



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

(43) Date of publication:
02.06.1999 Bulletin 1999/22

(21) Application number: 97930798.0

(22) Date of filing: 15.07.1997

(51) Int. Cl.⁶: E02F 9/20, E02F 9/22

(86) International application number:
PCT/JP97/02450

(87) International publication number:
WO 98/03739 (29.01.1998 Gazette 1998/04)

(84) Designated Contracting States:
DE

(30) Priority: 19.07.1996 JP 190901/96

(71) Applicant: KOMATSU LTD.
Minato-ku, Tokyo 107 (JP)

(72) Inventors:
• NAGATA, Noritaka
Hiratsuka-shi, Kanagawa 254 (JP)

• NAKAMORI, Takeshi
Hiratsuka-shi, Kanagawa 254 (JP)

(74) Representative:
Selting, Günther, Dipl.-Ing. et al
Patentanwälte
von Kreisler, Selting, Werner
Postfach 10 22 41
50462 Köln (DE)

(54) **DEVICE FOR REDUCING A SHOCK AT A STROKE END OF A 2-PIECE BOOM TYPE CONSTRUCTION MACHINE**

(57) A two-piece boom type construction machine for securely reducing a shock at a stroke end of a first boom cylinder at low cost, in which first and second booms are put in a maximum derricking state when the first boom cylinder is put in a longest state, while the second boom cylinder in a shortest state, in which when changed from a stored posture to an operating posture, the second boom cylinder is retracted to a shortest state when in operation from a longest state when stored, and in which when in operation, the second boom cylinder is held in the shortest state, the construction machine comprises angle detecting means for detecting the angle of the first boom, restricted flow rate setting means having stored in advance therein a value representing a relationship between the angle of the first boom and the maximum supplying flow rate of the first boom cylinder such that the value becomes minimum within a predetermined angle range including a stroke end angle defined as the boom angle of the first boom when the first and second booms are put in the maximum derricking state, while the value gradually increases as it goes farther beyond the angle range, and flow rate control means for limit-controlling the flow rate of pressure oil to the first operating valve in a direction in which the boom is raised in accordance with the data stored in the restricted flow rate setting means.

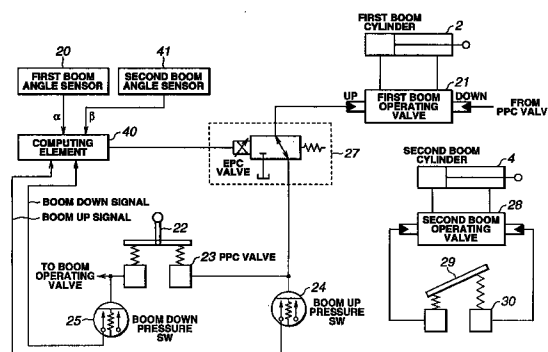


FIG.6

Description

TECHNICAL FIELD

[0001] The present invention relates to a shovelling machine having a plurality of booms, and in particular to a technique for reducing the shock which occurs in a shovelling machine having a two-piece boom when the boom cylinder reaches stroke end.

BACKGROUND ART

[0002] Two-piece boom type power shovels have a working mechanism consisting of two booms (first boom, second boom), an arm and a bucket. Compared with mono-boom type power shovels, they have a number of advantages including:

- the ability to fold the working mechanism (first and second booms) compactly during free running, transportation and parking;
- increased safety during running as a result of the low center of gravity of the automotive body; and
- improved field of vision in the forward direction while running.

[0003] In an ordinary conventional two-piece boom type power shovel the first boom cylinder, which drives the first boom (the one which is linked to the automotive body), is connected to the frame of the automotive body and to the first boom. The second boom cylinder, which drives the second boom (the one which is linked to the first boom and to the arm), is connected to the first boom and the second boom. In other words, each of the cylinders in an ordinary conventional two-piece boom type power shovel is connected to two adjoining working mechanisms, each of which rotates and moves when the corresponding cylinder is driven.

[0004] In Japanese Patent Application Laid-Open No.6-136779, the applicants of the present application proposed a technique for an entirely novel link structure for the working mechanisms in a two-piece boom type power shovel of this sort with normal link structure.

[0005] Figs. 9 and 10 illustrate a power shovel equipped with this novel link structure. Fig. 9 shows it in an operating posture with the booms in a maximum dericking posture, while Fig. 10 shows it in a stored posture.

[0006] In Figs. 9 and 10, 1 is the first boom, 2 is the first boom cylinder, 3 is the second boom, 4 is the second boom cylinder, 5 is the arm, 6 is the arm cylinder, 7 is the bucket, 8 is the bucket cylinder, and 9 is the automotive body.

[0007] In other words, in this link structure the first boom cylinder 2 is linked to the automotive body 9 and to the second boom 3, the second boom cylinder 4 is linked to the second boom 3 and the first boom 1, and the second boom 3 is driven by means of the first boom

cylinder 2 and the second boom cylinder 4.

[0008] Reasons for linking the first boom cylinder 2 to the automotive body 9 and to the second boom 3 include:

(1) The moment of the first boom 1 as a whole around its rotational fulcrum a means that it is possible to secure a greater distance to the point of application c of the first boom cylinder 2 if it the first boom cylinder is linked to the second boom 3 than if it is linked to the first boom 1. This in turn means that less force is required in order to rotate through the same boom angle, and it is possible to decrease the diameter of the first boom cylinder 2 while employing the same hydraulic source, thus yielding advantages in terms of cost.

(2) The range of boom angles through which it is capable of rotating is narrower if the first boom cylinder 2 is linked to the first boom 1.

[0009] Now, as may be seen from Fig. 11, the first boom cylinder 2 in the two-piece boom type power shovel illustrated in Fig. 9 and elsewhere needs to have its pedestal-side fulcrum b located further forward than the rotational fulcrum a of the first boom 1 so as to avoid interfering with the first boom 1 when it is in the stored posture. Moreover, in order for the cylinder force to act in the most effective manner, the point of application c must be located further forward than the point of linkage d between the first boom 1 and the second boom 3. (For instance, point c must be further forward than point d along the second boom 3 when it is positioned horizontally as in Fig. 11.) It should be added that the first boom cylinder 2 as indicated by a broken line in Fig. 11 is shown with its pedestal-side fulcrum b located close to the rotational fulcrum a of the first boom 1, in which case the first boom cylinder 2 would interfere with the first boom 1 in the stored posture.

[0010] In this manner, the first boom cylinder 2 in the two-piece boom type power shovel illustrated in Fig. 9 and elsewhere suffers from restriction in its location as a result of the abovementioned problems of interference and the like, and it is impossible to secure a satisfactory cylinder length in comparison with the conventional mono-boom type.

[0011] Now, it is possible to consider attaching a mechanical shock reducing device 10 as illustrated in Fig. 12 to each of the working mechanism cylinders in the two-piece boom type power shovel illustrated in Fig. 9 with a view to alleviating stroke-end shock in the working mechanisms.

[0012] However, the mechanical shock reducing device 10 illustrated in Fig. 12 suffers from the defect of reduced cylinder length occasioned by the fact that the throttle mechanism 11 is fitted within the working mechanism cylinder, making it that much shorter.

[0013] In other words, this involves fitting the first boom cylinder 2, in relation to which it has already been

pointed out that it is impossible to secure a satisfactory cylinder length in comparison with the conventional mono-boom type, with the mechanical shock reducing device 10. This is a factor in reducing length, the result being that the range within which the boom is capable of rotating becomes narrower.

[0014] Apart from the abovementioned mechanical shock reducing device there is also an electronic type. This electronic shock reducing device measures the stroke length of the working mechanism cylinder of which the shock is to be reduced. If the measurement value is close to stroke end, it restricts the pressure oil flow rate which activates the cylinder in the stroke-end direction, thus reducing cylinder velocity.

[0015] Now, there are two methods of measuring cylinder length. The direct method achieves this by attaching a stroke sensor to the working mechanism cylinder. The indirect method involves using an angle sensor to measure the angle of the working mechanism activated by the cylinder. The former requires the fitting of a direct-action type potentiometer, encoder and other devices to the cylinder, and is considerably more costly than the latter. Thus, considerations of cost mean that it is more effective to measure the angle of the working mechanism with the aid of an angle sensor.

[0016] However, the two-piece boom type power shovel illustrated in the abovementioned Figs. 9-11 has a special link structure which renders it impossible to determine unconditionally the first boom angle at stroke end of the first boom cylinder 2.

[0017] That is to say, Fig. 13 illustrates two states: in the first state (denoted by an unbroken line) the first boom cylinder 2 is fixed at stroke end and the second boom cylinder 4 is fully retracted, while in the second state (denoted by a broken line) the axis u of the first boom cylinder 2 intersects with the rotational fulcrum a of the first boom 1. The angle (posture) of the first boom 1 when the first boom cylinder reaches stroke end corresponds to the state of extension or retraction of the second boom cylinder 4, and varies within a range from the position of the angle Θ to that of the angle Θ' .

[0018] For this reason, the two-piece boom type power shovel illustrated in the abovementioned Figs. 9-11 does not admit of the conventional method of reducing shock in the first boom cylinder 2 by means of an ordinary conventional electronic shock-reducing device where an angle sensor is fitted on to the rotational fulcrum a of the first boom to detect the first boom angle and the shock of the first boom cylinder 2 is reduced by activating the electronic shock-reducing device on the basis of the detection value, and there have been calls for an effective solution to this problem.

[0019] It is an object of the present invention, which has been perfected in view of the foregoing circumstances, to provide a device for reducing stroke-end shock in a two-piece boom type construction machine which is cheap and effectively reduces shock at stroke end of the first boom cylinder.

DISCLOSURE OF THE INVENTION

[0020] The present invention is a device for reducing a stroke-end shock in a two-piece boom type construction machine having a first boom which is attached to a vehicle body in such a manner as to rotate freely, a second boom which is attached to the first boom in such a manner as to rotate freely, a first boom cylinder which links the vehicle body and the second boom, a second boom cylinder which links the second boom and the first boom, a first operation valve which serves to operate the first boom cylinder, a second operation valve which serves to operate the second boom cylinder, first operation means which outputs a command signal to the first operation valve and second operation means which outputs a command signal to the second operation valve, wherein when the first boom cylinder is in a longest state and the second boom cylinder is in a shortest state, the first and second booms attain maximum derricking state; when shifting from a stored posture to an operating posture, the second boom cylinder is retracted from a longest state during storage to a shortest state during operation, and when operating, the second boom cylinder is fixed in the shortest state, characterized in that the device comprises: angle detection means which detects an angle of the first boom; restricted flow rate setting means having stored in advance therein a value of a relationship between the angle of the first boom and a restricted oil flow rate of the first boom cylinder such that the value becomes minimum within a predetermined angle range including a stroke end angle defined as the boom angle of the first boom when the first and second booms are put in the maximum derricking state, while the value gradually increases as it goes farther beyond the angle range; and flow rate control means which restricts and controls the flow rate of pressure oil to the first operation valve in a direction in which the boom is raised in accordance with data stored in the restricted flow rate setting means.

[0021] By establishing as the stroke-end angle the boom angle of the first boom when the first and second booms assume maximum derricking state, this invention allows the pressure oil flow rate in the direction of boom up to be reduced in proportion to the degree of closeness to this stroke-end angle.

[0022] Moreover, the present invention is a device for reducing a stroke-end shock in a two-piece boom type construction machine having a first boom which is attached to a vehicle body in such a manner as to rotate freely, a second boom which is attached to the first boom in such a manner as to rotate freely, a first boom cylinder which links the vehicle body and the second boom, a second boom cylinder which links the second boom and the first boom, a first operation valve which serves to operate the first boom cylinder, a second operation valve which serves to operate the second boom cylinder, first operating means which outputs a

command signal to the first operation valve and second operating means which outputs a command signal to the second operation valve, characterized in that the device comprises: first boom angle detecting means which detects an angle of the first boom; second boom angle detecting means which detects an angle of the second boom; stroke-end angle setting means which stores in advance a relationship between the first boom angle at which the first boom cylinder reaches a stroke end, and the second boom angle; restricted flow rate setting means having stored in advance therein a value of a relationship between the angle of the first boom and a restricted oil flow rate of the first boom cylinder, for each of a plurality of reference angles defined as a plurality of first boom angles at which the first boom cylinder reaches the stroke end, such that the value becomes minimum within a predetermined angle range including the reference angle, while the value gradually increases as it goes farther beyond the angle range; calculation selecting means which assigns values detected by the second boom angle detecting means to the predetermined relationships of the stroke-end angle setting means so as to calculate the first boom angle which is the stroke-end angle corresponding to the detection values, and selects a predetermined relationship of the restricted flow rate setting means which corresponds to the calculated first boom angle; and flow rate control means which restricts and controls the flow rate of pressure oil to the first operation valve in a direction in which the boom is raised in accordance with the selected predetermined relationship.

[0023] By detecting the first boom angle α and the second boom angle β , and reducing stroke-end shock in accordance with the results of detecting these two angles, this invention allows the stroke-end shock of the first boom cylinder 2 to be reduced effectively even in conditions where the second boom cylinder 4 is extended or retracted at will.

[0024] Furthermore, the present invention is a device for reducing a stroke-end shock in a two-piece boom type construction machine having a first boom which is attached to a vehicle body in such a manner as to rotate freely, a second boom which is attached to the first boom in such a manner as to rotate freely, a first boom cylinder which links the vehicle body and the second boom, a second boom cylinder which links the second boom and the first boom, a first operation valve which serves to operate the first boom cylinder, a second operation valve which serves to operate the second boom cylinder, first operating means which outputs a command signal to the first operation valve and second operating means which outputs a command signal to the second operation valve, characterized in that the device comprises: first boom angle detecting means which detects an angle of the first boom; second boom angle detecting means which detects an angle of the second boom; stroke-end angle setting means which stores in advance a relationship between the first boom

angle at which the first boom cylinder reaches a stroke end, and the second boom angle; restricted flow rate setting means having stored in advance therein a value of a relationship between the angle of the first boom and a restricted oil flow rate of the first boom cylinder such that the value becomes minimum within a predetermined angle range including a reference angle defined as one first boom angle at which the first boom cylinder reaches the stroke end, while the value gradually increases as it goes farther beyond the angle range; correction calculating means which assigns a value detected by the second boom angle detecting means to the predetermined relationship of the stroke-end angle setting means so as to calculate the first boom angle, which is the stroke-end angle corresponding to the detection value, and corrects predetermined data of the restricted flow rate setting means in accordance with the calculated first boom angle; and flow rate control means which restricts and controls the flow rate of pressure oil to the first operation valve in a direction in which the boom is raised in accordance with the corrected result of the correction calculating means.

[0025] By detecting the first boom angle α and the second boom angle β , this invention also allows the stroke-end shock of the first boom cylinder 2 to be reduced in accordance with the results of detecting these two angles.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026]

Fig. 1 is a block diagram illustrating a first embodiment of the present invention;

Fig. 2 is a diagram illustrating an example of valve structure to replace the EPC valve of the embodiment illustrated in Fig. 1;

Fig. 3 is a diagram illustrating a modified example of the first embodiment;

Fig. 4 is a diagram illustrating the mode of rotation of the first and second booms;

Fig. 5 is a diagram illustrating the pattern of restricted oil flow rate to the first boom cylinder in the first embodiment;

Fig. 6 is a block diagram illustrating a second embodiment of the present invention;

Fig. 7 is a diagram illustrating the relationship between the angle of the second-boom and the stroke-end angle of the first boom in the second embodiment;

Fig. 8 is a diagram illustrating the pattern of restricted oil flow rate to the first boom cylinder in the second embodiment;

Fig. 9 is a diagram illustrating the operating posture of a two-piece boom type power shovel to which the present invention has been applied;

Fig. 10 is a diagram illustrating the stored posture of a two-piece boom type power shovel to which the

present invention has been applied;

Fig. 11 is a diagram explaining restrictions in the cylinder link structure of a two-piece boom type power shovel to which the present invention has been applied;

Fig. 12 is a diagram illustrating a conventional device for reducing mechanical shock; and

Fig. 13 is a diagram illustrating the mode of rotation of the first and second booms.

BEST MODE FOR CARRYING OUT THE INVENTION

[0027] There follow, with reference to the drawings, descriptions of several embodiments of the present invention.

[0028] In the embodiments which follow, the present invention has been applied to a two-piece boom type power shovel of the sort illustrated in Figs. 9-11.

Embodiment 1

[0029] In the present first embodiment an angle sensor is attached to the rotational fulcrum a of the first boom 1, and stroke-end shock in the first boom cylinder is reduced in accordance solely with the output of this single angle sensor.

[0030] It is a prerequisite for implementing the present first embodiment that the operator execute the following operations.

[0031] That is to say, the first boom cylinder 2 is operated with the aid of an operating lever, and the second boom cylinder 4 with the aid of an operating pedal. In the stored posture illustrated in Fig. 4, the first boom cylinder 2 assumes a fairly short state while the second boom cylinder 4 assumes a longest state (cf. Fig. 5). Further, in the operating posture illustrated in Fig. 4 (the operating posture when the boom assumes the maximum derricking posture, which corresponds to the state of the boom angle Θ in Fig. 13), the first boom cylinder 2 assumes a longest state while the second boom cylinder 4 assumes a shortest state (cf. Fig. 5). Meanwhile, in the operational range the second boom cylinder 4 is fixed in a shortest state, and the first boom cylinder 2 alone is altered at will.

[0032] Consequently, in the present embodiment, transition from the stored posture to the operating posture is achieved by ensuring that the operator implements operations in such a manner as fully to retract the second boom cylinder from its longest state during storage to a shortest state at start of operation (state in which the first boom 1 assumes its maximum derricking posture). In other words, it is a precondition that this operation be implemented.

[0033] Now, as will be seen from Fig. 13, the angle of the first boom when the first boom cylinder 2 reaches the up-side stroke end with the second boom cylinder 4 assuming a shortest state, ie the operating posture, is Θ . Consequently, Embodiment 1 is configured in such a

manner as to reduce stroke-end shock in the first boom cylinder 2 by decreasing the oil flow rate to the bottom side of the first boom cylinder 2 when the angle of the first boom approaches Θ .

5 [0034] Fig. 1 illustrates an example of the structure of the drive control system required for the implementation of Embodiment 1, a first boom angle sensor 20 being attached to the rotational fulcrum a of the first boom 1 in order to detect the first boom angle α (cf. Fig. 4).

10 [0035] A first boom operating valve 21 drives the first boom cylinder 2, extending and retracting it. A boom operating lever 22 drives the first boom cylinder 2, extending and retracting it. A PPC valve 23 feeds pilot pressure oil to the up-side pilot port 21a of the first boom operating valve 21 when the boom operating lever 22 is operated on the up side, and to the down-side pilot port 21b of the first boom operating valve 21 when the boom operating lever 22 is operated on the down side. The oil passage from the PPC valve 23 to the up-side pilot port 21a is provided with a boom up pressure switch 24, which detects execution of the boom up operation by the boom operating lever 22. Similarly, the oil passage from the PPC valve 23 to the down-side pilot port 21b is provided with a boom down pressure switch 25, which detects execution of the boom down operation by the boom operating lever 22. Detection signals from these pressure switches 24, 25 are output to a computing element 26.

20 [0036] The oil passage from the PPC valve 23 to the up-side pilot port 21a is provided with an EPC valve 27, which in response to commands from the computing element 26 feeds pilot pressure oil to the up-side pilot port 21a of the first boom operating valve 21, acting in such a manner as to restrict the pressure oil flow rate on the up side to the first boom cylinder 2.

25 [0037] Meanwhile, a second boom operating valve 28 drives the second boom cylinder 4, extending and retracting it. This second boom operating valve 28 is operated by an operating pedal 29. In other words, pilot oil pressure corresponding to the angle of depression of the operating pedal 29 is fed by means of a PPC valve 30 to the second boom operating valve 28, allowing the second boom cylinder 4 to extend and retract.

30 [0038] There follows a detailed description of the computing element 26. As is illustrated in Fig. 5, a restricted oil flow rate pattern for the first boom cylinder 2 is stored in advance within the computing element 26, which outputs flow rate restriction signals to the EPC valve 27 in accordance with this restricted oil flow rate pattern.

35 [0039] In other words, the vertical axis in Fig. 5 represents the restricted oil flow rate (maximum flow rate) of the first boom cylinder 2, while the horizontal axis represents the angle α of the first boom. The position of the angle Θ corresponds to the position of the operating posture (stroke-end position of the first boom cylinder 2 when the second boom cylinder 4 is in a shortest state) in Fig. 4.

40 [0040] That is to say, in the pattern shown in Fig. 5 the

restricted oil flow rate value Q is at its minimum Q_3 at a prescribed angle range of approximately Θ ($\Theta_2 \leq \alpha \leq \Theta_3$). Moreover, if the first boom angle is in the operational range, ie $\alpha < \Theta$, the normal operational restricted oil flow rate value Q_1 is the restriction value when $\alpha < \Theta_1$, the restricted oil flow rate value Q decreasing gradually as the boom angle α increases when $\Theta_1 \leq \alpha \leq \Theta_2$.

[0041] Furthermore, if the first boom angle is in the storage range, ie $\alpha > \Theta$, the restricted oil flow rate value Q is made to be Q_2 ($Q_3 < Q_2 < Q_1$) when $\Theta_4 \leq \alpha \leq \Theta_5$, and the restricted oil flow rate value Q is decreased gradually as the boom angle α decreases when $\Theta_3 \leq \alpha \leq \Theta_4$.

[0042] The reason for ensuring that there is a reasonably high restricted flow rate value Q_2 when $\alpha > \Theta_4$ is as follows.

[0043] When the working mechanism moves from the stored posture to the operating posture, the first boom cylinder 2 moves towards the stroke end, as when lifting the second boom 3 in the operational range. Thus, setting the restricted oil flow rate value Q in the vicinity of the minimum value Q_3 when $\Theta_3 \leq \alpha \leq$ stored posture would serve to slow the working mechanism down during transition from the stored posture to the operating posture. This would create problems, and the machine would cease to move when the engine is idling.

[0044] Thus, by ensuring a reasonably high restricted flow rate value Q_2 when $\alpha > \Theta_4$, the present embodiment makes it possible to move swiftly from the stored posture to the operating posture.

[0045] When the computing element 26 in Fig. 1 detects a boom up operation as a result of a signal from the boom up pressure switch 24, it reads from the restricted oil flow rate pattern illustrated in Fig. 5 the restricted oil flow rate value Q corresponding to the detection signal α from the first boom angle sensor 20. Once read, the signal is output to the EPC valve 27, thus serving to reduce stroke-end shock in the first boom cylinder 2 while the second boom 3 is being lifted.

[0046] Fig. 2 illustrates an on/off valve 31 and throttle valve 32 which are used instead of the EPC valve 27 of Fig. 1. In this case, the duty of the on/off command signal output from the computing element 26 to the on/off valve 31 is controlled so as to restrict the flow rate in accordance with patterns such as those illustrated in Fig. 5.

[0047] Fig. 3 illustrates a modified example of the first embodiment. In this case, the boom operating lever 22 of Fig. 1 is replaced by an electrical lever 33, the lever signal of which is input directly into the computing element 26.

Embodiment 2

[0048] In the present second embodiment an angle sensor 20 is attached to the rotational fulcrum a of the first boom 1, and an angle sensor 41 is attached to the rotational fulcrum d of the second boom 3 (cf. Fig. 4), so

that stroke-end shock in the first boom cylinder is reduced in accordance with the detection output of these two angle sensors 20, 41.

[0049] Fig. 6 illustrates an example of the structure of the drive control system required for the implementation of Embodiment 2, a second boom angle sensor 41 being added to Embodiment 1, the computing element 26 of which is replaced by a computing element 40. All other structural elements are the same as in Embodiment 1, and will not be described again here.

[0050] As in the previous embodiment, the first boom angle sensor 20 is attached to the rotational fulcrum a of the first boom 1 in order to detect the first boom angle α (cf. Fig. 4).

[0051] The second boom angle sensor 41 is attached to the rotational fulcrum d of the second boom 3 in order to detect the second boom angle β (cf. Fig. 4).

[0052] As will be seen again from Fig. 13, the angle (posture) of the first boom 1 in the present two-piece boom type power shovel when the first boom cylinder 2 reaches stroke end varies in a range between the position of the angle Θ and that of the angle Θ' in response state of extension or retraction of the second boom cylinder 4.

[0053] Now, let the second boom angle β be labelled ϕ when the first boom angle α is Θ , and ϕ' when the first boom angle α is Θ' , as is shown in Fig. 13. In other words, the first boom angle α in the operating posture when the first boom cylinder 2 is in a longest state and the second boom cylinder is in a shortest state is Θ , and the second boom angle at that time is ϕ . Meanwhile, the first boom angle α when the first boom cylinder 2 is in a longest state and its axis u intersects the fulcrum a of the first boom 1 is Θ' , and the second boom angle at that time is ϕ' .

[0054] Thus, within this range of angles ($\Theta \leq \alpha \leq \Theta'$, $\phi \leq \beta \leq \phi'$), the boom angles α , β assume an unconditional relationship as illustrated in Fig. 7. In other words, provided that the relationship shown in Fig. 7 is established in advance for each actual machine, it is possible to utilize this relationship to determine the stroke-end angle δ of the first boom cylinder 2 in accordance with the value of the angle β when the second boom 3 is in the range $\phi \leq \beta \leq \phi'$.

[0055] The relationship between the stroke-end angle δ and the second boom angle β as illustrated in Fig. 7 is set and stored in advance within the computing element 40 of Fig. 6.

[0056] As is illustrated in Fig. 8, a restricted oil flow rate pattern for the first boom cylinder 2 is stored in advance within the computing element 40 of Fig. 6. The computing element 26 outputs flow rate restriction signals to the EPC valve 27 in accordance with this restricted oil flow rate pattern.

[0057] In other words, as Fig. 8 shows, a plurality of patterns of the sort illustrated in Fig. 5 but transposed parallelly forward in a horizontal direction within the angle range $\Theta \leq \alpha \leq \Theta'$ is stored in a restricted oil flow

rate pattern memory in the computing element 40. A pattern corresponding to the stroke-end angle δ ($\Theta \leq \delta \leq \Theta'$) of the first boom cylinder determined in accordance with the angle β of the second boom 3 is selected from among this plurality of patterns and used to restrict and control the flow rate.

[0058] When the computing element 40 in Fig. 6 detects a boom up operation as a result of a signal from the boom up pressure switch 24, it takes the detection signal α from the first boom angle sensor 20 and the detection signal β from the second boom angle sensor 41, and calculates the stroke-end angle δ ($\Theta \leq \delta \leq \Theta'$) of the first boom cylinder 2 corresponding to the current angle β of the second boom on the basis of the angle relationships illustrated in Fig. 7.

[0059] Next, the computing element 40 selects from among the plurality of patterns illustrated in Fig. 8 the one which corresponds to the calculated stroke-end angle δ , and outputs to the EPC valve 27 a restricted flow rate value signal corresponding to the detection signal α of the first boom angle sensor 20 in the selected pattern. This serves to reduce stroke-end shock in the first boom cylinder 2 while the second boom 3 is being lifted.

[0060] It should be added that when $\beta < \phi'$, ie when the second boom angle β is between the stored posture (posture when the second boom cylinder 4 is in a longest state) and the state at ϕ' , the pattern which is adopted from among the plurality of patterns illustrated in Fig. 8 is the one for when the stroke-end angle δ is Θ' .

[0061] By ensuring a reasonably high restricted flow rate value Q2 when $\alpha > \Theta_4$ (Θ_4') as may be seen in Fig. 8, the present second embodiment also makes it possible to move swiftly from the stored posture to the operating posture.

[0062] Thus, in the present second embodiment the first boom angle α and second boom angle β are detected, and stroke-end shock in the first boom cylinder is reduced in accordance with the results detected for these two angles. In this manner it is possible effectively to reduce stroke-end shock in the first boom cylinder 2 even in conditions where the second boom cylinder 4 is extended or retracted at will.

[0063] Furthermore, as may be seen from Fig. 8, the abovementioned second embodiment provides a plurality of restricted oil flow rate patterns in accordance with the stroke-end angle δ . However, it is also possible to provide a single restricted oil flow rate pattern corresponding to a single stroke-end angle as illustrated in Fig. 5, and to determine the restricted oil flow rate pattern which matches the actual stroke-end angle δ by correcting this single pattern (simply transposing the pattern parallelly in a horizontal direction) in accordance with the actual stroke-end angle δ as obtained from the angle relationships illustrated in Fig. 7.

[0064] That is to say, suppose a restricted oil flow rate pattern was provided as illustrated in Fig. 5, where the stroke-end angle of the first boom cylinder is Θ . Sup-

pose also that the second boom angle β obtained from the second boom angle sensor 41 while the device was working was ϕ' . The computing element 40 calculates the stroke-end angle δ ($= \Theta'$) corresponding to this second boom angle ϕ' from the relationships illustrated in Fig. 7. It then determines the difference $\Delta\Theta$ ($= \Theta' - \Theta$) between the calculated stroke-end angle Θ' and the stroke-end angle Θ (fixed value), and by correcting the restricted oil flow rate pattern illustrated in Fig. 5 (transposing it parallelly in a horizontal direction) by a value determined in advance in accordance with this deviation $\Delta\Theta$, determines the restricted oil flow rate pattern corresponding to the stroke-end angle Θ' .

[0065] In the above embodiments the upward operation of the second boom 3 has been detected with the aid of the pressure switch 24, but this may also be effected at will by other means. For instance, the angle α of the first boom 1 may be monitored and the upward operation of the second boom 3 detected on the basis of the monitored values. In this manner it is possible to reduce stroke-end shock in the first boom cylinder by allowing the EPC valve 27 to work at such time as the first boom angle α attains a predetermined angle in boom up operational state.

INDUSTRIAL APPLICABILITY

[0066] As has been explained above, the present invention makes it possible even in a construction machine with a two-piece boom structure to reduce stroke-end shock in the first boom cylinder effectively and cheaply with the aid of even a single angle sensor by making the boom angle of the first boom when the first and second booms are in maximum derricking state the stroke-end angle.

[0067] Moreover, by ensuring to a certain degree the flow restriction value on the second boom up side when the operational mechanism is in the stored posture range, it facilitates the transition from the stored posture to the operating posture, thus improving operational efficiency.

[0068] Furthermore, by detecting the first and second boom angles and reducing stroke-end shock in the first boom cylinder in accordance with the results detected for these two angles, the present invention makes it possible effectively to reduce stroke-end shock in the first boom cylinder even in conditions where the second boom cylinder is extended or retracted at will.

Claims

1. A device for reducing a stroke-end shock in a two-piece boom type construction machine having a first boom which is attached to a vehicle body in such a manner as to rotate freely, a second boom which is attached to the first boom in such a manner as to rotate freely, a first boom cylinder which links the vehicle body and the second boom, a second

boom cylinder which links the second boom and the first boom, a first operation valve which serves to operate the first boom cylinder, a second operation valve which serves to operate the second boom cylinder, first operation means which outputs a command signal to the first operation valve and second operation means which outputs a command signal to the second operation valve, wherein when the first boom cylinder is in a longest state and the second boom cylinder is in a shortest state, the first and second booms attain a maximum derricking state; when shifting from a stored posture to an operating posture, the second boom cylinder is retracted from a longest state during storage to a shortest state during operation, and when operating, the second boom cylinder is fixed in the shortest state, characterized in that the device comprises:

angle detection means which detects an angle of the first boom;

restricted flow rate setting means having stored in advance therein a value of a relationship between the angle of the first boom and a restricted oil flow rate of the first boom cylinder such that the value becomes minimum within a predetermined angle range including a stroke end angle defined as the boom angle of the first boom when the first and second booms are put in the maximum derricking state, while the value gradually increases as it goes farther beyond the angle range; and

flow rate control means which restricts and controls the flow rate of pressure oil to the first operation valve in a direction in which the boom is raised in accordance with data stored in the restricted flow rate setting means.

2. The device for reducing stroke-end shock in a two-piece boom type construction machine according to Claim 1, characterized in that the relationship of the restricted oil flow rate in the first boom cylinder to the angle of the first boom is set with the aid of the restricted flow rate setting means in such a manner that, in a range from the first boom angle corresponding to the stored posture to a prescribed first angle between the first boom angle corresponding to the stored posture and the stroke-end angle, a prescribed flow rate restriction value is adopted which is smaller than a maximum feed flow rate set during operation and greater than a minimum value thereof.

3. A device for reducing stroke-end shock in a two-piece boom type construction machine having a first boom which is attached to a vehicle body in such a manner as to rotate freely, a second boom which is attached to the first boom in such a manner

as to rotate freely, a first boom cylinder which links the vehicle body and the second boom, a second boom cylinder which links the second boom and the first boom, a first operation valve which serves to operate the first boom cylinder, a second operation valve which serves to operate the second boom cylinder, first operating means which outputs a command signal to the first operation valve and second operating means which outputs a command signal to the second operation valve, characterized in that the device comprises:

first boom angle detecting means which detects an angle of the first boom;

second boom angle detecting means which detects an angle of the second boom;

stroke-end angle setting means which stores in advance a relationship between the first boom angle at which the first boom cylinder reaches a stroke end, and the second boom angle;

restricted flow rate setting means having stored in advance therein a value of a relationship between the angle of the first boom and a restricted oil flow rate of the first boom cylinder, for each of a plurality of reference angles defined as a plurality of first boom angles at which the first boom cylinder reaches the stroke end, such that the value becomes minimum within a predetermined angle range including the reference angle, while the value gradually increases as it goes farther beyond the angle range;

calculation selecting means which assigns values detected by the second boom angle detecting means to the predetermined relationships of the stroke-end angle setting means so as to calculate the first boom angle which is the stroke-end angle corresponding to the detection values, and selects a predetermined relationship of the restricted flow rate setting means which corresponds to the calculated first boom angle; and

flow rate control means which restricts and controls the flow rate of pressure oil to the first operation valve in a direction in which the boom is raised in accordance with the selected predetermined relationship.

4. The device for reducing stroke-end shock in a two-piece boom type construction machine according to Claim 3, characterized in that the relationship of the restricted oil flow rate in the first boom cylinder to the first boom angle is set for each of the reference angles with the aid of the restricted flow rate setting means in such a manner that in a range from the first boom angle corresponding to the stored posture to a prescribed first angle between the first boom angle corresponding to the stored posture

and the stroke-end angle a prescribed flow rate restriction value is adopted which is smaller than a maximum feed flow rate set during operation and greater than the minimum value thereof.

- 5
10
15
20
5. A device for reducing stroke-end shock in a two-piece boom type construction machine having a first boom which is attached to a vehicle body in such a manner as to rotate freely, a second boom which is attached to the first boom in such a manner as to rotate freely, a first boom cylinder which links the vehicle body and the second boom, a second boom cylinder which links the second boom and the first boom, a first operation valve which serves to operate the first boom cylinder, a second operation valve which serves to operate the second boom cylinder, first operating means which outputs a command signal to the first operation valve and second operating means which outputs a command signal to the second operation valve, characterized in that the device comprises:

first boom angle detecting means which detects an angle of the first boom;
second boom angle detecting means which detects an angle of the second boom;
stroke-end angle setting means which stores in advance a relationship between the first boom angle at which the first boom cylinder reaches a stroke end, and the second boom angle;
restricted flow rate setting means having stored in advance therein a value of a relationship between the angle of the first boom and a restricted oil flow rate of the first boom cylinder such that the value becomes minimum within a predetermined angle range including a reference angle defined as one first boom angle at which the first boom cylinder reaches the stroke end, while the value gradually increases as it goes farther beyond the angle range;
correction calculating means which assigns a value detected by the second boom angle detecting means to the predetermined relationship of the stroke-end angle setting means so as to calculate the first boom angle, which is the stroke-end angle corresponding to the detection value, and corrects predetermined data of the restricted flow rate setting means in accordance with the calculated first boom angle; and
flow rate control means which restricts and controls the flow rate of pressure oil to the first operation valve in a direction in which the boom is raised in accordance with the corrected result of the correction calculating means.

25
30
35
40
45
50
55

6. The device for reducing stroke-end shock in a two-piece boom type construction machine according to

Claim 5, characterized in that the relationship of the restricted oil flow rate in the first boom cylinder to the angle of the first boom is set with the aid of the restricted flow rate setting means in such a manner that, in a range from the first boom angle corresponding to the stored posture to a prescribed first angle between the first boom angle corresponding to the stored posture and the stroke-end angle, a prescribed flow rate restriction value is adopted which is smaller than a maximum feed flow rate set during operation and greater than a minimum value thereof.

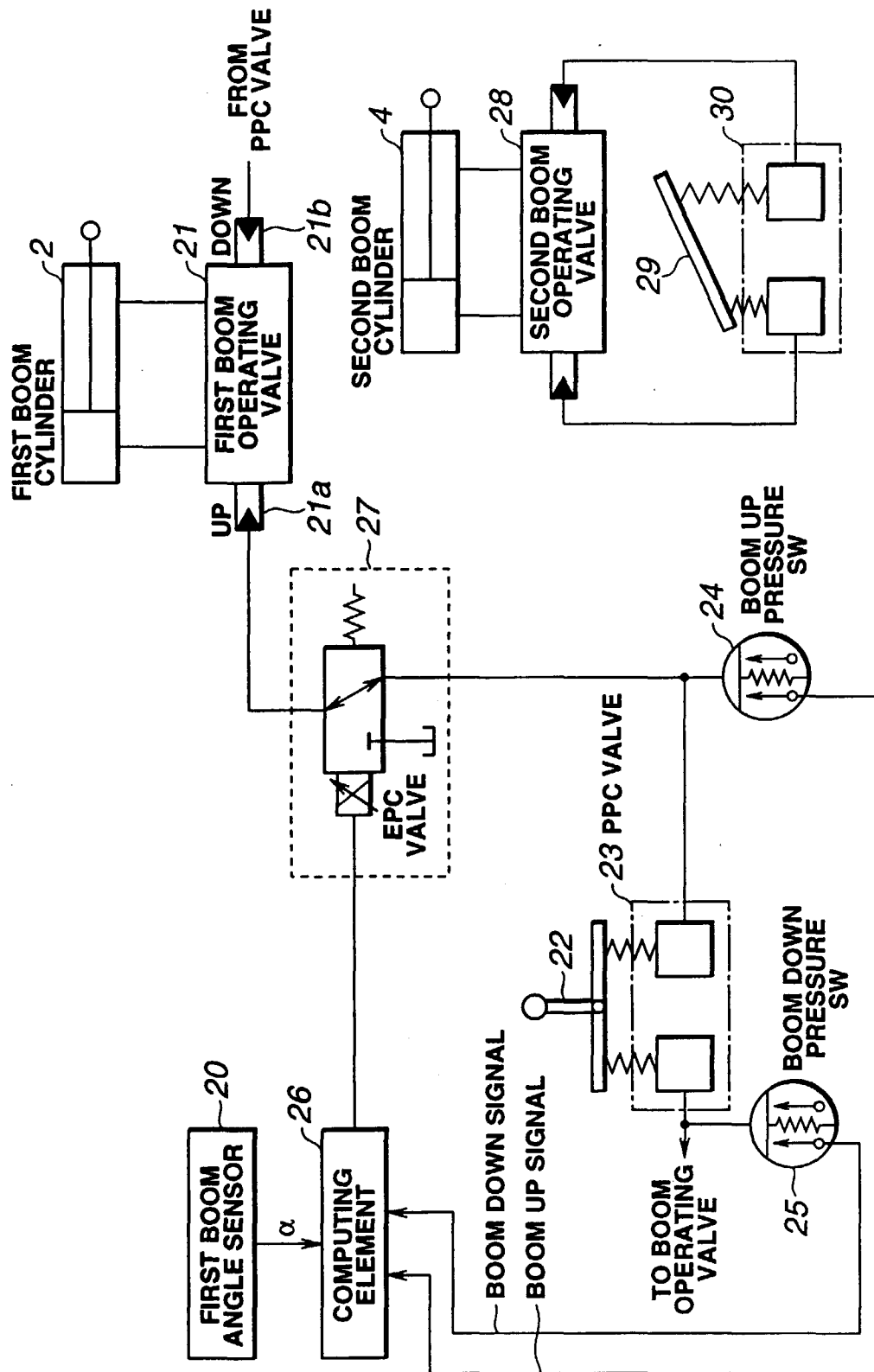


FIG.1

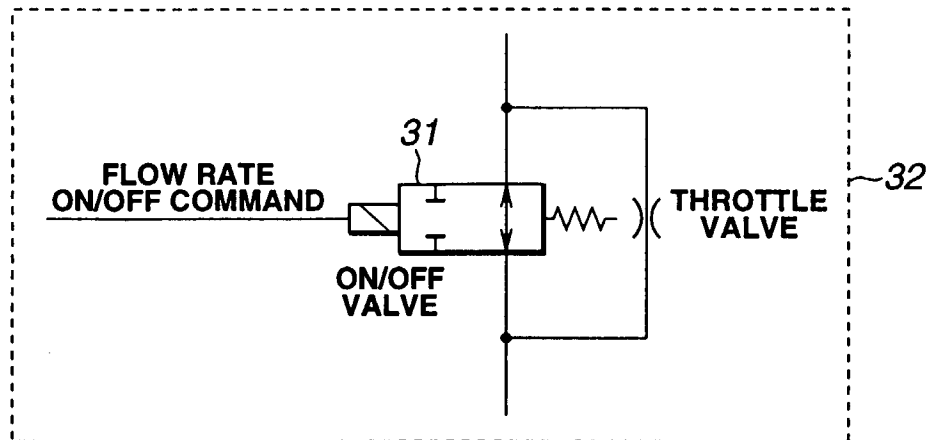


FIG.2

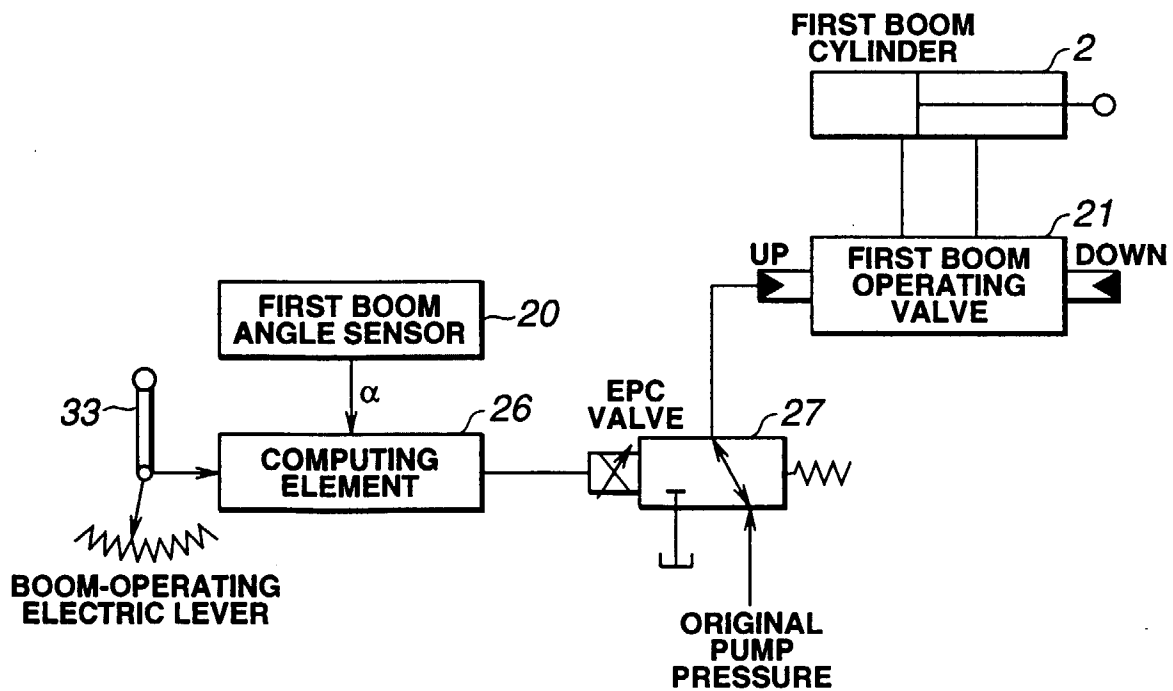


FIG.3

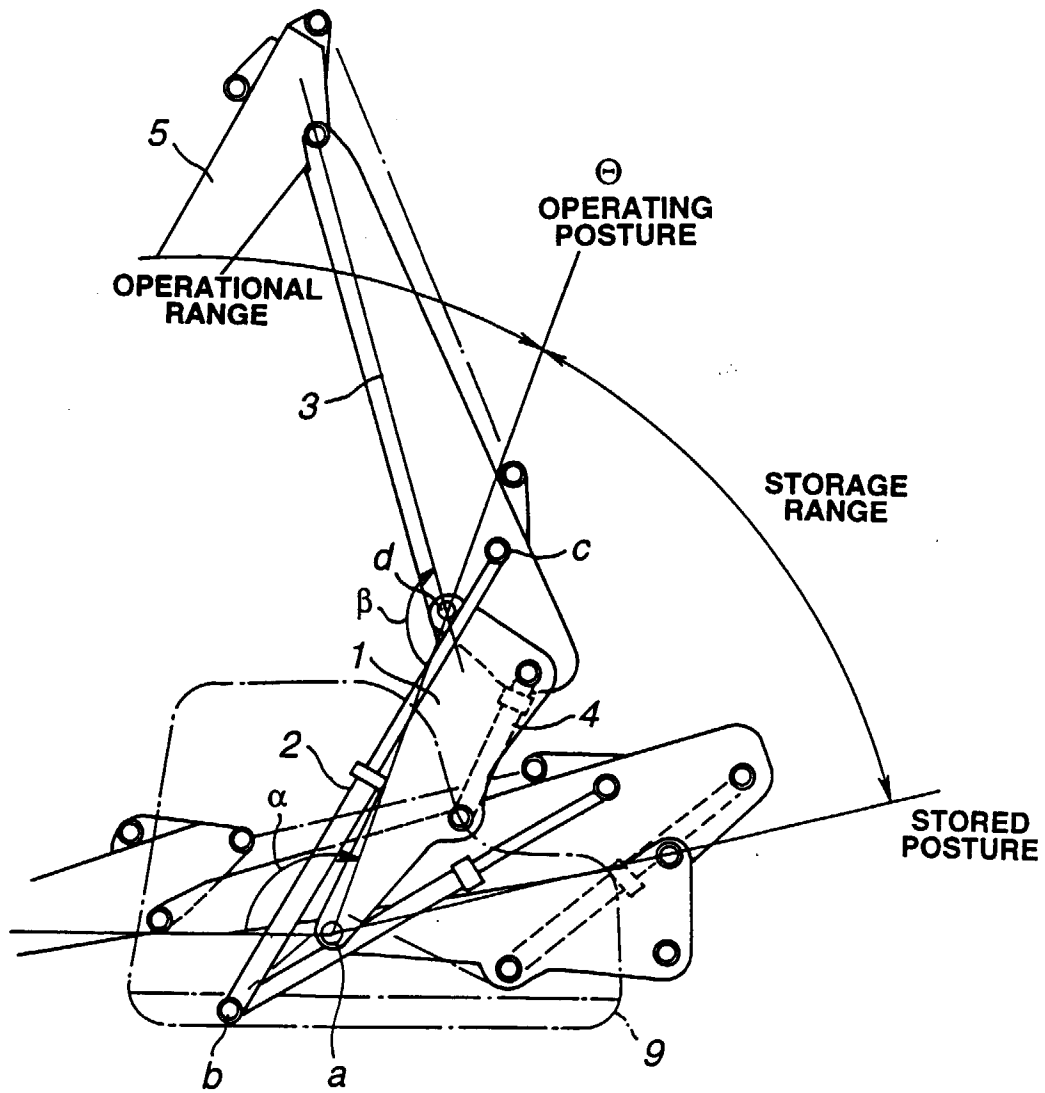


FIG.4

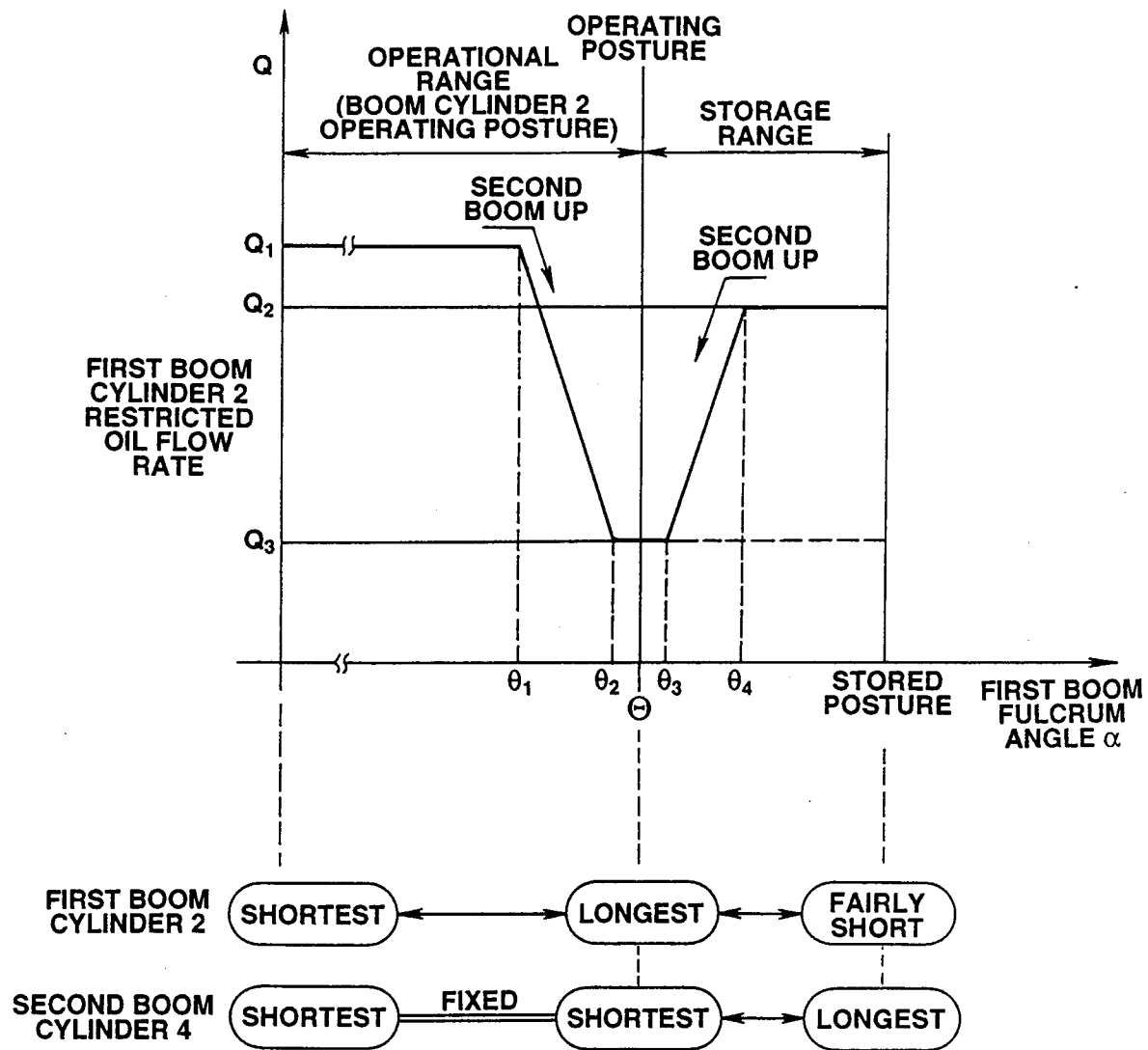


FIG.5

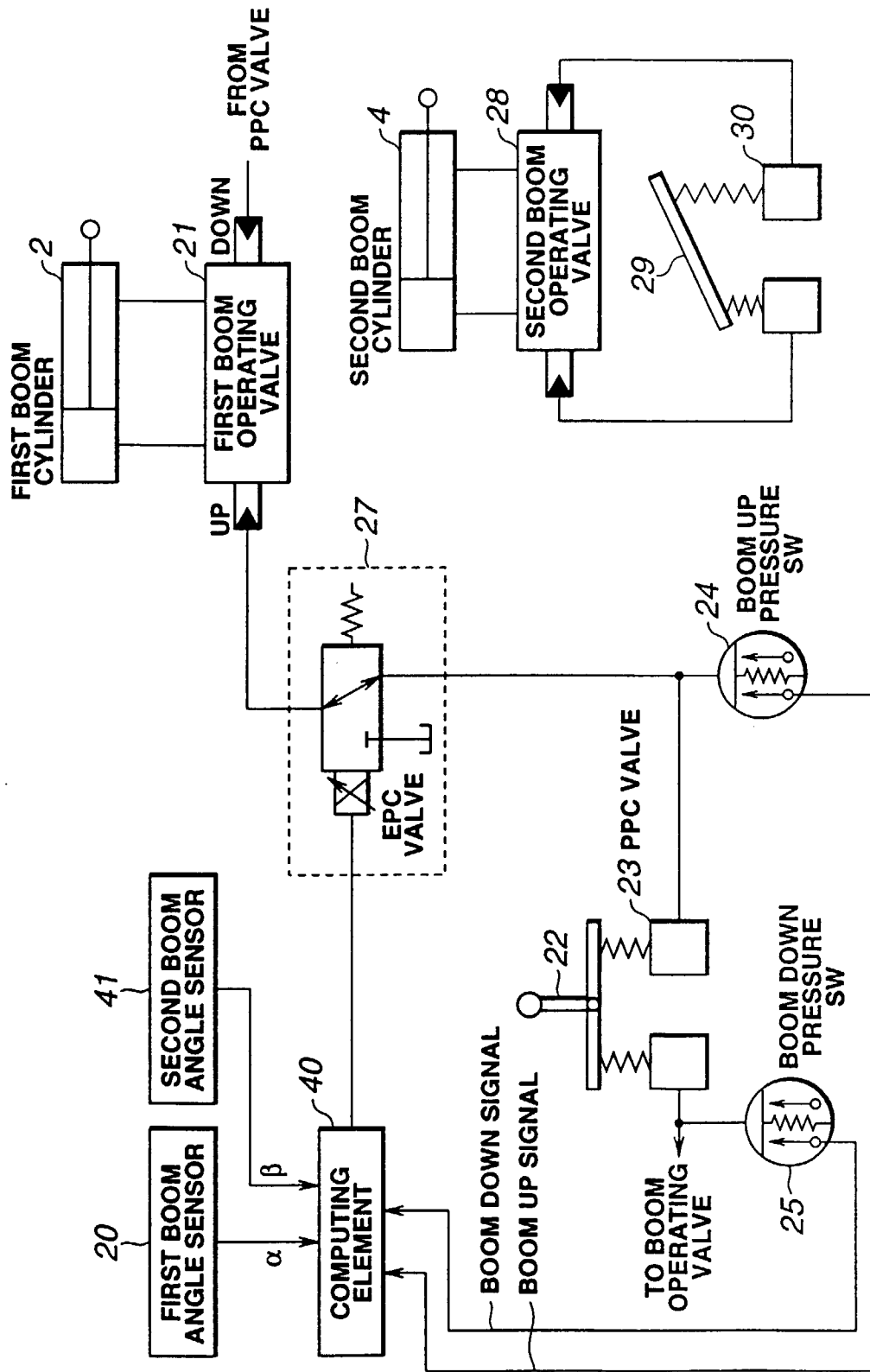


FIG.6

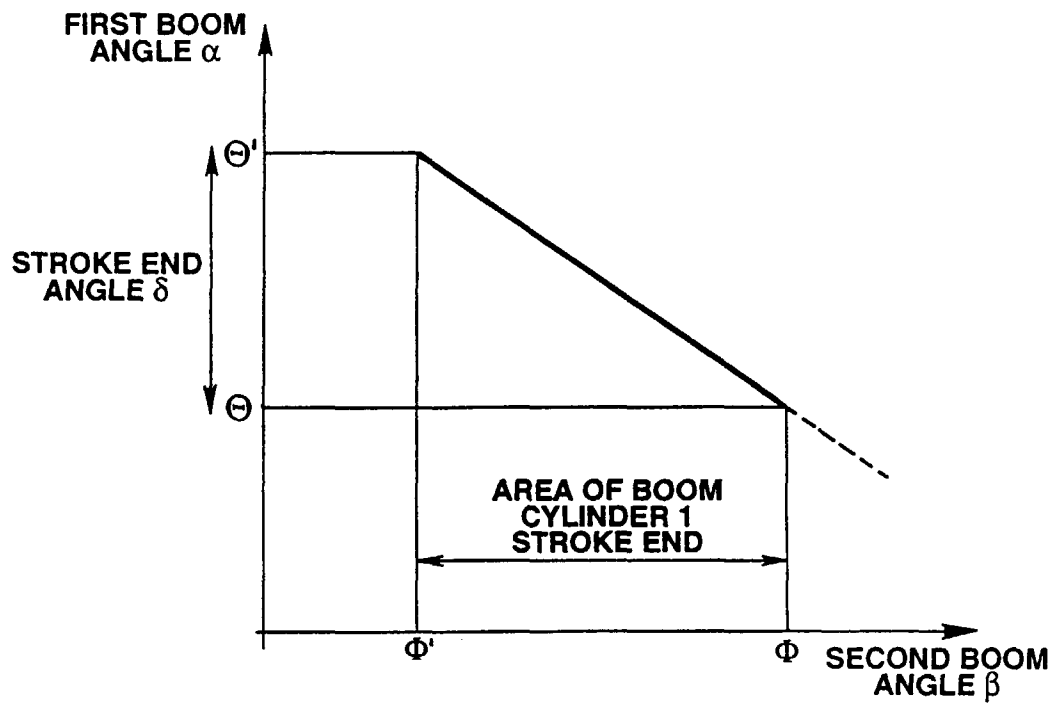


FIG.7

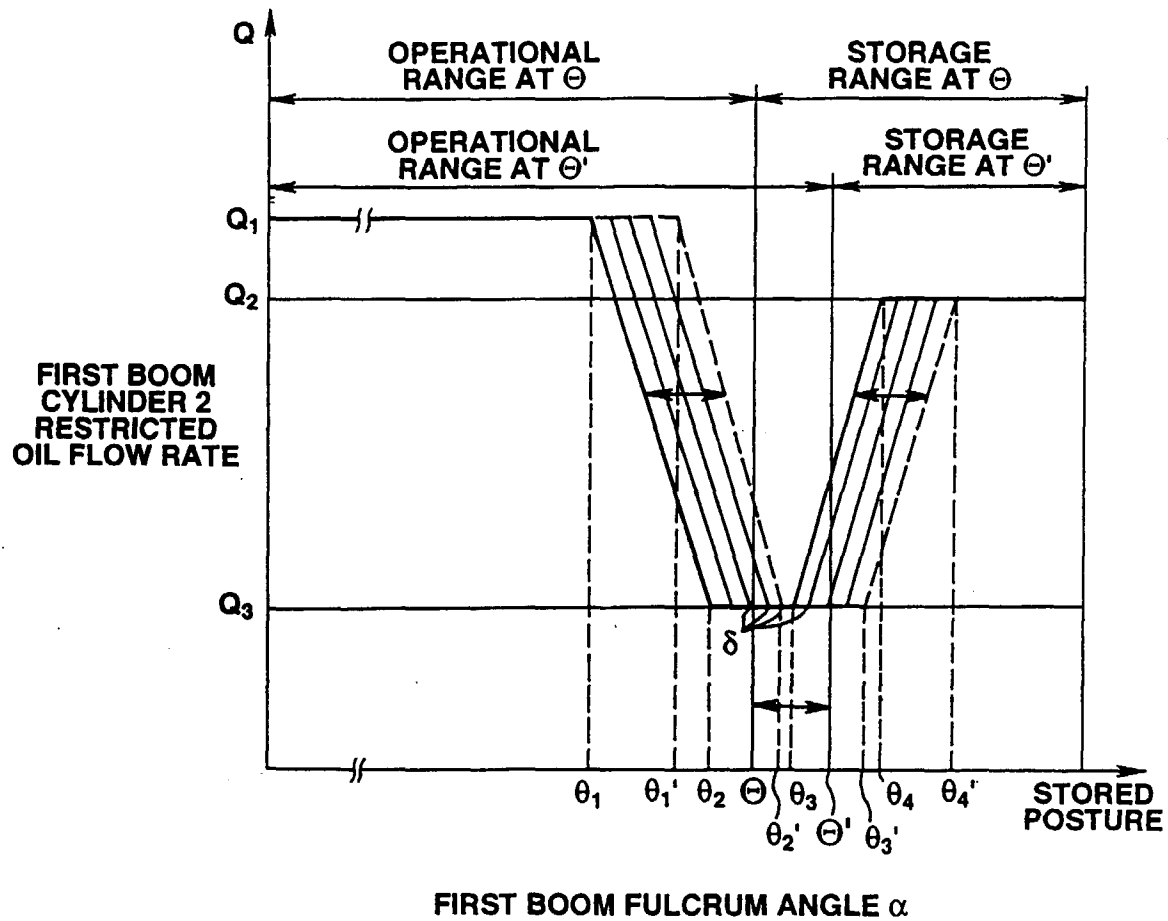


FIG.8

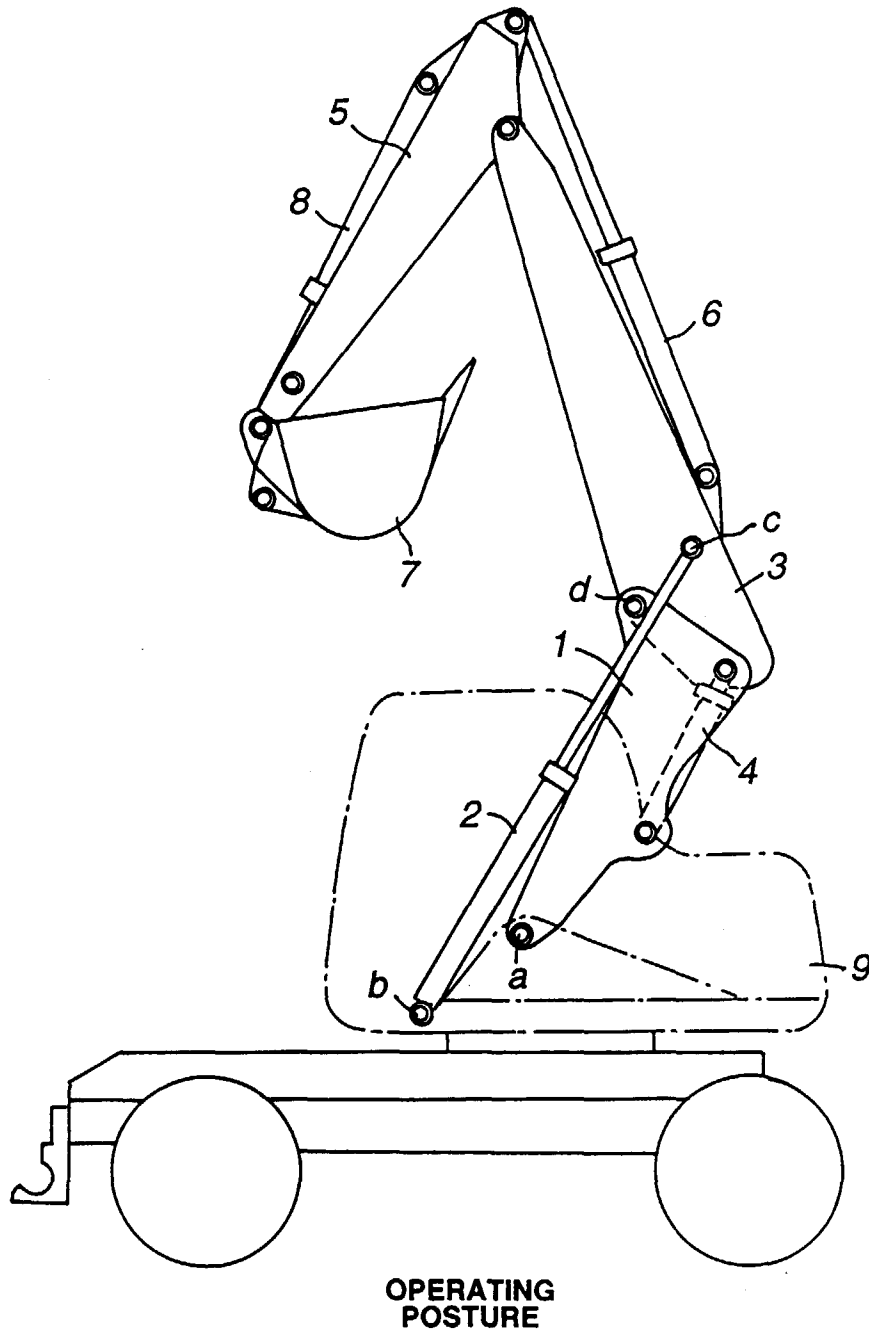
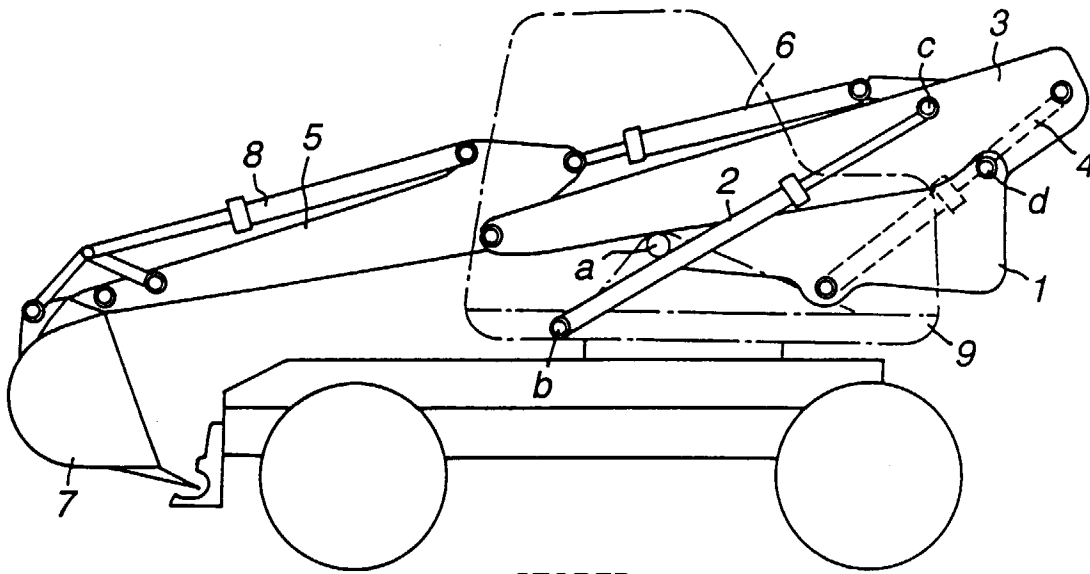


FIG. 9



STORED
POSTURE

FIG.10

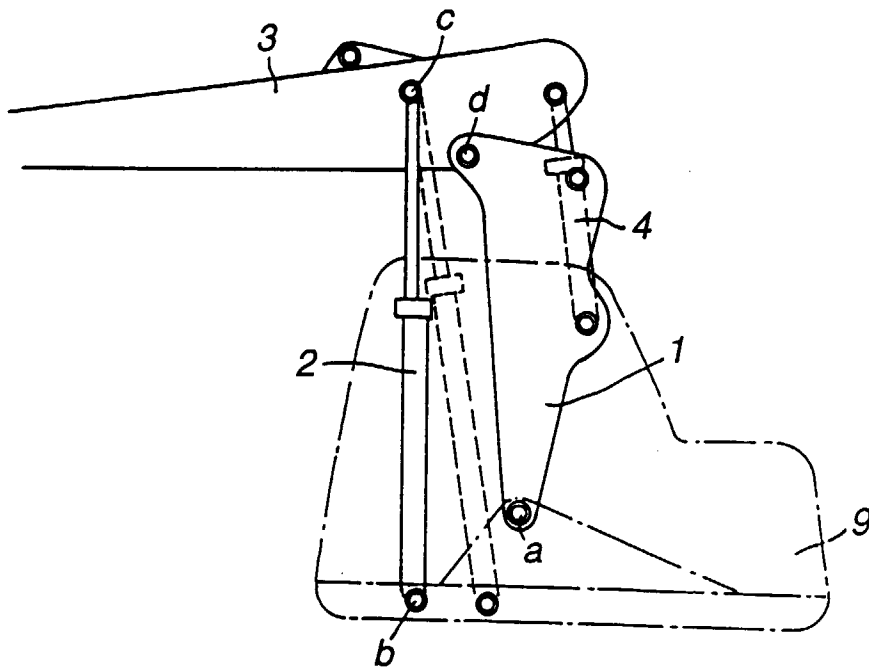


FIG.11

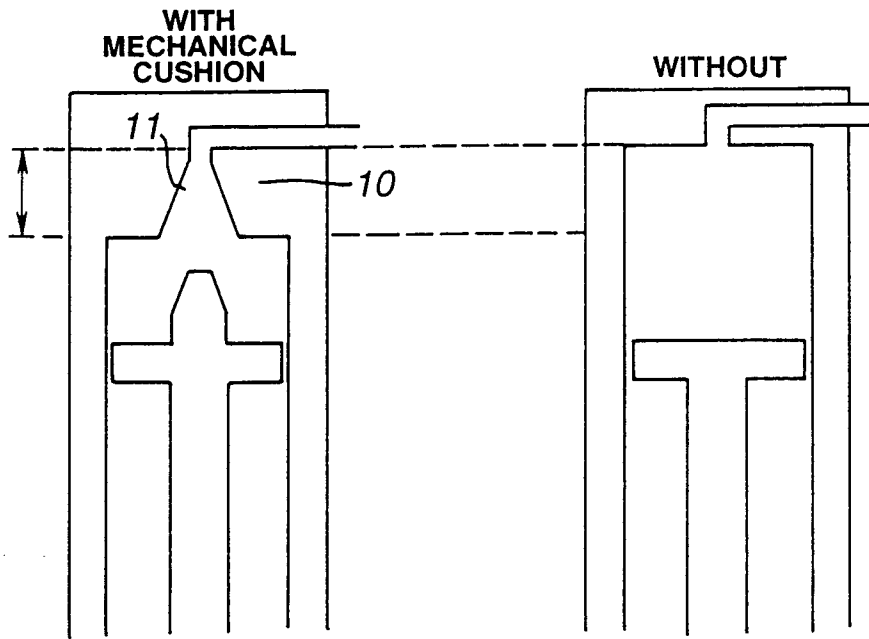


FIG. 12

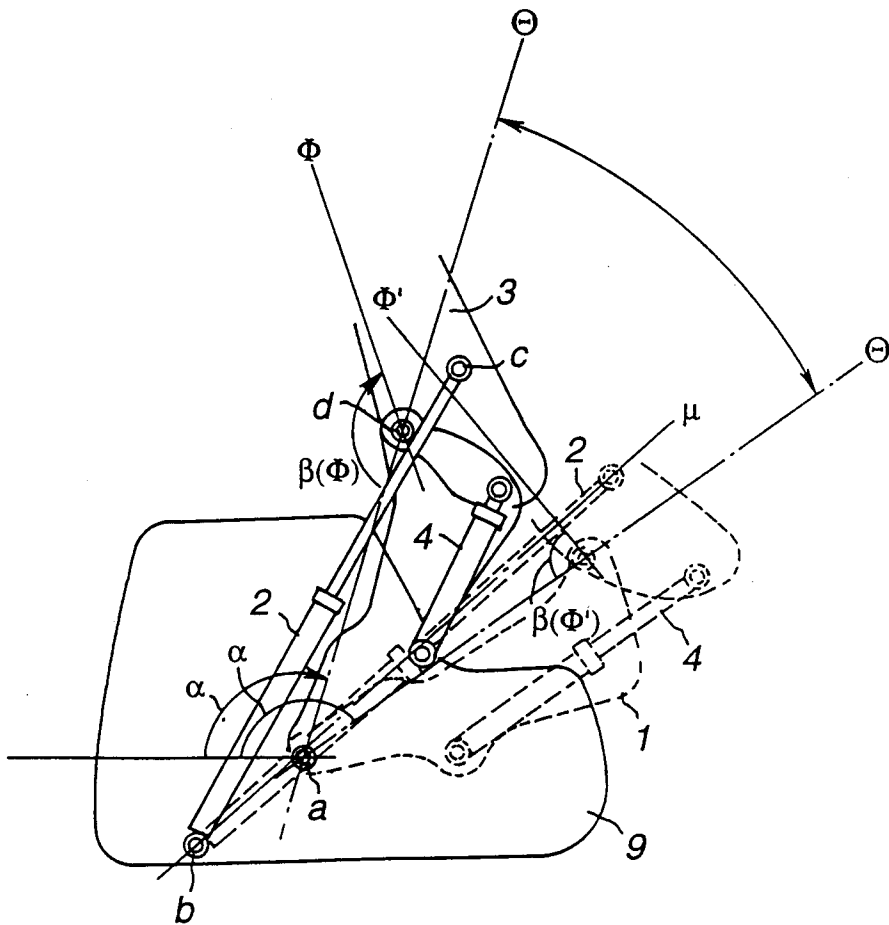


FIG. 13

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP97/02450

A. CLASSIFICATION OF SUBJECT MATTER Int. Cl ⁶ E02F9/20, E02F9/22 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 ⁶ E02F9/20, E02F9/22 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1926 - 1997 Kokai Jitsuyo Shinan Koho 1971 - 1997 Toroku Jitsuyo Shinan Koho 1994 - 1997 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.
A	JP, 8-81979, A (Kubota Corp.), March 26, 1996 (26. 03. 96) (Family: none)	1 - 6
A	JP, 2-253002, A (Hitachi Construction Machinery Co., Ltd.), October 11, 1990 (11. 10. 90) (Family: none)	1 - 6
A	JP, 2-135779, U (Kubota Corp.), November 13, 1990 (13. 11. 90) (Family: none)	1 - 6
A	JP, 2-279841, A (Yutani Heavy Industries, Ltd.), November 15, 1990 (15. 11. 90) (Family: none)	1 - 6
A	JP, 2-279838, A (Yutani Heavy Industries, Ltd.), November 15, 1990 (15. 11. 90) (Family: none)	1 - 6
A	JP, 2-57703, A (Kobe Steel, Ltd.), February 27, 1990 (27. 02. 90) (Family: none)	1 - 6
A	JP, 3-257229, A (Kubota Corp.), November 15, 1991 (15. 11. 91) (Family: none)	1 - 6
☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "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) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "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 "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 "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 "&" document member of the same patent family		
Date of the actual completion of the international search October 9, 1997 (09. 10. 97)		Date of mailing of the international search report October 21, 1997 (21. 10. 97)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.		Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP97/02450

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP, 2-292420, A (Hitachi Construction Machinery Co., Ltd.), December 3, 1990 (03. 12. 90) (Family: none)	1 - 6

Form PCT/ISA/210 (continuation of second sheet) (July 1992)