 to the first position and causes the second boom control valve 3 to communicate with the boom-up pilot line Pi such that the first boom control valve 2 and the second boom control valve 3 can be switched in the direction where the boom is lifted; and a second position where it switches the first directional control valve 8 to the second position and causes the pilot line Pi2 to communicate with the tank T so that the stopper 11 is functionally inactivated to allow the first boom control valve 2 to be switched up to the fourth position, and where it switches the second directional control valve 10 to the second position, causes the boom-up pilot line Pi to communicate with the tank T, and prevents the second boom control valve 3 from communicating with the boom-up pilot line Pi so that the second boom control valve 3 cannot be switched.

[0055] According to an example of the present invention, the directional control switch 20 can be hydraulically and electrically connected with the first and second directional control valves 8 and 10.

[0056] In FIG. 4, the connection of the first boom control valve 2 of the present invention is illustrated in detail. The first boom control valve 2 is connected with the boom-up pilot line Pi on the left side thereof, and is provided with the stopper 11 on the right side thereof. The stopper 11

can communicate with the first directional control valve 8 at the first position of the first directional control valve 8, and thus can be supplied with the hydraulic operating fluid from the gear pump 9.

[0057] The pressure oil discharged from the first pump P1 flows through the center parallel line Ps, and the hydraulic operating fluid is supplied to the boom cylinder in response to the switching of the first boom control valve 2.

[0058] Meanwhile, although the directional control switch 20 is operated so as to select the flattening work position, the excavator can be adapted to perform the ordinary excavating work.

[0059] In other words, as illustrated in FIG. 6, only when a boom-up side hydraulic line Pi of the boom control valve 22 has pressure equal to and greater than a preset reference pressure, for instance 26k, the boom control valve 22 can be adapted to be switched to the fourth position. Thereby, in the case in which the joystick is controlled such that the pressure of the boom-up side hydraulic line is less than the reference pressure, the first boom control valve is adapted to be switched only to one of the first, second and third positions so as to be able to carry out the ordinary excavating work. For example, with the configuration of FIG. 6, on the basis of the operator pulling the operation lever of the joystick at a displacement of 10 mm in the direction, where the boom is lifted, when the displacement is less than 10 mm, the first boom control valve can be adapted to be switched only to one of the first, second and third positions, but when the displacement is more than 10 mm, the first boom control valve can be adapted to be switched to one of the first through fourth positions. This method of operating the boom-up joystick in order to switch the first boom control valve 2 to the fourth position can be changed to the case in which the boom 24 is operated in a lowering direction. In this case, the boom 24 will be operated in a manner such that it is lowered by its self-weight while being lowered.

[0060] The flattening work and the ordinary excavating work using the excavator having the above-mentioned hydraulic system according to the present invention will be described below.

<Flattening Work> Second Position of Directional Control Switch 20

[0061] When the operator switches the directional control switch 20 to the second position, which corresponds to the flattening work mode, for the purpose of the flattening work, the first directional control valve 8 is switched to the second position, and the pilot line Pi2 communicates with the tank T. As a result, the stopper 11 is functionally inactivated, and thus the first boom control valve 2 can be switched up to the fourth position. Further, the second directional control valve 10 is switched to the second position, thereby allowing the boom-up pilot line Pi of the second boom control valve 3 to communicate with the tank T, so that the second boom control valve 3 is not

switched. At this time, when the first boom control valve 2 is switched to the fourth position, the inlet and outlet ports of the boom cylinder 23 communicate with each other.

[0062] Thus, the front including the boom is lowered by its self-weight, and the flat surface of the bucket comes into contact with the ground, so that pressing action occurs. Subsequently, when the arm is pulled in a crowd direction, the self-weight of the front is applied to the ground, so that the flatting work is realized as in FIGS. 7 and 8.

[0063] Meanwhile, when it is necessary to inevitably carry out boom-up operation during the flatting work, the hydraulic characteristics of the boom control valves 2 and 3 can be divided into two stages, as illustrated in FIG. 6, such that the operation thereof can be changed. In FIG. 6, the first boom control valve 2 can be switched to one of the first, second and third positions under the conditions: pilot pressure of 20k and stroke of 10 mm or less, such that the ordinary excavating work permitting boom-up/-down operation is carried out. Only when the pilot pressure exceeds 20k, the first boom control valve 2 is adapted to be switched to the fourth position.

[0064] In other words, when the operator slightly pulls the boom-up joystick (pressure of 20k or less, and displacement of 10 mm or less) in spite of the selection of the directional control switch 20 in the flatting work mode, the first boom control valve 2 is switched within a range from the first position to the third position without being switched to the fourth position, and the second boom control valve 3 is not yet switched. In this case, the boom 24 is lifted and lowered by the hydraulic operating fluid passing through the first boom control valve 2. Meanwhile, it is not until the operator pulls the boom-up joystick at a displacement of 10 mm or more and thus the pilot pressure exceeds 20k that the first boom control valve 2 is switched to the fourth position, the floating state, and thus the boom is lowered toward the ground by its self-weight.

<Ordinary Work> First Position of Directional Control Switch 20

[0065] When the operator switches the directional control switch 20 to the first position for the purpose of the excavating work, the second directional control valve 10 is switched to the first position. Thereby, the boom-up pilot lines Pi of the first and second boom control valves 2 and 3 communicate to allow the first and second boom control valves 2 and 3 to be switched in the direction where the boom is lifted. Simultaneously, the first directional control valve 8 is switched to the first position, so that the stopper 11 of the boom-down side port of the first boom control valve 2 communicates with the gear pump 9 through the pilot line Pi2. Thereby, the function of the stopper 11 is restored, so that the first boom control valve 2 is prevented from being switched to the fourth position.

[0066] Thus, when the operator operates the front attachments, the first and second boom control valves 2 and 3 are operated within a range from the first position and the third position for the purpose of the excavating work, that is, the boom-up, boom-down and boom stop, so that the ordinary excavating work is performed together with the other front attachments.

[0067] In the drawings and specification, typical exemplary embodiments of the invention have been disclosed, and although specific terms are employed, they are used in a generic and descriptive sense only and are not for the purposes of limitation, the scope of the invention being set forth in the following claims.

Claims

1. A hydraulic system for an excavator, comprising:

a first pump (P; P1);
a boom cylinder (23), which drives a boom (24) so as to be lifted and lowered using hydraulic operating fluid supplied from the first pump (P; P1); and

a first boom control valve (22; 2), which controls flow of the hydraulic operating fluid supplied from the first pump (P; P1) to the boom cylinder (23) and controls operation of the boom cylinder (23);

characterized in that

the first boom control valve (22; 2) can be switched to one of a first position for maintaining neutrality of the boom, a second position for lifting the boom, a third position for lowering the boom, and a fourth position for allowing the boom to be freely lifted and lowered by self-weight or external force; and
the first boom control valve (22) blocks the hydraulic operating fluid supplied from the first pump to the boom cylinder and allows head-side and rod-side chambers of the boom cylinder to communicate with each other at the fourth position thereof; and **in that** it further comprises:

a stopper (11), which restricts the first boom control valve (22; 2) from being switched to the fourth position so as to allow the first boom control valve (22; 2) to be switched only to one of the first, second and third positions;

a gear pump (9);

a pilot line (Pi2) connecting the stopper (11) and the gear pump (9);

a first directional control valve (8), which is installed on the pilot line (Pi2) and is switched between a first position where the pilot line (Pi2) communicates with the gear pump (9) and a second position where the

pilot line (Pi2) communicates with a tank; a directional control switch (20) for switching the first directional control valve (8), wherein the directional control switch (20) is selectively switched to one of:

a first position where the first directional control valve (8) is switched to the first position, where the stopper (11) communicates with the gear pump (9) through the pilot line (Pi2), and where the stopper (11) is functionally activated to restrict the first boom control valve (22; 2) from being switched to the fourth position; and

a second position where the first directional control valve (8) is switched to the second position, where the pilot line (Pi2) communicates with the tank (T), and where the stopper (11) is functionally inactivated to allow the first boom control valve (22; 2) to be switched to the fourth position; and

when the directional control switch (20) is switched to the first position, the first boom control valve (22; 2) is switched up to the fourth position only when a boom-up side port thereof has pressure equal to or greater than a preset reference pressure, and is switched only to one of the first, second and third positions when the pressure of the boom-up side port is less than the preset reference pressure; and

the preset reference pressure is set to pressure occurring at the boom-up side port when an operator operates an operating lever beyond a predetermined displacement or angle in a direction where the boom is lifted.

2. The hydraulic system according to claim 1, wherein:

the fourth position of the first boom control valve (22; 2) is located at one outermost port of the first boom control valve (22; 2); and the stopper (11) is connected to the other outermost port of the first boom control valve (22; 2) and supplies a predetermined hydraulic pressure to the other outermost port so as to restrict the first boom control valve (22; 2) from being switched to the fourth position.

3. A hydraulic system according to claim 1 further, comprising:

a second pump (P2); wherein the boom cylinder (23) drives the boom

(24) so as to be lifted and lowered using hydraulic operating fluid supplied from the first and second pumps (P1; P2); and

a second boom control valve (3), which controls flow of the hydraulic operating fluid supplied from the second pump (P2) to the boom cylinder (23) and controls operation of the boom cylinder (23);

wherein the boom-up side ports (Pi) of the first and second boom control valves (2; 3) are hydraulically connected to a boom-up pilot line (Pi); the hydraulic operating fluids passing through the first and second boom control valves (2; 3) are joined and supplied to the boom cylinder (23) when the boom is lifted.

4. The hydraulic system according to claim 3, wherein:

the fourth position of the first boom control valve (2) is located at one outermost port of the first boom control valve; and

the stopper (11) is connected to the other outermost port of the first boom control valve (2) and supplies a predetermined hydraulic pressure to the other outermost port so as to restrict the first boom control valve from being switched to the fourth position.

5. The hydraulic system according to claim 3, further comprising means for interrupting the connection of the boom-up pilot line (Pi) and the second boom control valve (3) when the stopper (11) is functionally inactivated by the switching of the first directional control valve (8).

6. The hydraulic system according to claim 5, wherein the interrupting means includes a second directional control valve (10), which can be switched between a first position where the boom-up pilot line (Pi) is connected with the second boom control valve (3) and a second position where the boom-up pilot line (Pi) is disconnected from the second boom control valve (3).

7. The hydraulic system according to claim 6, wherein the directional control switch (20) is arranged for switching the first directional control valve (8) and the second directional control valve (10), wherein the directional control switch (20) is selectively switched to one of:

the first position where the first directional control valve (8) is switched to the first position, where the stopper (11) communicates with the gear pump (9) through the pilot line (Pi2), where the stopper (11) is functionally activated to restrict the first boom control valve (2) from being switched to the fourth position, where the sec-

ond directional control valve (10) is switched to the first position, where the second boom control valve (3) communicates with the boom-up pilot line (Pi), and where the first boom control valve (2) and the second boom control valve (3) can be switched in a direction where the boom is lifted; and

the second position where the first directional control valve (8) is switched to the second position, where the pilot line (Pi2) communicates with the tank (T), where the stopper (11) is functionally inactivated to allow the first boom control valve (2) to be switched up to the fourth position, where the second directional control valve (10) is switched to the second position, where the boom-up pilot line (Pi) communicates with the tank (T), and where the second boom control valve (3) is prevented from communicating with the boom-up pilot line (Pi) and is not switched.

Patentansprüche

1. Hydrauliksystem für einen Bagger, das Folgendes umfasst:

- eine erste Pumpe (P; P1);
- einen Auslegerzylinder (2, 3), der einen Ausleger (24) so antreibt, dass er mittels einer von der ersten Pumpe (P; P1) zugeführten Betriebs-hydraulikflüssigkeit angehoben und abgesenkt wird; und
- ein erstes Auslegersteuerventil (22; 2), das den Fluss der Betriebshydraulikflüssigkeit steuert, die von der ersten Pumpe (P; P1) zu dem Auslegerzylinder (23) zugeführt wird, und den Betrieb des Auslegerzylinders (23) steuert;

dadurch gekennzeichnet, dass

das erste Auslegersteuerventil (22; 2) in eine von folgenden Positionen geschaltet werden kann: eine erste Position zum Beibehalten der Neutralität des Auslegers, eine zweite Position zum Anheben des Auslegers, eine dritte Position zum Absenken des Auslegers und eine vierte Position, die es ermöglicht, den Ausleger durch sein eigenes Gewicht oder eine von außen wirkende Kraft frei anzuheben oder abzusenken; und

das erste Auslegersteuerventil (22) die von der ersten Pumpe zu dem Auslegerzylinder geleitete hydraulische Betriebsflüssigkeit sperrt und es kopfseitigen und schubstangenseitigen Kammern des Auslegerzylinders gestattet, in seiner vierten Position miteinander zu kommunizieren, und dadurch, dass es des Weiteren Folgendes umfasst:

- einen Endanschlag (11), der verhindert, dass das erste Auslegersteuerventil (22; 2) in die vier-

te Position umgeschaltet wird, damit das erste Auslegersteuerventil (22; 2) nur in die erste oder die zweite oder die dritte Position umgeschaltet werden kann;

- eine Zahnradpumpe (9);
- eine Pilotleitung (Pi2), die den Endanschlag (11) und die Zahnradpumpe (9) verbindet;
- ein erstes Richtungssteuerventil (8), das in der Pilotleitung (Pi2) installiert ist und zwischen einer ersten Position, in der die Pilotleitung (Pi2) mit der Zahnradpumpe (9) kommuniziert, und einer zweiten Position, in der die Pilotleitung (Pi2) mit einem Tank kommuniziert, umgeschaltet wird;
- einen Richtungssteuerschalter (20) zum Umschalten des ersten Richtungssteuerventils (8), wobei der Richtungssteuerschalter (20) wahlweise umgeschaltet wird:

- in eine erste Position, wobei das erste Richtungssteuerventil (8) in die erste Position umgeschaltet wird, wobei der Endanschlag (11) mit der Zahnradpumpe (9) über die Pilotleitung (Pi2) kommuniziert und wobei der Endanschlag (11) funktional aktiviert wird, um zu verhindern, dass das erste Auslegersteuerventil (22; 2) in die vierte Position umgeschaltet wird; oder

- in eine zweite Position, wobei das erste Richtungssteuerventil (8) in die zweite Position umgeschaltet wird, wobei die Pilotleitung (Pi2) mit dem Tank (T) kommuniziert, und wobei der Endanschlag (11) funktional deaktiviert wird, um es zu ermöglichen, dass das erste Auslegersteuerventil (22; 2) in die vierte Position geschaltet werden kann; und

wenn der Richtungssteuerschalter (20) in die ersten Position umgeschaltet wird, das erste Auslegersteuerventil (22; 2) nur dann bis zur vierten Position umgeschaltet wird, wenn an seinem Ausleger-aufwärtsseitigen Port ein Druck anliegt, der mindestens so groß ist wie ein voreingestellter Referenzdruck, und nur dann in die erste oder die zweite oder die dritte Position umgeschaltet wird, wenn der Druck des Ausleger-aufwärtsseitigen Ports niedriger ist als der voreingestellte Referenzdruck;

und

der voreingestellte Referenzdruck auf einen Druck eingestellt wird, der an dem Ausleger-aufwärtsseitigen Port anliegt, wenn ein Bediener einen Bedienhebel über einen vorgegebenen Betätigungsweg oder einen vorgegebenen Winkel in einer Richtung, in welcher der Ausleger angehoben wird, hinaus bewegt.

2. Hydrauliksystem nach Anspruch 1, wobei:

- sich die vierte Position des ersten Auslegersteuerventils (22; 2) an einem äußersten Port des ersten Auslegersteuerventils (22; 2) befindet; und
 der Endanschlag (11) mit dem anderen äußersten Port des ersten Auslegersteuerventils (22; 2) verbunden ist
 und einen vorgegebenen Hydraulikdruck an den anderen äußersten Port anlegt, um zu verhindern, dass das erste Auslegersteuerventil (22; 2) in die vierte Position umgeschaltet wird.
3. Hydrauliksystem nach Anspruch 1, das des Weiteren Folgendes umfasst:
- eine zweite Pumpe (P2);
 wobei der Auslegerzylinder (23) den Ausleger (24) so antreibt, dass er mittels der von der ersten und der zweiten Pumpe (P1; P2) zugeführten Betriebshydraulikflüssigkeit angehoben und abgesenkt wird; und
 - ein zweites Auslegersteuerventil (3), das den Fluss der Betriebshydraulikflüssigkeit steuert, die von der zweiten Pumpe (P2) zu dem Auslegerzylinder (23) zugeführt wird, und den Betrieb des Auslegerzylinders (23) steuert;
 wobei die Ausleger-aufwärtsseitigen Ports (Pi) des ersten und des zweiten Auslegersteuerventils (2; 3) hydraulisch mit einer Ausleger-aufwärts-Pilotleitung (Pi) verbunden sind;
 die Betriebshydraulikflüssigkeiten, die durch das erste und das zweite Auslegersteuerventil (2; 3) fließen, zusammengeführt werden und zu dem Auslegerzylinder (23) geführt werden, wenn der Ausleger angehoben wird.
4. Hydrauliksystem nach Anspruch 3, wobei:
- sich die vierte Position des ersten Auslegersteuerventils (2) an einem äußersten Port des ersten Auslegersteuerventils befindet; und
 der Endanschlag (11) mit dem anderen äußersten Port des ersten Auslegersteuerventils (2) verbunden ist und
 einen vorgegebenen Hydraulikdruck an den anderen äußersten Port anlegt, um zu verhindern, dass das erste Auslegersteuerventil in die vierte Position umgeschaltet wird.
5. Hydrauliksystem nach Anspruch 3, das des Weiteren ein Mittel umfasst, um die Verbindung der Ausleger-aufwärts-Pilotleitung (Pi) und des zweiten Auslegersteuerventils (3) zu unterbrechen, wenn der Endanschlag (11) durch das Umschalten des ersten Richtungssteuerventils (8) funktional deaktiviert ist.
6. Hydrauliksystem nach Anspruch 5, wobei das Unterbrechungsmittel ein zweites Richtungssteuerventil (10) umfasst, das zwischen einer ersten Position, in der die Ausleger-aufwärts-Pilotleitung (Pi) mit dem zweiten Auslegersteuerventil (3) verbunden ist, und einer zweiten Position, in der die Ausleger-aufwärts-Pilotleitung (Pi) von dem zweiten Auslegersteuerventil (3) getrennt ist, umgeschaltet werden kann.
7. Hydrauliksystem nach Anspruch 6, wobei der Richtungssteuerschalter (20) dafür ausgelegt ist, das erste Richtungssteuerventil (8) und das zweite Richtungssteuerventil (10) umzuschalten, wobei der Richtungssteuerschalter (20) wahlweise umgeschaltet wird:
- in die erste Position, wobei das erste Richtungssteuerventil (8) in die erste Position umgeschaltet wird, wobei der Endanschlag (11) mit der Zahnradpumpe (9) über die Pilotleitung (Pi2) kommuniziert, wobei der Endanschlag (11) funktional aktiviert ist, um zu verhindern, dass das erste Auslegersteuerventil (2) in die vierte Position umgeschaltet wird, wobei das zweite Richtungssteuerventil (10) in die erste Position umgeschaltet wird, wobei das zweite Auslegersteuerventil (3) mit der Ausleger-aufwärts-Pilotleitung (Pi) kommuniziert, und wobei das erste Auslegersteuerventil (2) und das zweite Auslegersteuerventil (3) in eine Richtung umgeschaltet werden können, in welcher der Ausleger angehoben wird; oder
 - in die zweite Position, wobei das erste Richtungssteuerventil (8) in die zweite Position umgeschaltet wird, wobei die Pilotleitung (Pi2) mit dem Tank (T) kommuniziert, wobei der Endanschlag (11) funktional deaktiviert ist, um es zu ermöglichen, dass das erste Auslegersteuerventil (2) in die vierte Position umgeschaltet werden kann, wobei das zweite Richtungssteuerventil (10) in die zweite Position umgeschaltet wird, wobei die Ausleger-aufwärts-Pilotleitung (Pi) mit dem Tank (T) kommuniziert, und wobei verhindert wird, dass das zweite Auslegersteuerventil (3) mit der Ausleger-aufwärts-Pilotleitung (Pi) kommuniziert und nicht umgeschaltet wird.
- Revendications**
1. Système hydraulique pour une excavatrice, comprenant :
- une première pompe (P ; P1) ;
 - un vérin de flèche (23), qui entraîne une flèche (24) de façon à être levé ou baissé en utilisant le fluide de travail hydraulique amené depuis la première pompe (P ; P1) ;

et

- une première soupape de commande de flèche (22 ; 2), qui commande le flux du fluide de travail hydraulique amené au vérin de flèche (23) depuis la première pompe (P ; P1) et le fonctionnement du vérin de flèche (23) ;

caractérisé en ce que

la première soupape de commande de flèche (22 ; 2) peut être commutée à une position parmi une première position pour maintenir la neutralité de la flèche,

une deuxième position pour lever la flèche, une troisième position pour baisser la flèche, et une quatrième position pour permettre que la flèche soit levée ou baissée librement par son propre poids ou une force externe ; et

la première soupape de commande de flèche (22) bloque le fluide de travail hydraulique amené au vérin de flèche depuis la première pompe et permet, à sa quatrième position, une communication réciproque des chambres côté tête et côté tige du vérin de flèche ;

et **en ce qu'il** comprend en outre :

- un dispositif d'arrêt (11), qui empêche la commutation de la première soupape de commande de flèche (22 ; 2) à la quatrième position de façon à ne permettre la commutation de la première soupape de commande de flèche (22 ; 2) qu'à une position parmi les première, deuxième et troisième positions ;

- une pompe à engrenages (9) ;
 - une ligne pilote (Pi2) reliant le dispositif d'arrêt (11) et la pompe à engrenages (9) ;
 - une première soupape de commande de direction (8), qui est installée sur la ligne pilote (Pi2) et commutée entre une première position où la ligne pilote (Pi2) communique avec la pompe à engrenages (9) et une seconde position où la ligne pilote (Pi2) communique avec un réservoir ;

- un commutateur de commande de direction (20) pour commuter la première soupape de commande de direction (8), le commutateur de commande de direction (20) étant commuté de façon sélective à une position parmi :

- une première position où la première soupape de commande de direction (8) est commutée à la première position, où le dispositif d'arrêt (11) communique avec la pompe à engrenages (9) par la ligne pilote (Pi2), et où le dispositif d'arrêt (11) est activé fonctionnellement

pour empêcher la commutation de la première soupape de commande de flèche (22 ; 2) à la quatrième position ; et

- une seconde position où la première soupape de commande de direction (8) est commutée à la seconde position, où la ligne pilote (Pi2) communique avec le réservoir (T), et où le dispositif d'arrêt (11) est inactivé fonctionnellement pour permettre la commutation de la première soupape de commande de flèche (22 ; 2) à la quatrième position ; et

lorsque le commutateur de commande de direction (20) est commuté à la première position, la première soupape de commande de flèche (22 ; 2) n'est commutée à la quatrième position que lorsque son orifice côté flèche levée présente une pression égale ou supérieure à une pression de référence préétablie, et n'est commutée à une position parmi les première, deuxième et troisième positions que lorsque la pression de l'orifice côté flèche levée est inférieure à la pression de référence préétablie ; et la pression de référence préétablie est réglée sur une pression produite au niveau de l'orifice côté flèche levée lorsqu'un opérateur fait fonctionner un levier de manoeuvre au-delà d'un déplacement ou d'un angle prédéterminé dans un sens où la flèche est levée.

2. Système hydraulique selon la revendication 1, dans lequel :

la quatrième position de la première soupape de commande de flèche (22 ; 2) est située au niveau d'un orifice le plus à l'extérieur de la première soupape de commande de flèche (22 ; 2) ; et

le dispositif d'arrêt (11) est relié à l'autre orifice le plus à l'extérieur de la première soupape de commande de flèche (22 ; 2) et applique une pression hydraulique prédéterminée à l'autre orifice le plus à l'extérieur de façon à empêcher la commutation de la première soupape de commande de flèche (22 ; 2) à la quatrième position.

3. Système hydraulique selon la revendication 1, comprenant en outre :

- une seconde pompe (P2) ;

dans lequel le vérin de flèche (23) entraîne la flèche (24) de façon à être levé ou baissé en utilisant le fluide de travail hydraulique amené depuis les première et seconde pompes (P1 ; P2) ; et

- une seconde soupape de commande de flèche (3), qui commande le flux du fluide de travail hydraulique amené au vérin de flèche (23) depuis la seconde pompe (P2) et le fonctionnement du vérin de flèche (23) ; 5
- dans lequel les orifices côté flèche levée (pi) des première et seconde soupapes de commande de flèche (2 ; 3) sont hydrauliquement reliés à une ligne pilote de la flèche levée (Pi) ; 10
les fluides de travail hydrauliques passant à travers les première et seconde soupapes de commande de flèche (2 ; 3) sont réunis et amenés au vérin de flèche (23) lorsque la flèche est levée. 15
4. Système hydraulique selon la revendication 3, dans lequel :
- la quatrième position de la première soupape de commande de flèche (2) est située au niveau d'un orifice le plus à l'extérieur de la première 20
soupape de commande de flèche ; et
le dispositif d'arrêt (11) est relié à l'autre orifice le plus à l'extérieur de la première soupape de 25
commande de flèche (2) et applique une pression hydraulique prédéterminée à l'autre orifice le plus à l'extérieur de façon à empêcher la commutation de la première soupape de commande de flèche à la quatrième position. 30
5. Système hydraulique selon la revendication 3, comprenant en outre des moyens d'interruption de la liaison de la ligne pilote de la flèche levée (Pi) et de la seconde soupape de commande de flèche (3) lorsque le dispositif d'arrêt (11) est inactivé fonctionnellement par la commutation de la première soupape 35
de commande de direction (8).
6. Système hydraulique selon la revendication 5, dans lequel les moyens d'interruption comportent une seconde soupape de commande de direction (10), qui peut être commutée entre une première position où la ligne pilote de la flèche levée (Pi) est reliée à la seconde soupape de commande de flèche (3) et une 40
seconde position où la ligne pilote de la flèche levée (Pi) est déconnectée de la seconde soupape de commande de flèche (3). 45
7. Système hydraulique selon la revendication 6, dans lequel le commutateur de commande de direction (20) est agencé pour commuter la première soupape de commande de direction (8) et la seconde soupape de commande de direction (10), le commutateur de commande de direction (20) étant commuté de façon sélective à une position parmi : 50
55
- la première position où la première soupape de commande de direction (8) est commutée à la

première position, où le dispositif d'arrêt (11) communique avec la pompe à engrenages (9) par la ligne pilote (Pi2), où le dispositif d'arrêt (11) est activé fonctionnellement pour empêcher la commutation de la première soupape de commande de flèche (2) à la quatrième position, où la seconde soupape de commande de direction (10) est commutée à la première position, où la seconde soupape de commande de flèche (3) communique avec la ligne pilote de la flèche levée (Pi), et où la première soupape de commande de flèche (2) et la seconde soupape de commande de flèche (3) peuvent être commutées dans un sens où la flèche est levée ; et la seconde position où la première soupape de commande de direction (8) est commutée à la seconde position, où la ligne pilote (Pi2) communique avec le réservoir (T), où le dispositif d'arrêt (11) est inactivé fonctionnellement pour permettre la commutation de la première soupape de commande de flèche (2) jusqu'à la quatrième position, où la seconde soupape de commande de direction (10) est commutée à la seconde position, où la ligne pilote de la flèche levée (Pi) communique avec le réservoir (T), et où la seconde soupape de commande de flèche (3) ne peut pas communiquer avec la ligne pilote de la flèche levée (Pi) et n'est pas commutée.

FIG. 1

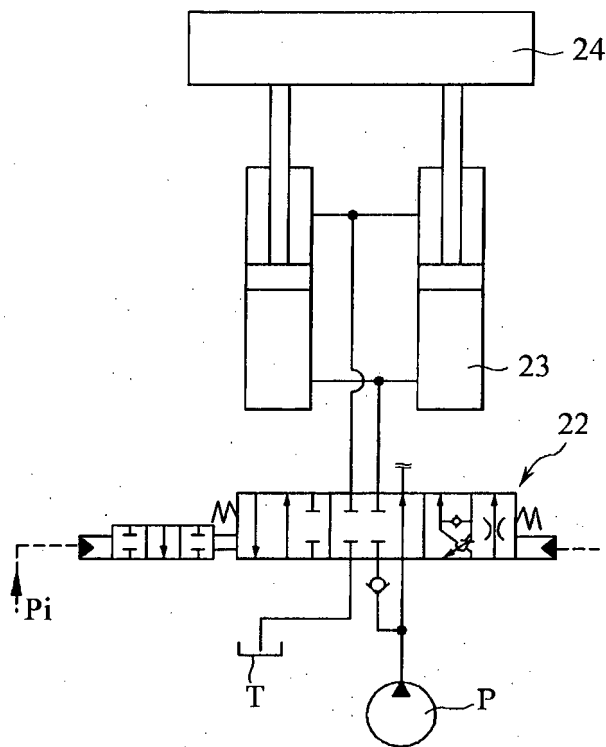


FIG. 2

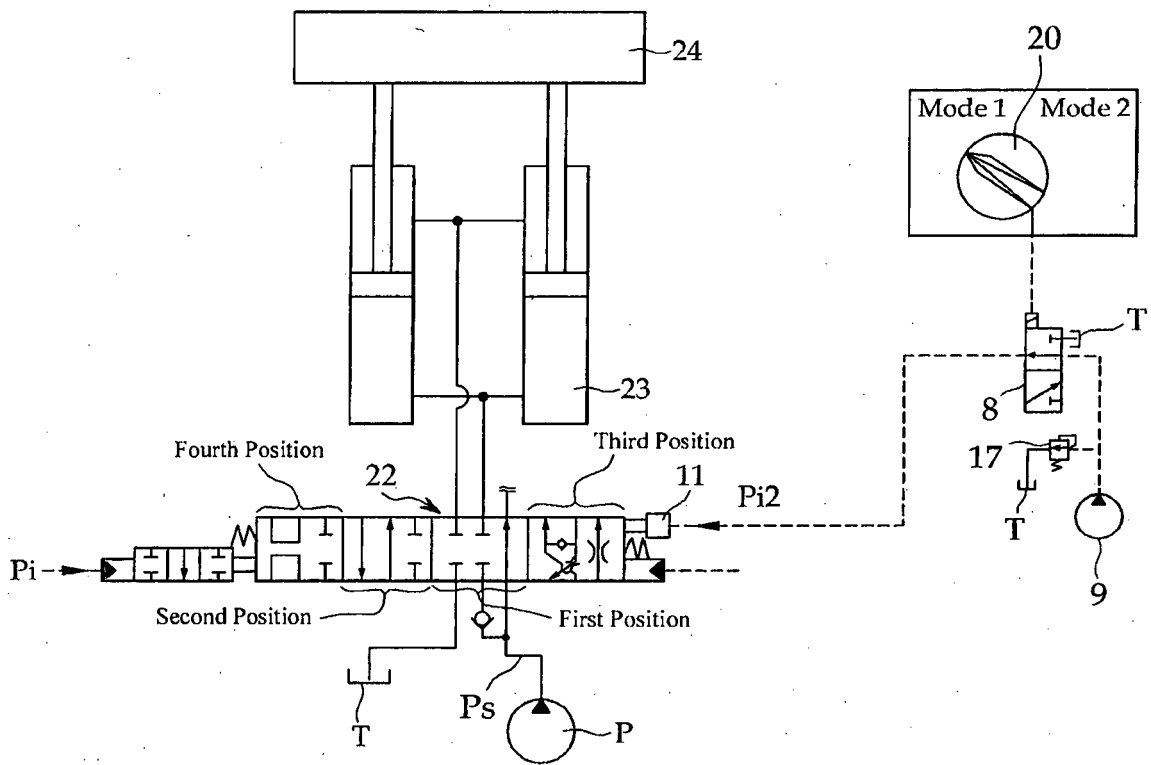


FIG. 5

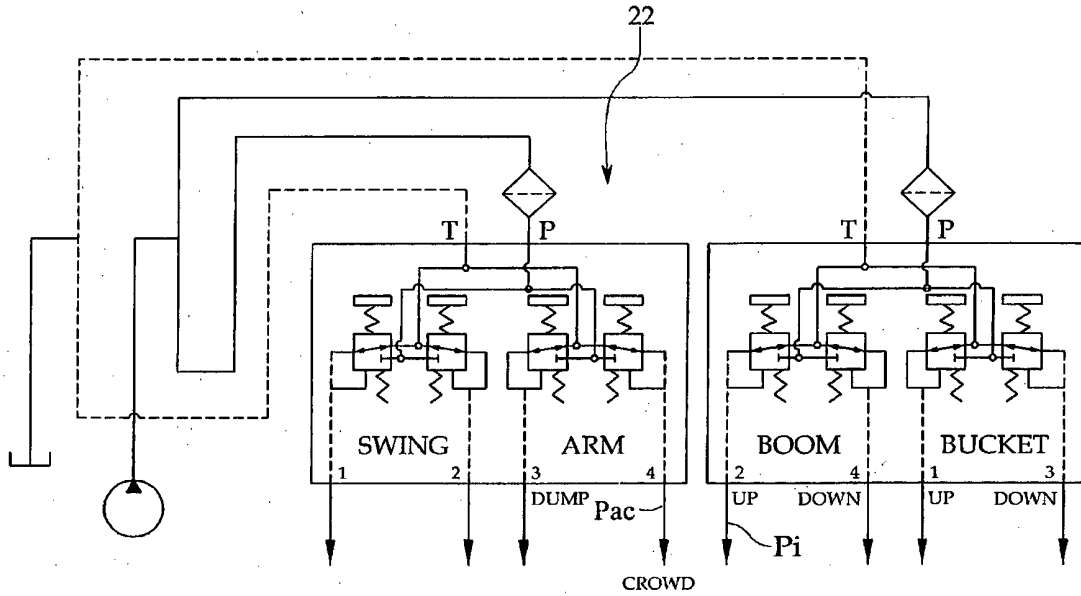


FIG. 6

Pilot Hydraulic Characteristics

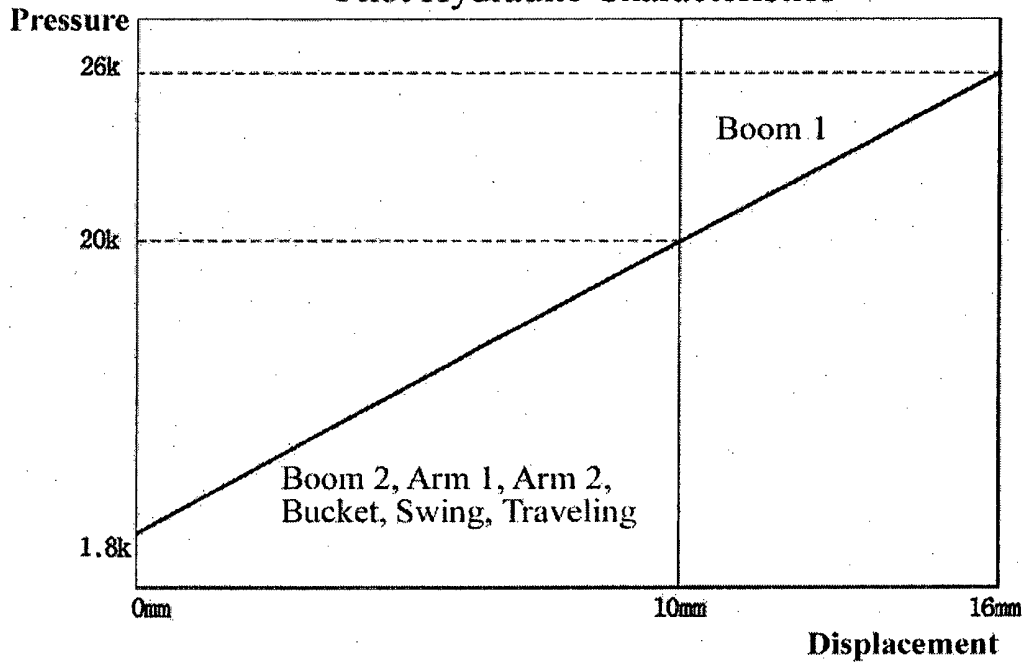


FIG. 7

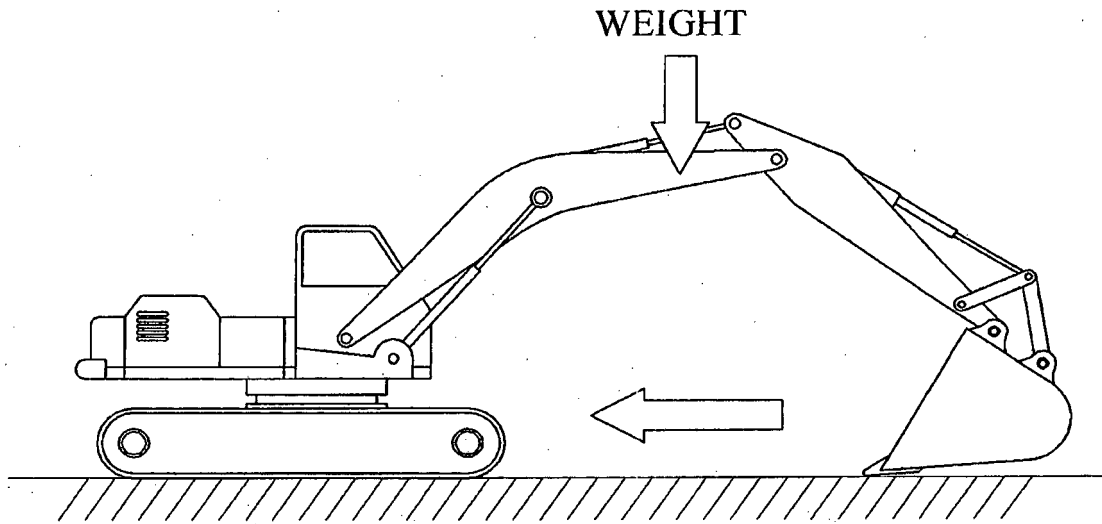
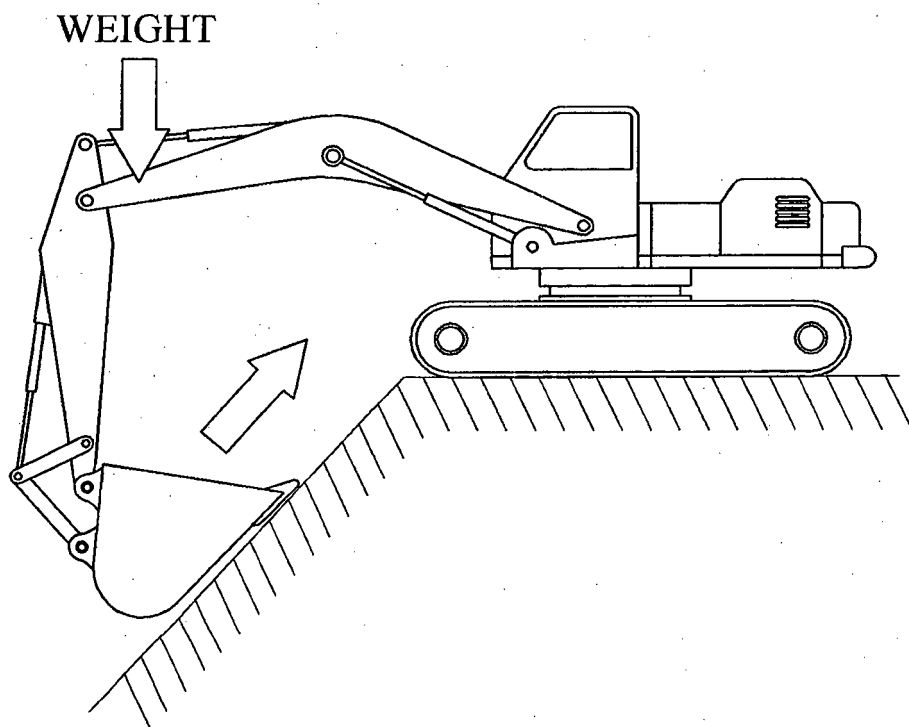


FIG. 8



REFERENCES CITED IN THE DESCRIPTION

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