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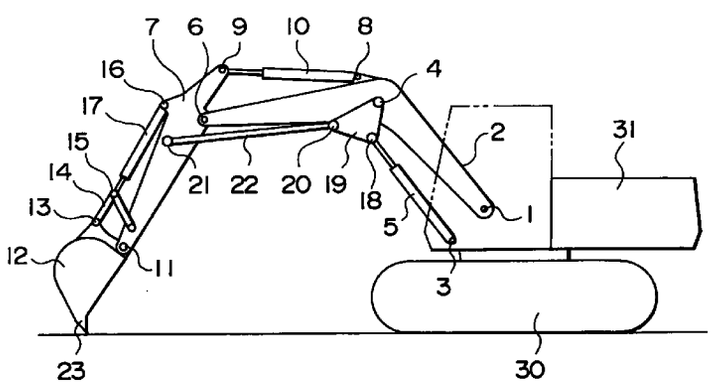
(54) LINK DEVICE FOR HYDRAULIC SHOVEL

(57) The present invention relates to a link device for a hydraulic excavator which facilitates horizontal digging by the hydraulic excavator. To this end, the device comprises a power lever (19) having a first fulcrum rockably connected to a boom (2) by means of a boom pin (4), a second fulcrum rockably connected to a boom cylinder (5) by means of a boom head pin (18), and a third fulcrum to which an arm pin (20) is mounted; and a power rod (22) one end of which is connected to an arm power pin (21) attached to an arm (7), and the other end of which is connected to an arm pin (20). When the arm (7) is rocked by extending and contracting an arm cylinder (10), the boom (2) is swung vertically in operatively associated therewith, and the tip of a bucket (12) moves on a straight line.

FIG. 1



EP 0 818 581 A1

Description

TECHNICAL FIELD

The present invention relates to a link device for a hydraulic excavator, and more particularly, to a link device for a hydraulic excavator which has a simple structure and is capable of horizontal digging.

BACKGROUND ART

Hitherto, techniques shown in Fig. 4 have been known as normal linkages for hydraulic excavators. To an upper machinery 31 mounted on a lower machinery 30, a boom 2 is mounted vertically swingable by means of a boom hoot pin 1. One end of a boom cylinder 5 is connected to the upper machinery 31 by means of a boom bottom pin 3, and the other end is connected to the boom 2 by means of a boom head pin 18 so that the boom cylinder 5 extends and contracts to swing vertically the boom 2. An arm 7 is rockably mounted to the tip of the boom 2 by means of an arm foot pin 6. One end of an arm cylinder 10 is connected to the boom 2 by means of an arm bottom pin 8, and the other end is connected to a rear end of the arm 7 by means of an arm head pin 9 so that the arm cylinder 10 extends and contracts to rock the arm 7.

A bucket 12 is rockably mounted to the tip of the arm 7 by means of a bucket foot pin 11. One end of a bucket cylinder 17 is connected to the arm 7 by means of a bucket bottom pin 16, and the other end is connected to the bucket 12 through a bucket head pin 13, a bucket link 14, and a bucket link pin 15. The bucket cylinder 17 extends and contracts to rock the bucket 12. When performing a digging work, the boom cylinder 5 is extended and contracted to swing vertically the boom 2, and a tooth 23 of the tip of the bucket 12 is brought into abutment with a digging place. Next, the arm cylinder 10 is extended to draw the tip of the arm 7 so as to perform digging. Then, the bucket cylinder 17 is extended to pull up the bucket 12 toward the proximal side so as to dig up earth and sand.

However, in the case of digging the ground surface horizontally, when the tooth 23 of the bucket 12 is brought into abutment with a horizontal ground surface A-B, and the arm 7 is drawn, the tooth 23 moves like a circular arc P-Q-R, and lowers from the ground surface without moving horizontally. For this reason, it is required to raise or lower the position of the arm foot pin 6 in accordance with rocking of the arm 7. That is, the arm cylinder 10 and the boom cylinder 5 should be operated simultaneously by a suitable amount so that the tooth 23 moves horizontally, whereby flatness of the digging surface becomes extremely uncertain, and an operator's skill is required.

In order to solve the problem, as shown in Fig. 5, it has been known that a leveling hydraulic cylinder 53 is provided between the boom 2 and the arm 7 (refer to, for example, Japanese Examined Utility Model Publication No. 59-35659). An extrusion-side oil chamber and a retract-side oil chamber of a piston rod 53a of the leveling hydraulic cylinder 53 are in communication with an extrusion-side oil chamber and a retract-side oil chamber of a piston rod 5a of the boom cylinder 5 by means of pipes 56 and 57, respectively. This allows the boom 2 to be raised and lowered in operatively associated with the movement of the arm 7 so that the tip 23 of the bucket 12 moves on a straight line.

However, the above arrangements suffer from a problem in that the leveling hydraulic cylinder 53 and pipes 56 and 57 are required, a structure becomes complicated and the cost of manufacturing is high and moreover, it is difficult to perform an accurate horizontal digging.

DISCLOSURE OF THE INVENTION

The present invention has been made to solve the drawbacks of the prior art, and its object is to provide economically a link device for a hydraulic excavator which has a simple structure and is capable of horizontal digging.

According to the present invention, there is provided a link device for a hydraulic excavator having a boom mounted vertically swingable to a chassis by means of a boom foot pin and rocked by a boom cylinder one end of which is mounted to the chassis through a boom cylinder bottom pin, an arm rockably mounted to the tip of the boom by means of an arm foot pin and rocked by an arm cylinder, and a bucket rockably mounted to the tip of the arm by means of a bucket foot pin and rocked by a bucket cylinder, the device comprising:

a power lever having a first fulcrum rockably connected to the boom by means of a boom pin, a second fulcrum rockably connected to the boom cylinder by means of a boom head pin, and a third fulcrum to which an arm pin is mounted; and
a power rod one end of which is connected to an arm power pin attached to the arm, and the other end of which is connected to the arm pin.

In addition, the boom pin, the boom head pin, and the boom bottom pin may preferably be located on a straight line in a state where the tip of a tooth of the bucket is located on an intersection of a vertical line passing through the arm foot pin and the ground surface. In addition, a straight line connecting the boom pin and the arm pin may preferably be substantially parallel to a straight line connecting the arm foot pin and the am power pin. Further, a straight line connecting the boom pin and the arm foot pin may preferably be substantially parallel to a straight line connecting the arm pin and the arm power pin.

In addition, the ratio r1/r2 may preferably be sub-

stantially equal to the ratio L1/L2 when a vertical distance between a straight line connecting the boom pin and the boom bottom pin and the boom foot pin is taken as r1, a distance between the boom pin and the boom head pin is taken as r2, a vertical distance between the boom foot pin and a vertical line passing through the arm foot pin is taken as L1, and a distance between the intersection and the arm foot pin is taken as L2 in a state where the tip of the tooth of the bucket is located on the intersection of the vertical line passing through the arm foot pin and the ground surface. Incidentally, a range in which r2 is smaller than (r1 x L2/L1) is more preferable within the range in which the ratio r1/r2 is substantially equal to the ratio L1/L2.

In addition, the boom pin, the boom head pin, and the boom bottom pin may be located on a straight line in a state where the tip of the tooth of the bucket is located on the intersection of the vertical line passing through the arm foot pin and the ground surface, and, when the arm is operated toward the front of the chassis from the state of being located on the straight line while extension and contraction of the bucket cylinder being held fixed, a distance r2 between the boom pin and the boom head pin may preferably be set so that the tip of the tooth moves substantially on a straight line. Further, when linear digging is not performed, the power rod may be removed, and the power lever may be locked so as not to rock around the boom pin.

According to the described arrangements, when the tooth of the bucket is brought into the digging place to rock the arm in the digging direction with the boom cylinder locked, the arm rotates counterclockwise around the arm foot pin, so that the power lever rotates counterclockwise around the boom pin through the power rod. At this time, since the boom cylinder does not extend and contract, the boom will be raised and the tooth of the bucket ascends by that amount, so that the tooth of the bucket moves linearly. More exactly, the tooth of the bucket moves substantially on a straight line with a tendency to slightly rise at an intermediate section.

In addition, when the device is constructed so that the boom pin, etc. are located on a straight line, by further operating the arm in the digging direction from a state where the tip of the tooth is located on the intersection, the power lever rotates counterclockwise around the boom pin through the power rod. Since the boom cylinder does not extend and contract at this time, the boom will be lowered and the tooth of the bucket descends by the amount, so that the tooth of the bucket moves linearly. Further, if the straight line connecting the boom pin and the arm pin is substantially parallel to the straight line connecting the arm foot pin and the arm power pin, or if the straight line connecting the boom pin and arm foot pin is substantially parallel to the straight line connecting the arm pin and the arm power pin, the tooth of the bucket can move more linearly.

If the ratio r1/r2 of the distance r1 to the distance r2 is substantially equal to the ratio L1/L2 of the distance L1 to the distance L2, the tooth moves substantially linearly. Incidentally, when the distance r2 is slightly shorter than r1 x L2/L1, the error can be minimized. Further, by setting the distance r2 so that the tip of the tooth of the bucket moves substantially on a straight line with the extension and contraction of the bucket cylinder fixed, a linear leveling operation can be performed even in a extruding operation of the am. In addition, when the linear digging is not performed, the power rod is removed and the power lever is fixed to the boom, whereby the device can be used as a normal hydraulic excavator.

BRIEF DESCRIPTION OF DRAWINGS

Fig. 1 is a side view of a hydraulic excavator showing a construction of a first embodiment of a link device according to the present invention;

Fig. 2 is a side view of the hydraulic excavator for explaining a relative size of each part when an arm of Fig. 1 is made perpendicular;

Fig. 3 is a side view of the hydraulic excavator showing a construction of a second embodiment of the link device according to the present invention;

Fig. 4 is a side view of a hydraulic excavator comprising a normal linkage according to a prior art; and

Fig. 5 is a side view of a hydraulic excavator according to another prior art.

BEST MODE FOR CARRYING OUT THE INVENTION

The preferred embodiments of a link device for a hydraulic excavator according to the present invention will be described in detail with reference to the attached drawings.

Referring to Fig. 1, to an upper machinery 31 mounted on a lower machinery 30, a boom 2 is mounted vertically swingable by means of a boom hoot pin 1. A first fulcrum of a triangular power lever 19 having three fulcrums is rockably mounted near the center of a boom 2 by means of a boom pin 4. One end of a boom cylinder 5 is connected to the upper machinery 31 by means of a boom bottom pin 3, and the other end is connected to a second fulcrum of the power lever 19 by means of a boom head pin 18.

An arm 7 is rockably mounted to the tip of the boom 2 by means of an am foot pin 6. The rear end of the arm 7 is connected to an arm cylinder 10 by means of an arm head pin 9 so that the arm 7 is rocked by extension and contraction of the arm cylinder 10. A bucket 12 is rockably mounted to the tip of the arm 7 by means of a bucket foot pin 11. One end of a bucket cylinder 17 is connected to the arm 7 by means of a bucket bottom pin 16, and the other end is connected to the bucket 12 through a bucket head pin 13, a bucket link 14, and a bucket link pin 15. The bucket 12 is rocked by the exten-

sion and contraction of the bucket cylinder 17.

One end of a power rod 22 is connected to a third fulcrum of the power lever 19 by means of an arm pin 20, and the other end is connected to the arm 7 by means of an arm power pin 21, and by extending and contracting the boom cylinder 5, the boom 2 is swung vertically. A straight line connecting the boom pin 4 and the arm pin 20 is substantially parallel to a straight line connecting the arm foot pin 6 and the arm power pin 21, and a straight line connecting the boom pin 4 and the arm foot pin 6 is substantially parallel to a straight line connecting the arm pin 20 and the arm power pin 21. That is, the boom pin 4, the arm foot pin 6, the arm power pin 21, and the arm pin 20 form substantially a parallelogram.

Referring to Fig. 2, when the tip of the tooth 23 of the bucket 12 is brought into coincidence with an intersection C of a vertical line passing through the arm foot pin 6 and the ground surface A-B, the boom pin 4, the boom head pin 18, and the boom bottom pin 3 are located on a straight line. In this state, a distance between the boom foot pin 1 and a straight line connecting the boom pin 4 and the boom bottom pin 3 is taken as r1, a distance between the boom pin 4 and the boom head pin 18 is taken as r2, a distance between the boom foot pin 1 and the vertical line passing through the arm foot pin 6 is taken as L1, and a distance between the arm foot pin 6 and the tip of the tooth 23 is taken as L2. The relation between them is such that the ratio r1/r2 is substantially the same as the ratio L1/L2, and is rather that r2 is slightly smaller than r1 x L2/L1.

When digging the ground horizontally, as shown in Fig. 1, the arm cylinder 10 is contracted to project the arm 7 toward the front, and the tip of the tooth 23 of the bucket 12 is brought into abutment with the ground surface A-B. Next, the arm cylinder 10 is extended to draw the arm 7 to the proximal side. The arm 7, as shown in Fig. 2, rocks the power lever 19 through the power rod 22 while being in a vertical position so as to raise the boom 2. When the tooth 23 passes point C, the boom 2 is lowered again. At this time, since the dimensional proportion of each part is in the relation as described above, the tip of the tooth 23 slightly tends to move convexly, but moves substantially in horizontal along the ground surface A-B. That is, an operator can easily perform horizontal digging by only operating the arm cylinder 10.

Fig. 3 illustrates a construction of a second embodiment of the link device. An intermediate fulcrum of a power lever 19a having three fulcrums is rockably mounted to a boom 2 by means of a boom pin 4a. A lower fulcrum of the power lever 19a is connected to a head section of a boom cylinder 5 by means of a boom head pin 18a. The upper fulcrum of the power lever 19a is connected to one end of a power rod 22a by means of an arm pin 20a. The other end of the power rod 22a is connected to the rear end of an arm 7 by means of an arm power pin 21a. The other portions are the same as those of the first embodiment.

A straight line connecting the arm pin 20a and the boom pin 4a is substantially parallel to a straight line connecting the am power pin 21a and the arm foot pin 6, and a straight line connecting the arm power pin 21a and the arm pin 20a is substantially parallel to a straight line connecting the arm foot pin 6 and the boom pin 4a. That is, the arm pin 20a, the arm power pin 21a, the arm foot pin 6, and the boom pin 4a form substantially a parallelogram. The operation is the same as that of the first embodiment.

According to the arrangements of the present invention as described above in detail,

(1) The dimensional configuration of the link device is set so that an error with a liner digging is minimized by a simple structure, so that the cost is reduced. In addition, a horizontal digging with high accuracy and a linear digging of a normal plane can be performed only by operating the arm (that is, an arm operating valve), so that reduction in fatigue of the operator, and an improvement in operability can be achieved;

(2) According to a heavy digging, the boom tends to rise due to a tooth reaction force, so that pressure is generated on the side of the boom cylinder rod against this. This allows the arm to be pulled in a digging direction through the power lever and the power link, so that arm digging force increases; and

(3) When the linear digging is not performed, the power rod is removed, and the power lever is fixed to the boom, whereby the device can be used as a normal hydraulic excavator.

INDUSTRIAL APPLICABILITY

The present invention is useful as a link device for a hydraulic excavator which can perform a horizontal digging and a linear digging of a normal plane with high accuracy by a simple work of operating an arm only, offer reduction in fatigue of an operator and an improvement in operability, and increase arm digging force.

Claims

1. A link device for a hydraulic excavator having a boom (2) mounted vertically swingable to a chassis by means of a boom foot pin (1) and rocked by a boom cylinder (5) one end of which is mounted to the chassis through a boom cylinder bottom pin (3), an arm (7) rockably mounted to the tip of said boom (2) by means of an arm foot pin (6) and rocked by an arm cylinder (10), and a bucket (12) rockably mounted to the tip of said arm (7) by means of a bucket foot pin (11) and rocked by a bucket cylinder (17), said device comprising:

a power lever (19) having a first fulcrum rocka-

bly connected to said boom (2) by means of a boom pin (4), a second fulcrum rockably connected to said boom cylinder (5) by means of a boom head pin (18), and a third fulcrum to which an arm pin (20) is mounted; and

a power rod (22) one end of which is connected to an arm power pin (21) attached to said arm (7), and the other end of which is connected to said arm pin (20).

2. A link device for a hydraulic excavator according to claim 1, wherein said boom pin (4), said boom head pin (18), and said boom bottom pin (3) are located on a straight line in a state where the tip of a tooth (23) of said bucket (12) is located on an intersection (C) of a vertical line passing through said arm foot pin (6) and the ground surface.

3. A link device for a hydraulic excavator according to claim 1, wherein a straight line connecting said boom pin (4) and said am pin (20) is substantially parallel to a straight line connecting said arm foot pin (6) and said arm power pin (21).

4. A link device for a hydraulic excavator according to claim 1, wherein a straight line connecting said boom pin (4) and said arm foot pin (6) is substantially parallel to a straight line connecting said arm pin (20) and said arm power pin (21).

5. A link device for a hydraulic excavator according to claim 1, wherein the ratio r1/r2 is substantially equal to the ratio L1/L2 when a vertical distance between a straight line connecting said boom pin (4) and said boom bottom pin (3) and said boom foot pin (1) is taken as r1, a distance between said boom pin (4) and said boom head pin (18) is taken as r2, a vertical distance between said boom foot pin (1) and a vertical line passing through said arm foot pin (6) is taken as L1, and a distance between said intersection (C) and said arm foot pin (6) is taken as L2 in a state where the tip of the tooth (23) of said bucket (12) is located on the intersection (C) of the vertical line passing through said arm foot pin (6) and the ground surface.

6. A link device for a hydraulic excavator according to claim 1, wherein said boom pin (4), said boom head pin (18), and said boom bottom pin (3) are located on a straight line in a state where the tip of the tooth (23) of said bucket (12) is located on the intersection (C) of the vertical line passing through said arm foot pin (6) and the ground surface, and wherein, when said arm (7) is operated toward the front of the chassis from said state of being located on the straight line while extension and contraction of said bucket cylinder (17) being held fixed, a distance r2 between said boom pin (4) and said boom head pin (18) is set so that the tip of said tooth (23) moves substantially on a straight line.

7. A link device for a hydraulic excavator according to claim 1, wherein, when linear digging is not performed, said power rod (22) is removed, and said power lever (19) is locked so as not to rock around said boom pin (4).

FIG. 1

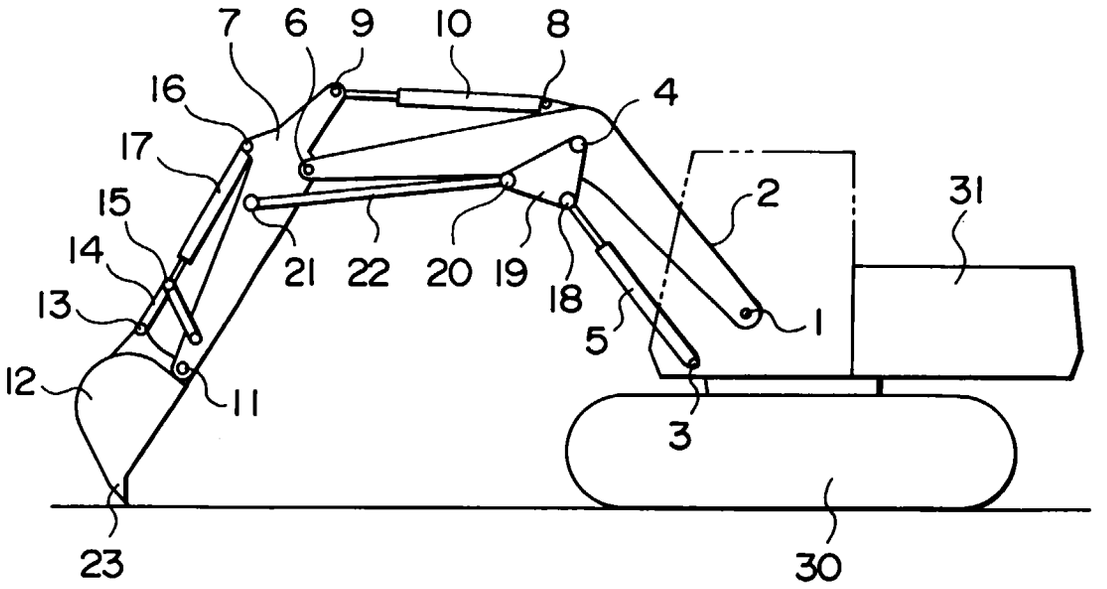

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FIG. 2

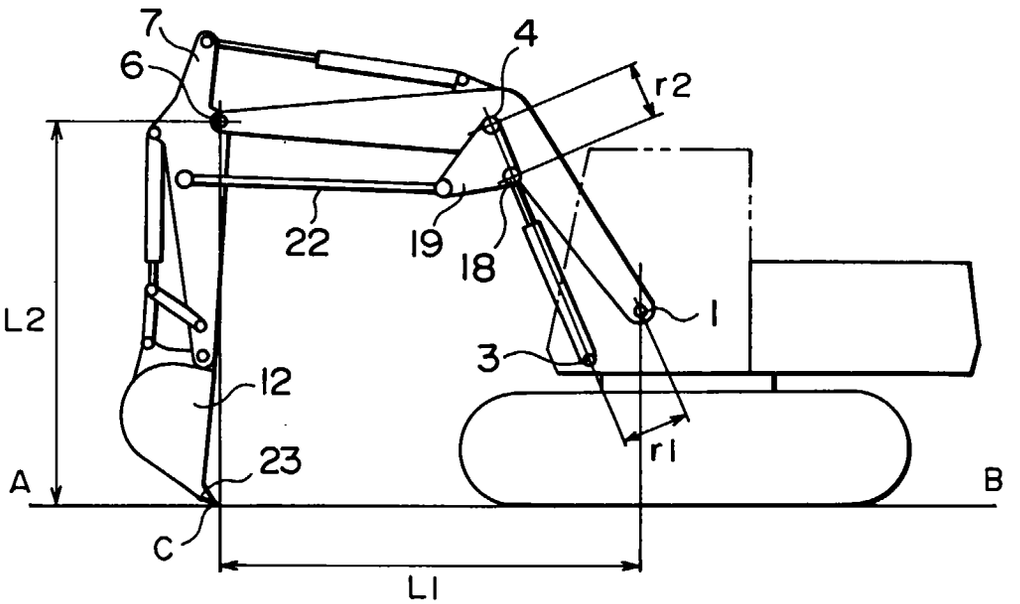
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FIG. 3

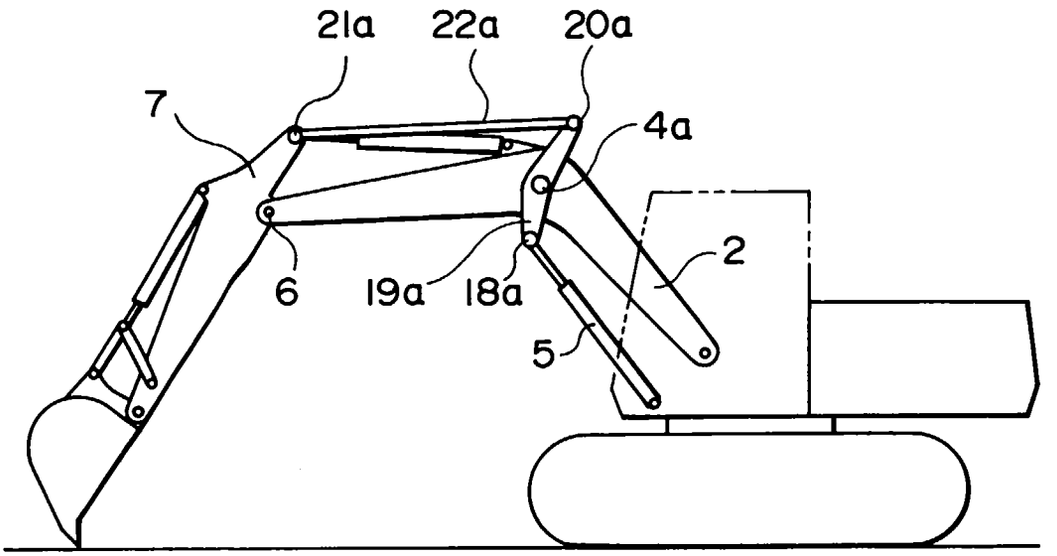


FIG. 4 PRIOR ART

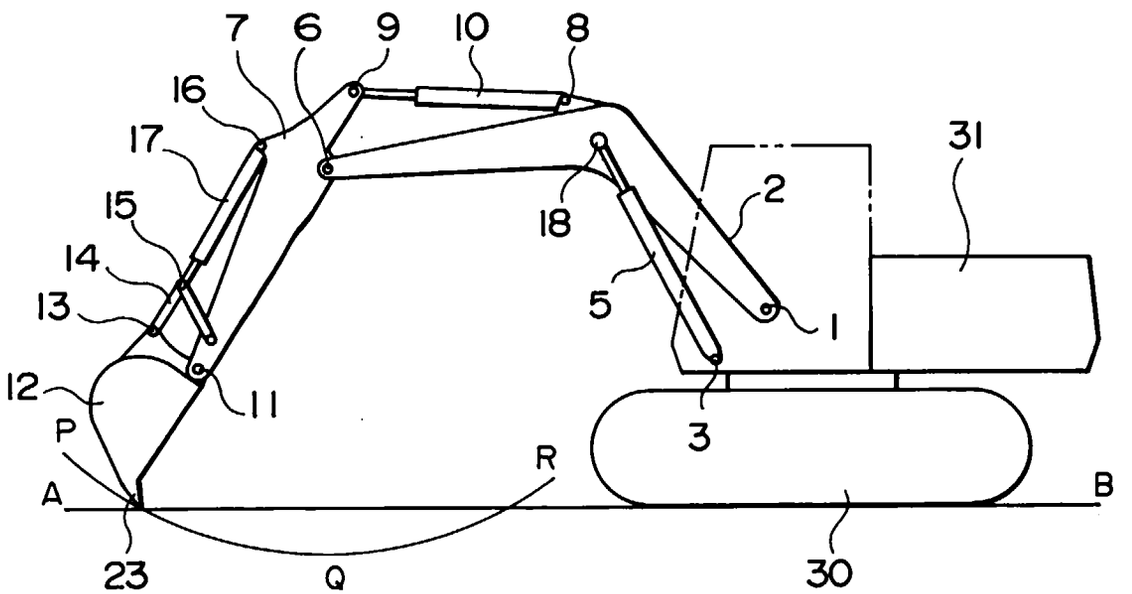
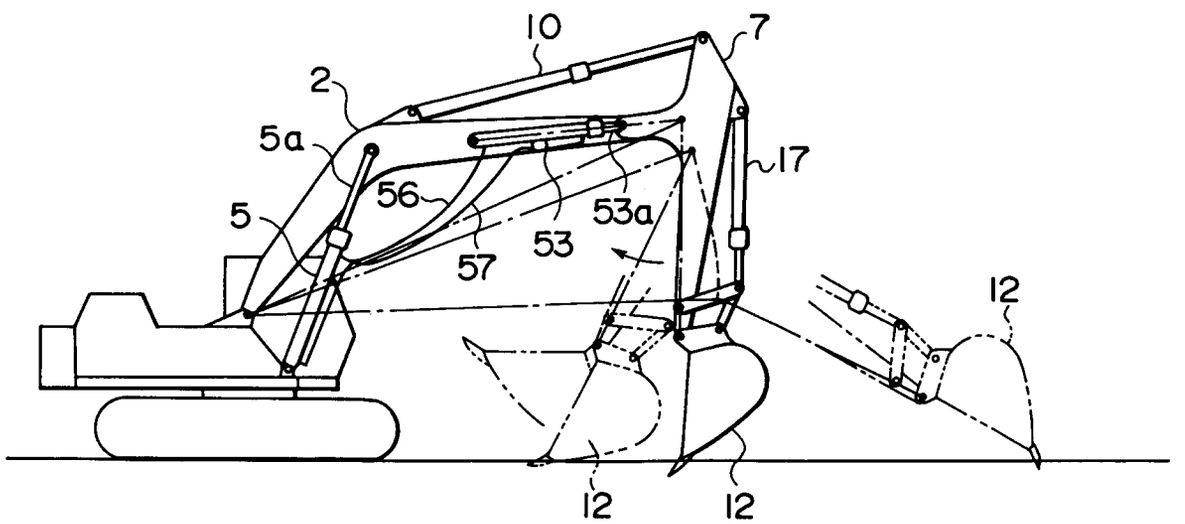


FIG. 5 PRIOR ART



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP96/00826

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl^6 E02F3/32

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 E02F3/32

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1926 - 1996
Kokai Jitsuyo Shinan Koho 1971 - 1996

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Microfilm of the specification and drawings annexed to the written application of Japanese Utility Model Application No. 143513/1984 (Laid-open No. 58263/1986)(Komatsu Ltd.), April 19, 1986 (19. 04. 86)(Family: none)	1
A	Microfilm of the specification and drawings annexed to the written application of Japanese Utility Model Application No. 48704/1985 (Laid-open No. 169165/1986)(Komatsu Ltd.), October 20, 1986 (20. 10. 86)(Family: none)	1

☐ 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
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
May 17, 1996 (17. 05. 96)	May 28, 1996 (28. 05. 96)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

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