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[54] **AUTOMATIC BUCKET POSITIONING DEVICE**

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[51] **Int. Cl.** **E02f 3/00**

[58] **Field of Search** 214/764, 779

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[57] **ABSTRACT**

Hydraulic means operating in conjunction with a hydraulic power unit for automatically stopping in an intermediate position a device whose position is controlled by the hydraulic power unit. A digging bucket is automatically stopped at a digging position intermediate to dumping and breakout positions with respect to a boom arm. A pilot valve connected to an intermediate region of a cylinder of the hydraulic power unit regulates the control valve for the power unit.

5 Claims, 2 Drawing Figures

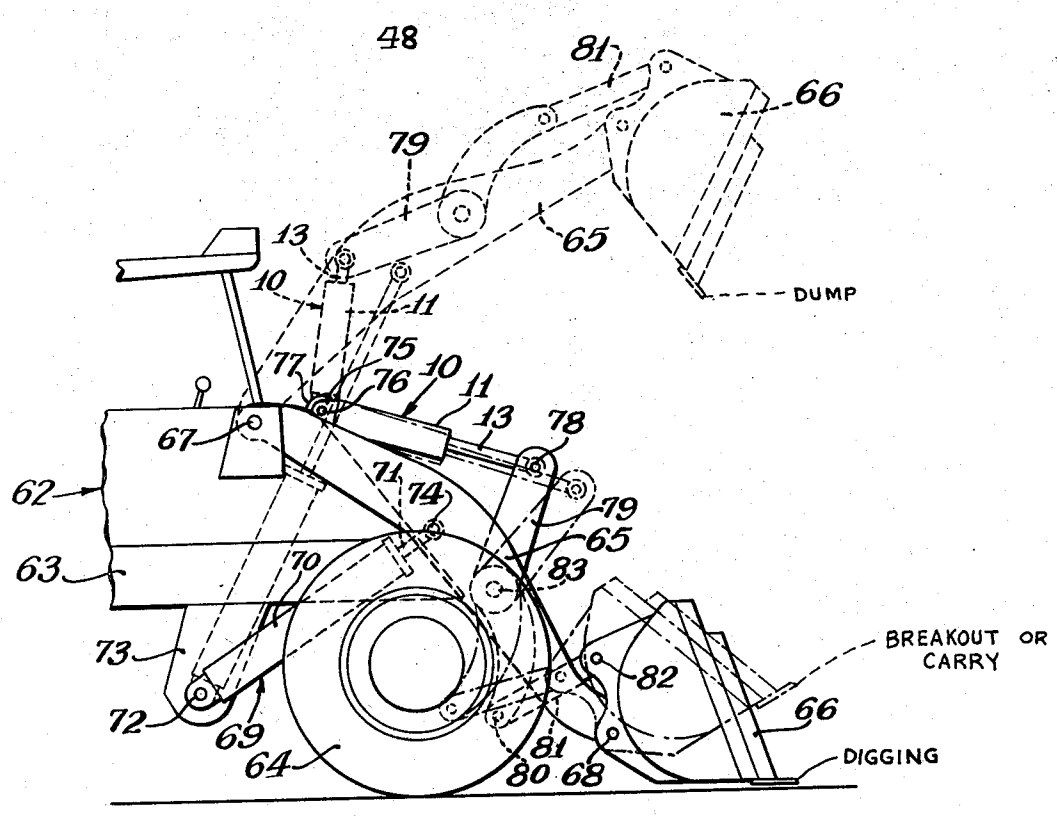


FIG. 1.

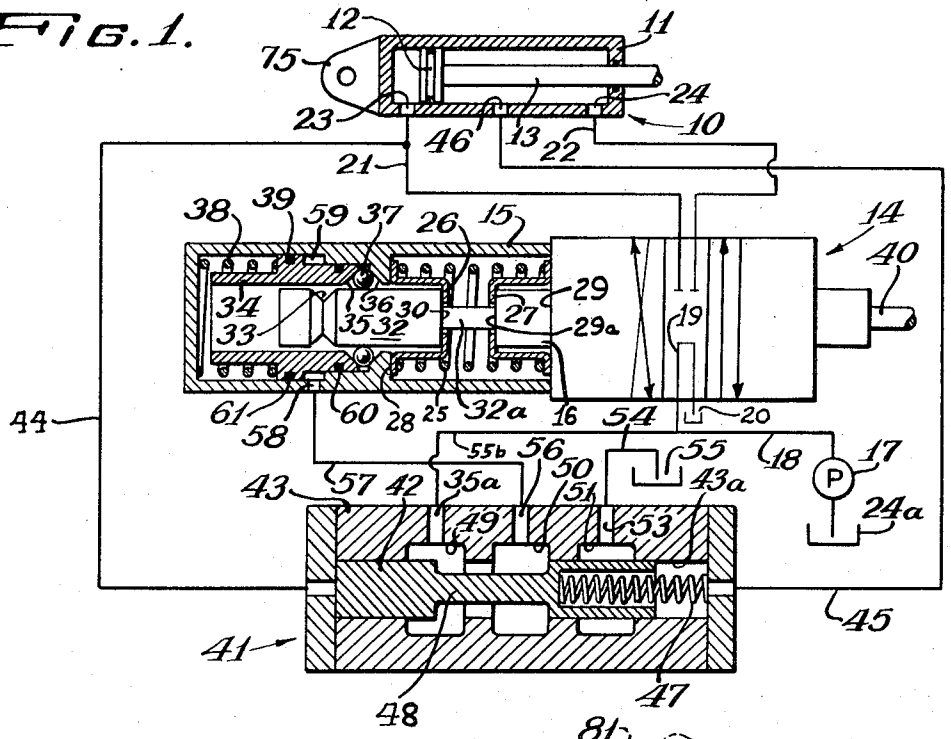
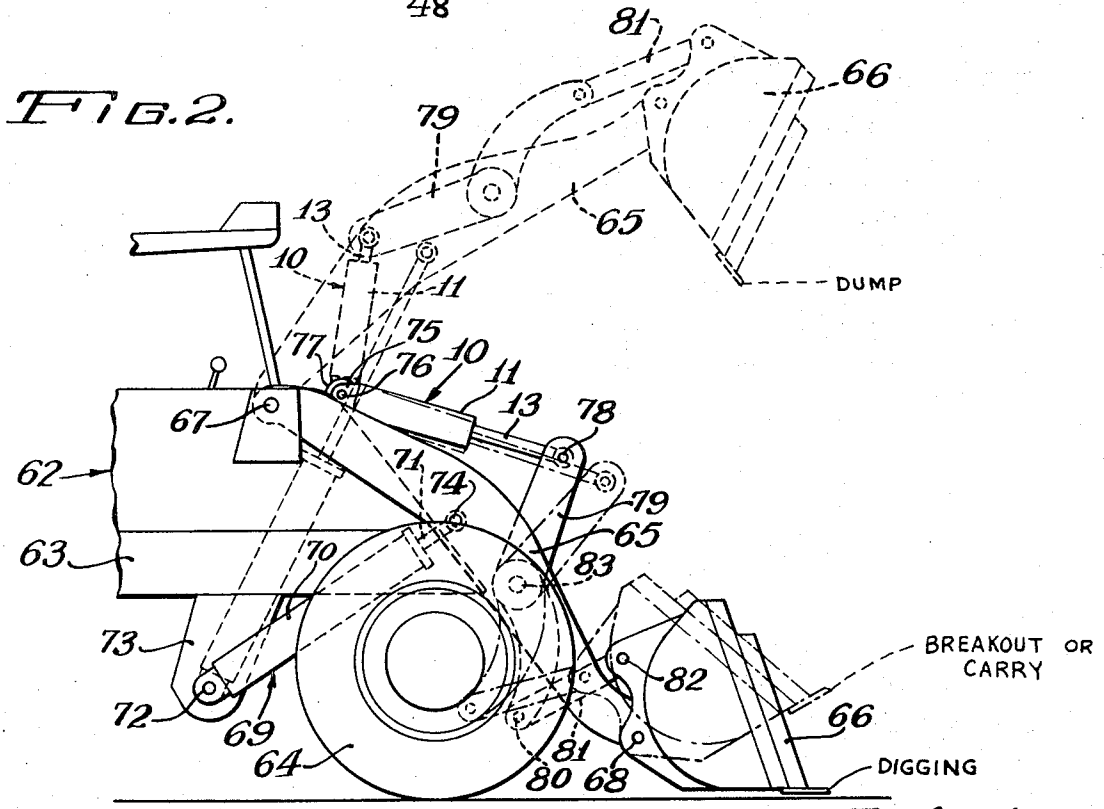


FIG. 2.



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AUTOMATIC BUCKET POSITIONING DEVICE

The present invention relates to automatic positioning by hydraulic means. More particularly, the invention relates to the use of hydraulic means for automatically placing a device in an intermediate position between extreme positions.

The digging bucket of a tractor loader may have three positions with respect to the pivoted boom arm carrying the bucket: (1) a dumping position normally used with the boom arm raised for unloading the bucket, (2) a breakout or carry position well displaced from the dumping position, and (3) a digging position so located between the dumping and breakout positions that the bottom edge is parallel to the ground, and normally used in lowered position of the boom arm for enabling the bucket to dig and load itself with material.

It is highly desirable, for the sake of facilitating operation of the tractor loader, for the bucket to assume its intermediate digging position automatically. It is known to employ mechanical devices for this purpose, but such devices are cumbersome and may add appreciably to the burden of the accessory equipment to which a tractor loader is already subjected.

According to the present invention, automatic positioning at an intermediate location is accomplished by hydraulic means that operate in conjunction with a hydraulic power unit already present for shifting to and between various positions of adjustment.

More particularly, I have invented an hydraulic power system primarily adapted for use on a tractor loader, the loader having a pivoted bucket, and having a pivoted boom which is pivotally carried by the tractor and which pivotally carries the bucket. The hydraulic power system provided according to my invention includes an extensibly and foreshortenably movable pressure piston connected to the pivoted bucket; a self neutralizing control valve hydraulically disposed between the piston and a source of high and low pressure, and manually movable between an extreme extended position to hydraulically direct piston movement into extreme extension, and an extreme depressed position to hydraulically direct piston movement into extreme foreshortening; the valve neutralizing in an intermediate position hydraulically locking the piston part way in its movement of extension; a pressure tap hydraulically connected to the piston, sensing and signalling when the piston is part way in its movement of extension; a ball detent to detent the valve in the extreme extended position directing the piston to extend; and mechanism responsive to the signal of the piston so moving part way, to kick out the detent whereby the valve neutralizes, interrupting the movement of extension of the piston and forthwith locking same.

The kick-out mechanism just referred to includes a depression movable by the valve into positions corresponding to positions of the latter; the depression, in the position corresponding to the neutralized valve intermediate position confronting smooth means inactive in character; the depression, in the position corresponding to the extreme valve extended position directing piston movement into extreme extension, confronting the detent which actively protrudes into the depression and which detents the valve in the described way; the depression, in the position corresponding to the extreme valve depressed position directing piston movement into extreme foreshortening, confronting smooth means inactive in character so that the valve detenting occurs in moving the piston in the one direction only.

The foregoing operation results in: the piston moving the bucket full forward into extreme dump position when the valve is manually sustained in the extreme depressed position hydraulically directing piston movement of foreshortening; the piston moving the bucket full back into the extreme carry position when the valve is manually sustained in the extreme extended valve position hydraulically directing piston movement of extension; and the piston pivoting and holding the bucket in an intermediate position for digging when the valve is sustained in the released automatically from the just said extreme extended valve position.

The present invention is illustrated and described to show its use in automatically positioning a digging bucket with respect to a boom arm, but may have various other uses, including bringing the boom arm to some intermediate position with respect to a tractor on which the boom arm is mounted.

IN THE DRAWINGS

FIG. 1 is a diagrammatic and sectional view of the hydraulic system of the present invention; and

FIG. 2 is a partial elevational view of a tractor loader to which the present invention is applied.

As shown in FIG. 1, a hydraulic power unit **10** comprises a cylinder **11**, a piston **12** slidably mounted in the cylinder, and a rod **13** secured to the piston **12** and projecting from one end of the cylinder **11**. A control valve **14**, which comprises a stationary housing **15** and a movable spool **16** slidably mounted in the housing **15** is connected with a pump **17** by a line **18**, by a line **19** with drain indicated at **20**, and by lines **21** and **22** with openings **23** and **24**, respectively, in the cylinder **11** adjacent its opposite ends. When the spool **16** is in the central position shown, the lines **18** and **19** are connected with one another so that the pump **17** takes hydraulic fluid from drain indicated at **24a** and returns the fluid directly by way of lines **18** and **19** to drain at **20**. In the central position of spool **16**, lines **21** and **22** are blocked so that the position of the piston **12** in the cylinder **11** is fixed. When the spool **16** of the control valve **14** is displaced to the right as viewed in FIG. **1** from the position shown in this figure, the piston **12** moves to the right as viewed in FIG. **1**, because the left end of the cylinder **11** is connected with the pump **17** by way of lines **18** and **21**, and the right end of the cylinder with drain at **20** by way of lines **22** and **19**. When the spool **16** is displaced to the left as viewed in FIG. **1** from the position shown, the lines **21** and **22** are reversed in their connections to pump line **18** and drain line **19**, and so the piston moves to the left as viewed in FIG. **1**.

The spool **16** of the control valve **14** is yieldingly held in the central position shown in FIG. **1** by means of a coil spring **25** and two cup-like members **26** and **27**. The ends of the coil spring **25** act against outwardly directed flanges on the members **26** and **27**, urging them against shoulders **28** and **29**, respectively, formed on the housing **15** of the control valve **14**. Perforated bases of the members **26** and **27**, respectively, engage shoulders **29a** and **30** formed, respectively, at junctures

of the spool 16 and an extension 32 thereof with a reduced portion 32a. The extension 32, which may be of the same diameter as the spool 16, is spaced from the spool by the reduced portion 32a. The extension 32 has an annular peripheral groove 33 serving as a ball detent pocket and defined by opposed conical surfaces. A sleeve 34 which is mounted in the body 15 of the control valve 14 so as to slide therein, loosely receives the extension 32 of the spool 16 and has at one end a conical surface 35. The body 15 of the control valve 14 has a conical surface 36 which faces the conical surface 35 on the sleeve 34. A plurality of detent balls 37 which are distributed about the extension 32 and may be four in number, lie between the conical surfaces 35 and 36 in engagement therewith. A coil spring 38 surrounds the sleeve 34 and has one end in engagement with the inside of one end of the valve housing 15 and the other end in engagement with an external peripheral flange 39 formed on the sleeve 34. Coil spring 38 urges the conical surface 35 against the balls 37 and the balls 37 against the conical surface 36.

The control valve 14 may be shifted manually from the neutral position of FIG. 1, by action against an external end portion 40. Control valve 14 is also regulated by a pilot valve 41 which comprises a movable spool 42 and a stationary housing 43 having a central bore 43a in which the spool 42 is slidably mounted. One end of the pilot valve 41 is connected with the end of the cylinder 11 of the hydraulic power unit 10 where the opening 23 is located, by means of a line 44 connected to the line 21. The other end of pilot valve 41 is connected by a line 45 with an opening 46 in the cylinder 11 at an intermediate or mid-region thereof. A coil spring 47, which engages the inside of the end of the housing 43 where the line 45 is connected, and a deep recess in the facing end of the spool 42, urges the spool to the position of FIG. 1, in which it engages the inside of the end of the housing 43 where the line 44 is connected. The spool 42 has a relatively long reduced portion 48 at an intermediate region. The body 43 of the pilot valve 41 has three axially spaced annular grooves 49, 50, and 51 formed about the bore 43a in which the spool 42 is mounted. The groove 51 is connected by a passage 53 in the body 43 and a line 54 with drain indicated at 55. The groove 49 is connected to the pump line 18 by a passage 35a in the body 43 and a line 55b leading therefrom. The groove 50 is connected by way of a passage 56 in body 43, a line 57, and an opening 58 in the body 15 of control valve 14, with a chamber 59 in the body. The chamber 59 is formed between sleeve 34, the body 15, flange 39 on sleeve 34, and a shoulder in body 15 facing flange 39. Seals 60 and 61 for the chamber 59 are located in external annular grooves formed in the sleeve 34 and its flange 39.

Let us consider the pressure conditions at various points of the apparatus just described for the position shown in FIG. 1. The pressure in the head end of the cylinder 11 and in line 21 slightly exceeds the pressure in line 22 and in the rod end of the cylinder 11 at all times when the bucket 66 is past center relative to a bucket pivot 68 hereinafter described. The spool 16 of the control valve 14 is in its middle position in which the lines 21 and 22 leading to the ends of the cylinder 11 of the hydraulic power unit 10 are blocket, so that the piston 12 is held against movement in the cylinder 11. The spool 42 of pilot valve 41 is pushed by the spring 47 against the left end of the housing 43, because the lines 44 and 45 leading to the ends of the pilot valve 41 are at the same pressure. With the spool 42 thus positioned, pump pressure exists in the chamber 59 formed between the sleeve 34 and the housing 15, because the chamber 59 is connected with the pump 17 by way of the lines 18 and 55*b*, passage 35*a*, groove 49, reduced portion 48 of spool 42, groove 50, passage 56, line 57 and opening 58. Thus, the sleeve 34 is urged to the left as viewed in FIG. 1 against the spring 38 to provide room for the balls 37 between the conical surfaces 35 and 36.

If now the piston 12 is to be moved to the right as viewed in FIG. 1, the spool 16 of control valve 14 is moved to the right so that the line 21 is connected to the pump 17 and the line 22 to the drain 20. As a result, the piston 12 starts its movement to the right. At this time, the piston 12 is to the left as viewed in FIG. 1 of the centrally located opening 46 in the cylinder 11, and the line 22 is thus connected to the line 45 across the space in the cylinder 11 to the right of the piston 12. Since line 22 is at drain pressure, line 45 is also at drain pressure. At the same time, the pump pressure existing in the line 21 also exists in the line 44 by virtue of the connection of the two lines with one another. Thus, the difference between the pump pressure transmitted by the line 44 to the left end of the pilot valve 41 and the drain pressure transmitted to the right end of the pilot valve results in rightward movement of the spool 42 as viewed in FIG. 1. With such movement, the region of spool 42 to the left of reduced portion 48 disconnects grooves 49 and 50 from one another and so cuts off the chamber 59 from the pump 17; at the same time, the reduced portion 48 connects the grooves 50 and 51 with one another and thereby opens the chamber 59 to the drain 55. So now the chamber 59 in the control valve 14 tends to collapse under the action of the spring 38 which tries to move the conical surfaces 35 and 36 toward one another. Rightward movement of the spool 16 of the control valve 14 will meantime have brought the groove 33 in the extension 32 on the spool 16 to the balls 37. The conical surfaces 35 and 36 trying to move toward one another by action of the spring 38 with collapse of the chamber 59 as previously described, seat the balls 37 inwardly into the groove 33. The result is a detent action or holding by the balls 37 and groove 33 of he spool 16 of the conical valve 14 in its rightwardly displaced position.

When the piston 12 is moved sufficiently to the right as viewed in FIG. 1, in the cylinder 11, the piston passes the mid-opening 46 formed in the cylinder 11. The result is that the line 45 is now connected at pump pressure by virtue of the connection of the lines 45 and 21 with one another across the openings 23 and 46 in the cylinder 11 and the space therein to the left of the piston 12. Now, lines 44 and 45 connected to the opposite ends of the pilot valve 41 are both at the same pump pressure, and so the spring 47 in the pilot valve 41 returns the spool 42 to the position of FIG. 1. Now the reduced portion 48 of the spool 42 connects the grooves 49 and 50 in the pilot valve 41 with one another, rather than the grooves 50 and 51, and so the chamber 59 in the control valve 14 is connected to the pump 17, rather than to the drain 55. The result is that

the sleeve 34 moves to the left as viewed in FIG. 1, moving the conical surfaces 35 and 36 apart and allowing the balls 37 to move outwardly out of the groove 33 in the extension 32 of the spool 16 of the control valve 14. Now, the spring 25 returns the spool 16 to the position of FIG. 1 with the result that the control valve 14 blocks the lines 21 and 22, and the piston 12 is stopped against further movement to the right as viewed in FIG. 1 in the cylinder 11.

If the piston 12 is to be moved to the right as viewed in FIG. 1 more than just beyond the mid-opening 46 in the cylinder 11, the spool 16 of the control valve 14 is manually held by engagement with the reduced end 40 on the spool 16 in the rightwardly displaced position. Thus, the release of the balls 37 from the groove 33 due to resumption of pump pressure in the chamber 59 is ineffective to return the spool of the control valve 14 to blocking position.

Reference is now made to FIG. 2 for a description of a tractor loader 62 to which the previously described hydraulic apparatus of the present invention may be applied. The tractor loader 62 comprises a body 63, front wheels 64, one being shown, a boom arm 65, and a digging bucket 66. The rear end of the boom arm 65 has a pivot 67 on the tractor body 63. The bucket 66 has a pivot 68 on the front end of the boom arm 65. The boom arm 65 is raised from a lowered full-line position to a raised dotted-line position by means of a hydraulic power unit 69 comprising a cylinder 70, a piston (not shown) slidably mounted in the cylinder 70, and a rod 71 secured to the piston and projecting from the cylinder 70. The cylinder 70 has a pivot 72 on a depending bracket 73 secured to the underside of the tractor body 63. The piston rod 71 has a pivotal connection 74 with a mid-region of the boom arm 65.

The hydraulic power unit 10 is used to control the position of the digging bucket 66 with respect to the boom arm 65. The cylinder 11 of the power unit 10 has an end flange 75 which has a pivotal connection 76 with a bracket 77 secured to the tractor body 63. The piston rod 13 of the power unit 10 has a pivotal connection 78 with one end of a lever 79. The other end of the lever 79 has a pivotal connection 80 with a link 81, which in turn has a pivotal connection 82 with the digging bucket 66. A mid-region of the lever 79 has a pivot 83 on the boom arm 65.

When the arm 65 is raised to the dotted-line position of FIG. 2, dumping by the bucket 66 will occur when it is swung to the dotted-line position. In the dumping position of the bucket 66, the piston 22 of the hydraulic power unit 10 will occupy a position somewhat as shown in FIG. 1; that is, it will be at or near the left end of the cylinder as viewed in FIG. 1.

DUMP POSITION: BUCKET FULL FORWARD

The bucket goes full forward with movement of the piston 12 fully retracted to a corresponding dump position. Movement of the piston 12 to this position will have been brought about by leftward depression as viewed in FIG. 1 of the spool 16 of the control valve 14, with the connection of the line 22 to the pump 17 and the line 21 to the drain 20.

In digging position, the bucket 66 will be as shown in full lines in FIG. 2. In breakout or carry position, the bucket 66 will be in the lower dotted-line position, displaced counterclockwise somewhat beyond the full-line position of FIG. 2. It will be observed that when considered with reference to the boom arm 65, the digging bucket 66 will occupy the extreme dumping and carry positions and also the intermediate position which is angularly between the dumping and carry positions.

TWO STAGE: LOAD-CARRY POSITIONS

The load position is taken in the first stage.

The piston 12 is so connected and adjusted with respect to the digging bucket 66 through the piston rod 13, the lever 79, and the link 81 that the digging bucket 66 is properly angled with respect to the boom arm 65 so as to assume digging position in the lowered position of the boom arm when the piston 12 of the power unit 10 has moved in the cylinder 11 to the right as viewed in FIG. 1 just beyond the opening 46 in the cylinder 11. The movement of the piston 12 to the right just beyond the opening 46 switches the line 45 from drain pressure to pump pressure, thus equalizing the pressures in the lines 44 and 45 connected to the ends of the pilot valve 41 and returning the spool 42 thereof to the position of FIG. 1 and applying pump pressure to the chamber 59 in the control valve 14, with the result that the spool 16 of the control valve 14 is returned to the blocking position of FIG. 1 in which blocking of the lines 21 and 22 by the control valve 14 holds the piston 12 against further rightward movement.

The carry position is taken in the second stage. The operator pulls the control valve from the centered position to the fully extended position, retracting the bucket full back to the carry position.

CARRY POSITION: BUCKET FULL BACK AT ONCE

If the digging bucket 66 is to be moved straightway from full forward to the full back, carry position, the spool 16 of the control valve 14 is moved to the right as viewed in FIG. 1 and held there, producing connection of the line 21 and the line 22 to pump pressure and drain pressure, respectively, and further movement of the piston 12 to the right as viewed in FIG. 1, in spite of the fact that the spool 42 of the pilot valve 41 returns to, or fails to move out of the position of FIG. 1, because of equality of pressures in lines 44 and 45, due to the location of the piston 12 to the right of opening 46 in cylinder 11.

BUCKET FORWARD STAGE

The drawings do not illustrate the invention applied in the bucket forward stage, which would have definite advantages but would only be employed as a single stage operation. Instead, in the actual example illustrated here, the invention is illustrated as applying to pivoting and automatically stopping the bucket in only the bucket back direction.

For the bucket back movement just referred to, it will be evident that movement of the pressure tap 46 to a different placement on the cylinder's length will change the precise position at which back movement is stopped and the bucket is hydraulically locked. And self-evidently for purposes of the bucket forward, single stage movement earlier referred to, movement of

the ball **37** and associated mechanism to the opposite side of the pocket **33** along with an appropriate change in hydraulic connections will change the two stage action so that the full forward movement of the bucket can be the movement automatically interrupted, if desired.

The automatic assumption of digging position by the bucket **66** facilitates operation of the tractor loader **62**. This is because the operator of the loader need concern himself only with the lowering of the boom arm **65** to the ground to position the bucket **66** for digging; he is freed of the chore of accurately angling of the bucket **66** with respect to the arm **65**, because indexing the bucket to the desired angle is automatically brought about by adjustment of the connection of the lever **79** and link between the bucket **66** and the piston rod **13**. The operator is merely required, just before or during lowering of the boom arm **65** by actuation of the power unit **69**, to move the spool **16** of the control valve **14** to the right as viewed in FIG. **1** a sufficient time and distance for the spool **16** to be held in its rightwardly displaced position by engagement of the ball detents **37** with the groove **33** on the extension **32** of the spool **16**.

What is claimed is:

1. A loader comprising:

a. a tractor,

b. a boom arm having one end pivotally connected with the tractor for movement of the other end between a lowered position adjacent the ground and an elevated position removed from the ground,

c. a bucket connected with said other end of the arm for movement with respect to said arm between a dumping position and a break-out position and across a digging position located between the dumping and break-out positions,

d. a power unit comprising a cylinder having one end connected to the boom arm, a piston slidably mounted in the cylinder, and a rod secured to the piston and projecting from the other end of the cylinder to an operative connection with the bucket for pivoting the same,

e. a control valve having connections with the ends of the cylinder, a source of fluid under pressure, and drain,

f. means for biasing the control valve to a first setting in which the connections to the ends of the cylinder are blocked and the source is connected with drain,

g. manual means for bringing the control valve to a second setting in which the said one end of the cylinder is connected to the source and the said other end to drain and to a third setting in which the connections of the ends of the cylinder to the source and drain are reversed.

h. means for holding the control valve in its second setting;

i. a pilot valve for regulating the holding means, having one end connected to the said one end of the cylinder and the other end connected to an intermediate region thereof so as to be sensitive to pressure in the cylinder at said one end and said intermediate region, and

j. lines connecting the pilot valve to the source and drain independently of the control valve.

2. The loader specified in claim **1** and further comprising a spring for actuating the holding means in the second setting of the control valve,

such actuation being enabled to occur in the second setting by virtue of the connection of the holding means via the pilot valve with drain, said connection being produced by the sensing of source pressure at the said one end of the pilot valve through connection of the said one end of the cylinder via the control valve with the source and by the sensing of drain pressure at the said other end of the pilot valve through location of the piston between the said one end and the mid-region of the cylinder and connection of the said other end of the cylinder via the control valve with drain,

the passage of the piston just beyond the said mid-region of the cylinder toward the said other end thereof occurring with arrival of the bucket in digging position and switching the sensing at the said other end of the pilot valve from drain pressure to source pressure and thereby producing a connection of the holding means via the pilot valve with the source, resulting in releasing the holding means.

3. In a tractor loader having pivoted bucket means adapted to be pivotally carried, and pivoted boom means which is pivotally carried by the tractor and which pivotally carries the pivoted bucket means:

hydraulic power system comprising an extensibly and foreshortenably movable, line-pressure-actuated piston connected to one of said pivoted means;

a source of line pressure and low pressure;

self neutralizing control valve hydraulically disposed between the piston and source, manually movable between a lst extreme position to hydraulically direct a first of piston movements into extreme extension or extreme foreshortening and a 2nd extreme position to hydraulically direct the opposite piston movement into extreme extension or extreme foreshortening; said valve neutralizing in an intermediate position hydraulically locking the piston partway in a movement;

means hydraulically connected to the piston, sensing and signalling when it is partway in at least the first of the extreme piston movements; said hydraulically connected means comprising a port in the path of travel of the piston in an area intermediate the ends of such travel, so as to be exposed to line pressure by the piston when uncovered thereby, and an hydraulic line connected to and communicating from the port an hydraulic line pressure signal when sensed by the port;

a detenter to detent the valve in the extreme valve position directing the piston in at least the first movement; and

signal responsive means connected to the hydraulic line so as to be responsive to the line pressure signal of the piston moving partway as aforesaid, to kickout the detenter whereby the valve neutralizes, interrupting at least the first movement of the piston and forthwith locking same.

4. The invention of claim **3**, the responsive means characterized by:

a depression movable by the valve into positions corresponding with positions of the latter

said depression in the position corresponding to the neutralized-valvesintermediate position, confronting smooth means inactive in character;

said depression, is the position corresponding to the extreme valve position directing the piston in its first movement, confronting a detent in the detenter active to protrude into the depression and detent the valve in the described way;

said depression, in the position corresponding to the extreme valve position directing the piston in said opposite movement, confronting smooth means inactive in character so that valve detenting occurs in moving the piston in one direction only.

5. The invention of claim 4,

the piston pivoting said pivoted bucket means full forward into the extreme dump position when the valve is manually sustained in an extreme position hydraulically directing said opposite piston movement;

the piston pivoting the bucket means full back into the extreme carry position when the valve is manually sustained in an extreme valve position hydraulically directing the first piston movement, the piston pivoting and holding the bucket means for digging when the valve is sustained and released automatically in the just said extreme valve position.

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