United States Patent [19]

Fuzzell

[11] **3,883,783**

[45] **May 13, 1975**

[54] **ELECTRONIC COMPONENT POSITIONER FOR LOADER VEHICLES AND THE LIKE**

[75] Inventor: **Joe E. Fuzzell**, Peoria, Ill.

[73] Assignee: **Caterpillar Tractor Company**, Peoria, Ill.

[22] Filed: **Nov. 2, 1973**

[21] Appl. No.: **412,208**

Related U.S. Application Data

[62] Division of Ser. No. 287,604, Sept. 11, 1972, Pat. No. 3,782,248.

[52] **U.S. Cl.**..... **317/148.5 R**; 307/252 R; 307/254

[51] **Int. Cl.** **H01h 47/32**

[58] **Field of Search** .. 317/135 A, 148.5 B, 148.5 R; 307/252 R, 254

[56] **References Cited**

UNITED STATES PATENTS

2,331,108	10/1943	Ganahl	91/358 A
3,151,311	9/1964	Spector et al	317/135 A
3,420,393	1/1969	Omon	91/358 A
3,524,562	8/1970	Fuzzell	214/762
3,667,723	6/1972	Schneider	91/358 A

Primary Examiner—L. T. Hix

Attorney, Agent, or Firm—Phillips, Moore, Weissenberger, Lempio & Strabala

[57] **ABSTRACT**

A conventional hydraulic fluid pump is hydraulically coupled bia a self-centering control valve means to a hydraulic cylinder having a reciprocatable cylinder rod coupled to a vehicle component. An electromagnet is disposed to latch the control valve means in a selected position when energized. Switch means is secured to the hydraulic cylinder, and means for actuating the switch means is secured to the cylinder rod for translation therewith. A logic circuit is connected to the switch means and to the electromagnet, whereby the electromagnet is energized in response to the degree of movement, and a first direction of movement, of the cylinder rod to latch the control valve means. The electromagnet is deenergized via the switch means and the means for actuating, when the cylinder rod reaches a preselected position proceeding from the opposite direction. This unlatches the control valve means which allows it to seek its self-centered position. Thus, fluid flow to the hydraulic cylinder ceases when the vehicle component reaches a preselected position.

3 Claims, 3 Drawing Figures

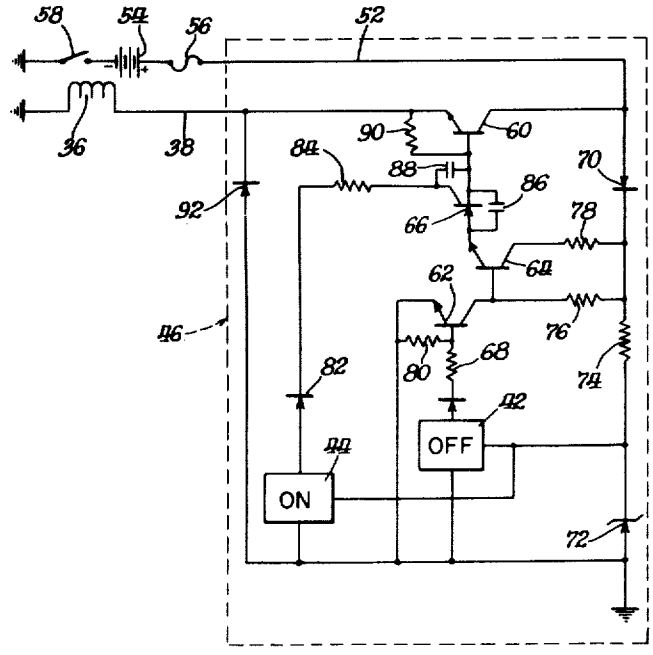


Fig. 1

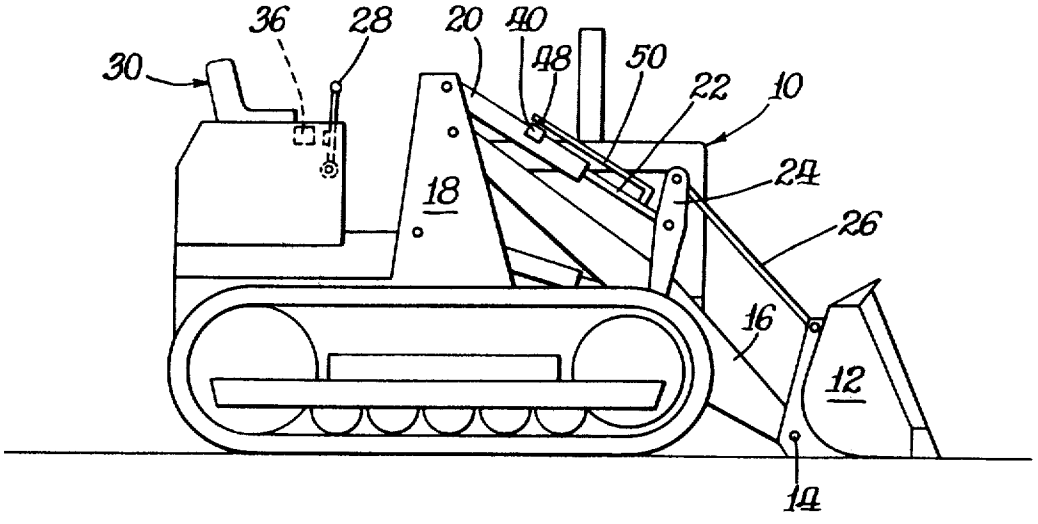

36
28
20
40
48
50
22
10
30
18
24
26
16
12
14

Fig. 2

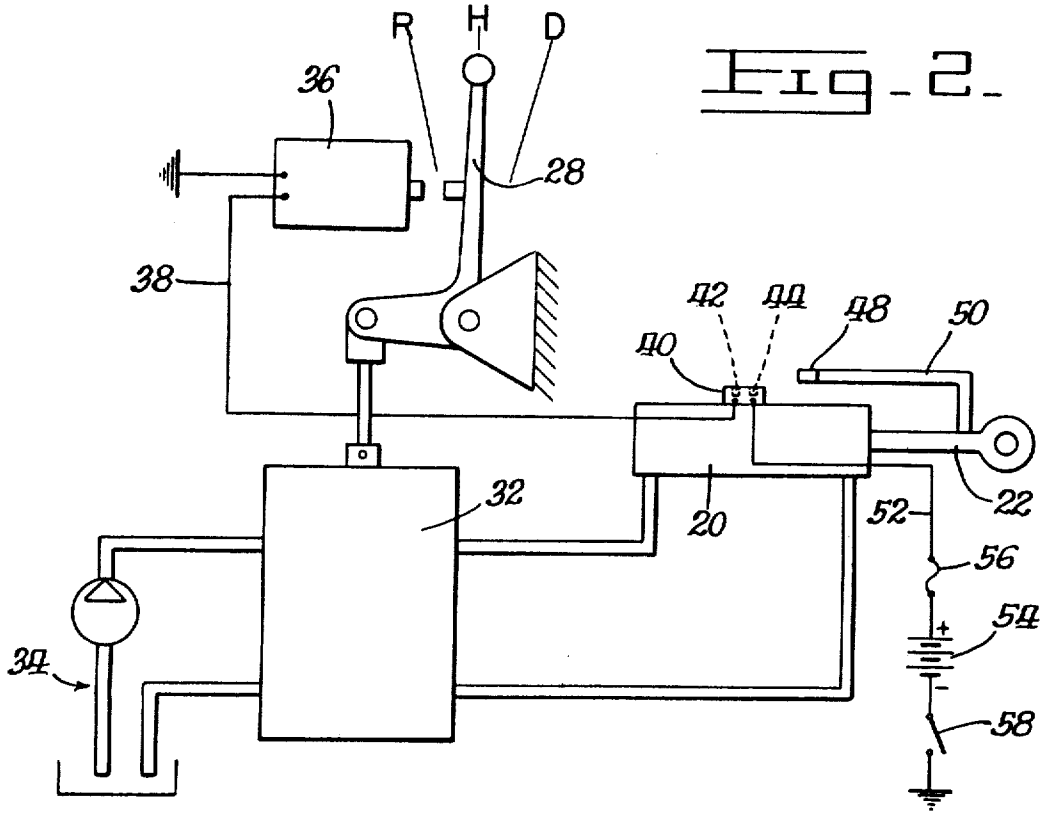
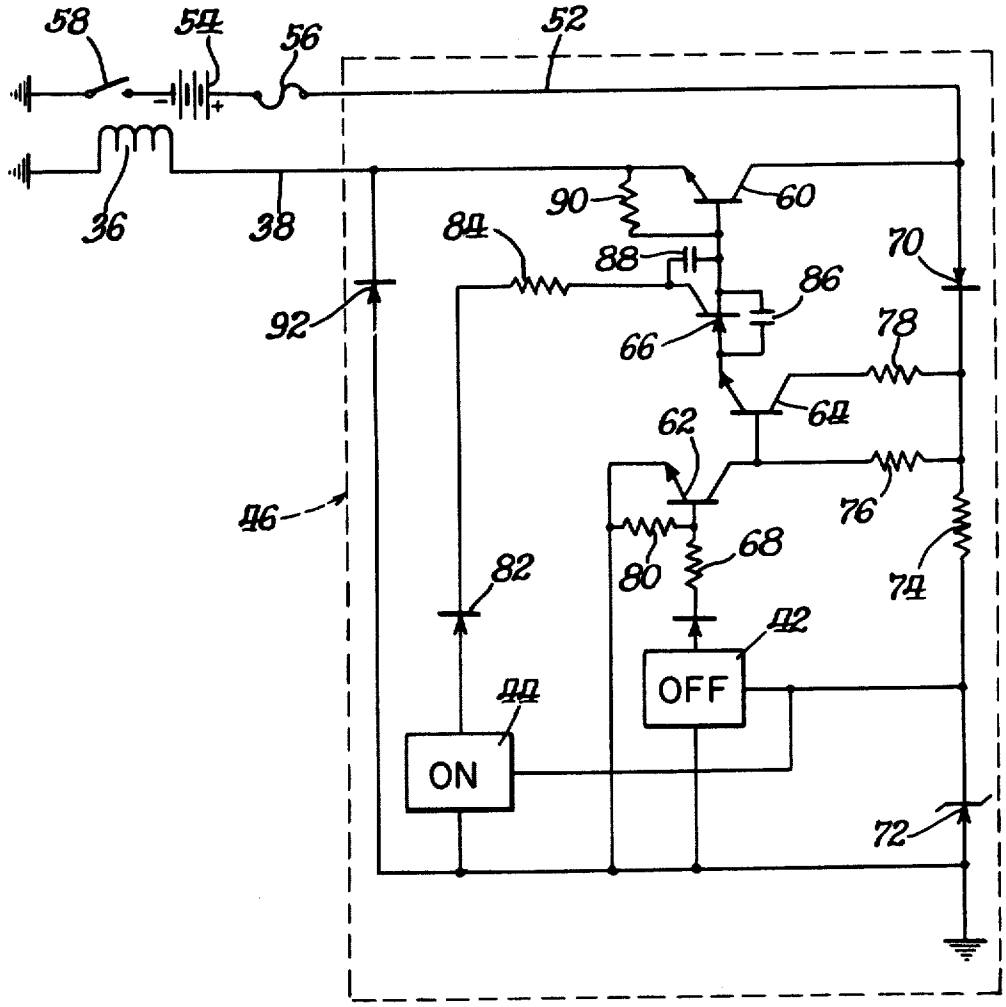

R
H
D
36
28
38
42
44
48
50
40
32
20
22
52
56
54
34
58

Fig. 3


58
54
56
52
36
38
90
60
84
88
70
86
92
66
78
64
62
46
76
82
80
68
74
42
OFF
44
ON
72

ELECTRONIC COMPONENT POSITIONER FOR LOADER VEHICLES AND THE LIKE

This is a division, of Ser. No. 287,604, filed Sept. 11, 1972, now U.S. Pat. No. 3,782,248.

BACKGROUND OF THE INVENTION

1. Field

The invention relates to an electronically operated positioning system for selectively and automatically positioning buckets, blades, or other vehicle components on heavy equipment vehicles and the like.

2. Prior Art

Various types of control systems have been contemplated for providing automatic positioning of various vehicle components; for example, a bucket on a bucket loader, etc. Typically, such positioning systems are hydraulically, mechanically or electrically controlled.

Hydraulic positioning systems suffer from control problems when malfunctions occur in the hydraulic system. For example, a leak in the slave cylinder or in the hydraulic circuits can cause bucket drifting ranging from slight movement to drifting simulating a slow dump. A broken supply line almost completely incapacitates the positioning control system. External repairs are time-consuming, particularly if the line to the tank has to be replaced. If an internal repair or adjustment has to be made in the hydraulic system, it is generally necessary to drain the hydraulic tank, which causes excessive down-time.

Electrical positioning systems overcome most of the inherent problems of the above-mentioned hydraulic systems, in that they are more reliable, more readily serviced, and are external and thus independent of the main hydraulic apparatus. However, most electrical positioning systems utilize micro-switch means mechanically coupled to cams, recessed rods, etc., attached to the positioning hydraulic cylinder to indicate the position of the bucket. See for instance, U.S. Pat. No. 3,420,393. Thus, the combination is subject to wear, dirt, vibration, etc., common to earthmoving apparatus, with the associated maintenance and breakdown problems.

In addition, prior art electrical positioning systems fail to provide desired functioning flexibility in that no provisions are made to allow the operator to readily perform various operations, e.g., as when "fish tailing", etc., the bucket. Typical prior art electrical positioning systems provide the disadvantage of latching the operator controls in the "rack-back" position whenever the control lever is moved to the latter position, as when fish tailing. The operator must then manually override the latched condition. Accordingly, the operator must avoid moving the control lever to the rack-back position if he does not wish the lever to be held in such position, which complicates the operator's handling of the vehicle, for example, as when performing the fish tailing action.

SUMMARY OF THE INVENTION

The invention provides an improved solid state electronic control circuit for controlling the tilt, position, attitude, etc., of a selected component on a loader, grader, vehicle and the like. To this end, a control lever is coupled to a self-centering control valve, which selectively directs hydraulic fluid to a tilt cylinder having a reciprocatable rod coupled to the vehicle component. An electromagnet is disposed to hold or latch the lever in the rack-back position when energized. The electromagnet is coupled to a solid state switch assembly, which contains a pair of adjacent, normally open switches, and a logic circuit adapted to distinguish the component operating mode and to selectively provide energizing current to the electromagnet. The pair of switches are adapted to close when placed in a magnetic field, which is selectively provided by a permanent magnet secured to the end of a rod which is, in turn, secured to the reciprocatable cylinder rod. The magnet passes adjacent the switches as the cylinder rod reciprocates.

During the rod extension, the magnet successively passes adjacent the pair of switches in one direction, which causes the solid state logic circuit to energize the electromagnet. When the control lever is then placed in the rack-back position, it is held in such position by the electromagnet. Deenergization of the electromagnet occurs via the logic circuit when the hydraulic rod is retracted, whereby the permanent magnet passes adjacent the switches in the opposite direction. The control valve and the control lever returns to a neutral position, whereupon further movement of the hydraulic rod, and thus of the component, ceases. Selected placement of the permanent magnet with respect to the degree of extension of the hydraulic rod determines the preselected position, tilt, orientation, etc., of the vehicle component being controlled.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a simplified elevation of a track-type loader vehicle with loader bucket, and of the basic arrangement of the invention component positioner.

FIG. **2** is a simplified electrohydraulic schematic of one embodiment of the invention combination.

FIG. **3** is a schematic diagram of the logic control circuit depicted in block schematic in FIG. **2.**

DESCRIPTION OF THE PREFERRED EMBODIMENTS

As shown in FIG. **1,** a track-type loader **10** has a bucket **12** pivotably supported as at **14** by one end of a pair of laterally spaced lift arms, only one of which is shown at **16.** The lift arms **16** are pivotally secured at their opposite ends to a pair of laterally spaced towers integrally secured to the loader frame, one of which is indicated at **18.** A hydraulic tilt cylinder **20,** having an extendable cylinder rod **22,** is pivotally intercoupled between each tower **18** and the bucket **12** via tilt linkage, which includes a lever **24** pivotally mounted to lift arm **16** and a link **26** connecting the lever **24** to the bucket **12.**

Regarding more particularly the invention positioner apparatus, and referring to FIGS. **1** and **2,** a manually operable, control lever **28** is located adjacent an operator's station **30,** and is operably connected to a spring actuated, self-centering control valve **32.** The latter is designed to selectively direct hydraulic fluid from a pump source **34** (FIG. **2**) to the tilt cylinder **20,** to control the position of the bucket **12.** An electromagnet **36** is suitably located, whereby the control lever **28** can be pivoted against the electromagnet and thus be held in the "R" or rack-back position when the electromagnet is energized.

The electromagnet **36** is connected by a lead **38** to a switch assembly **40,** containing a pair of spaced-apart switches **42,44.** The switch assembly **40** further in-

cludes a logic control circuit **46** (FIG. 3) which detects the bucket operating mode and provides current to selectively energize the electromagnet at predetermined periods during the bucket position and in response to its direction of motion.

Switches **42,44** are preferably solid state switches which operate via the Hall effect, and conduct current when placed in a magnetic field. In accordance with the invention, a magnetic field is provided by a permanent magnet **48** secured to the end of a control rod **50**, where the latter is demountably attached at its other end to the extendable cylinder rod **22**. The control rod **50**, with attached magnet **48**, is disposed to pass adjacent the switches **42,44** as the rod **22** is extended and retracted.

Extension of rod **22** from the fully retracted rackback position to the dump position, causes the magnet **48** to pass over switches **42** and **44** from left to right on the schematic of FIG. **2**. As will be more fully explained with respect to a detailed description of the logic circuitry of FIG. **3**, this action permits current to flow to the electromagnet **36**.

Upon completion of the dump operation, the operator places the control lever **28** in the R position, and since the electromagnet **36** is energized, the lever **28** will remain in this position until released by cessation of current to the electromagnet. Deenergization of the electromagnet **36** is provided by passage of magnet **48** over the switches **44,42** from right to left on the schematic, as the rod **22** retracts to rotate the bucket **12** back from the dump position. The self-centering spring of the hydraulic control valve **32** urges the control lever **28** to the "H" or hold position, stopping further retraction of the cylinder rod **22** and thus further movement of the bucket **12**. Suitable placement of the magnet **48** with respect to the position of the hydraulic rod **22** will assure that the bucket **12** is stopped in the proper loading position to begin the next work cycle.

The solid state switch assembly **40** is connected by a lead **52** to the positive terminal of a battery **54**. A fuse **56** is inserted between the assembly and the battery for circuit overload protection. The electromagnet **36** and the negative terminal of the battery are grounded. A hydraulic system pressure switch **58** is disposed between the battery and ground, and remains closed during the operation of the vehicle, but automatically functions to break the circuit when the vehicle is shut down. Similarly, the switch **58** may be operated by engine oil pressure, or other operating parameters. Additional switches, such as a master disconnect switch (not shown) may also be placed in the circuit as required.

A schematic diagram of an embodiment of the logic circuit **46** contained within the solid state switch assembly **40** is shown in FIG. **3**. A transistor **60** is disposed between the positive lead **52** and the lead **38** extending to electromagnet **36**. Transistor **62** has a grounded emitter and its base is connected through limiting resistor **68** and normally nonconducting switch **42** to ground. The collector of transistor **62** is connected to the base of the transistor **64**. The emitter of transistor **64** is connected through the silicon controlled rectifier (SCR) **66** to the base of the transistor **60**. A diode **70** providing reverse polarity protection, is disposed in the positive lead **52**.

A zener diode **72** is connected between the positive lead **52** and ground to provide a predetermined reference voltage to the normally nonconductive switches **42, 44**. A current-limiting resistor **74** provides protection for the zener diode **72**. Resistors **76** and **78** similarly serve to limit current through transistors **62, 64**. A resistor **80** is placed between the base of the transistor **62** and ground to prevent current leakage through the transistor by providing a reverse bias to the base when the switch **42** is non-conductive. A diode **82** and a limiting resistor **84**, placed between the switch **44** and the SCR **66**, provide high voltage and current protection respectively for the switch **44** when the SCR is conducting.

To prevent transient electric pulses from triggering the SCR **66**, a capacitor **86** is placed across the anode and cathode thereof, and a capacitor **88** is similarly placed across its gate and cathode.

To provide a reverse bias to the base of transistor **60** and thereby assure that the transistor remains in a nonconducting state when the SCR **66** is nonconducting, a resistor **90** is placed between the base of the transistor and the lead **38**. A diode **92**, placed between the lead **38** and ground serves to eliminate induced voltage from the electromagnet **36** whenever the current supplied to the electromagnet is interrupted.

By the above-described arrangement, a selected device, herein specifically shown as electromagnet **36**, can be energized or de-energized via a given voltage source, battery **54**, in response to conduction or nonconduction of a conductive device, silicon-controlled rectifier **66**. Leads **38** and **52** and transistor **60** comprise circuit means which are operatively associated with SCR **66** to couple the electromagnet **36** to battery **54** in response to conduction through SCR **66** and to uncouple electromagnet **36** from battery **54** upon termination of conduction through SCR **66**.

In operation, the above-described circuit functions in the following manner. With the bucket **12** loaded and in the rack-back position, rod **22** and consequently rod **50** attached thereto will be in retracted position. In the absence of a magnetic field in the proximity of the switches **42, 44**, the switches are nonconducting, thereby preventing the application of a positive voltage to the base of the transistor **60**. The absence of such a positive voltage prevents transistor **60** from conducting current to the electromagnet **36**.

The circuit is thus inactive, and the operator is thus free to move the control lever **28** to the "D" or dump position to empty the bucket **12**. The control valve **32** then directs pressurized fluid, as required, to the cylinder **20**, and rod **22** begins an outward extension.

During extension, the permanent magnet **48**, mounted on rod **50** which in turn is secured to rod **22** for integral movement therewith, first passes adjacent switch **42**. When magnet **48** is directly adjacent switch **42**, the switch will conduct current to the base of transistor **62** permitting the transistor to become conductive. Since the emitter is grounded, the collector and base of the transistor **64** will also be at substantially zero voltage potential. Transistor **64** will therefore be nonconductive. As the rod **22** continues its extension, the magnet **48** will move away from the switch **42**, whereby current is no longer conducted to the base of the transistor **62** and the latter transistor becomes nonconductive. As a result, a positive voltage is thus provided to the base of transistor **64**, permitting the transistor to conduct current to the anode of the SCR **66**.

The continued extension of hydraulic rod **22** will next bring the magnet **48** directly opposite the switch **44**

whereby current is conducted by the switch to the gate of SCR **66.** This will trigger the gate, enabling the SCR to conduct current to the base of the transistor **60.** The SCR will continue to conduct as long as a current flows therethrough. With a positive voltage thus provided at its base, transistor **60** conducts current to the electromagnet **36** to energize the latter.

After completion of the dump operation, when the operator is desirous of returning the bucket **12** to the proper dig position, the control lever **28** is moved to the R or rack-back position. As electromagnet **36** is now energized, the lever **28** is held in the rack-back position until the electromagnet is deenergized or until its holding force is manually overriden by the operator.

The bucket **12** returns from the dump position as rod **22** retracts. The magnet **48** first passes adjacent the switch **44** to once again supply current to the gate of the SCR **66.** Since the SCR is already conducting this action has no effect on the operation of the circuit, and the electromagnet **36** remains energized. As the rod **22** continues its retraction, the switch **44** opens again. As magnet **48** passes directly adjacent the switch **42** it becomes conductive, and a positive voltage is supplied to the base of the transistor **62.** The latter transistor thus becomes conductive, thereby interrupting the positive voltage present at the base of the transistor **64,** as previously described.

As a result, transistor **64** becomes nonconductive, and the SCR **66** opens to thus interrupt the current to the base of the transistor **60.** Consequently, transistor **60** also becomes nonconductive and current flow to the electromagnet **36** is interrupted, causing the latter to deenergize. When this occurs, the self-centering spring of the hydraulic control valve **32** urges the control lever **28** to the H or hold position, thus stopping further retraction of the rod **22.** Such action occurs at a predetermined position of the rod **22** such that the bucket **12** is in the desired position for subsequent loading or digging.

It may be seen, with a loaded bucket **12** in the rack-back position, the operator may dump the load by moving control lever **28** to the dump position. As the load is being dumped, the electromagnet **36** is energized when the magnet **48** passes adjacent the magnetic field sensitive switches **42,44** from left to right on the schematic.

Having dumped the load, the operator may retract the bucket **12** from the dump position by moving the control lever **28** to the rack-back position. Because the electromagnet is now energized, the lever **28** is maintained in the latter position until the magnet **48** passes adjacent the switches **44,42** preceding from the opposite direction, i.e., from right to left on the schematic. As this occurs, the electromagnet **36** is deenergized and the bucket **12** automatically stops in the proper loading position, ready to begin the next work cycle, without direction from the operator subsequent to his placing the lever **28** in the rack-back position.

As may be seen, switches **42** and **44** comprise first and second sequentially operable triggering means each of which operates when permanent magnet **48** passes adjacent thereto. The switches are closed during operation thereof and are open upon termination of operation thereof. In a sequence of operations from a loading position to a dumping position and then back to the loading position, the first triggering means, i.e., switch **42,** will terminate, the second triggering means, i.e., switch **44,** will operate and terminate, then operate and terminate again, followed by operation of the first triggering means.

When the first triggering means operates, transistors **62** and **64** respond to such operation to interrupt conduction of SCR **66,** thereby rendering it nonconductive. When the first triggering means terminates, transistors **62** and **64** respond to condition SCR **66** to conduct. SCR **66** will thereafter conduct when a gate pulse is applied thereto. A gate pulse will be applied to SCR **66** in response to operation of the second triggering means, i.e., switch **44.** Once SCR **66** is turned on by such a gate pulse, SCR **66** will remain conductive until the first triggering means, i.e., switch **42,** again operates to turn SCR **66** off.

It is to be noted that the arrangement described above will allow the operator to fish tail the bucket **12** to facilitate the loading operation without interference from the rack-back detent apparatus, as is common on prior art electrical bucket positioners. Fish tailing is the operation wherein the bucket **12** is rocked back and forth by the repetitious movement of the control lever **28** from the rack-back to the dump position. Fish tailing is unhindered by the bucket positioner of present invention since bucket movement is normally limited between the loading position and the full rack-back position during the fish tailing operation. Since electromagnet **36** is never energized in this mode, there is no effect on the movement of the lever **28,** i.e., the lever is not latched via the electromagnet.

What is claimed is:

1. A logic control circuit for energizing and deenergizing a selected device via a given voltage source, said logic control circuit comprising:

a conductive device;

circuit means operatively associated with said conductive device and adapted to couple said selected device to said voltage source in response to conduction through said conductive device and to uncouple said selected device from said voltage source upon termination of conduction through said conduction device;

first and second sequentially operable triggering means having a sequence of operations that after termination of said first triggering means said second triggering means operates and terminates and then operates and terminates again and then said first triggering means operates;

means responsive to operation of said first triggering means for rendering said conductive device nonconductive during operation of said first triggering means and for conditioning said conductive device for conduction after termination of operation of said first triggering means;

means responsive to operation of said second triggering means for initiating conduction through said conductive device during operation of said second triggering means and for maintaining conduction through said conductive device until a subsequent operation of said first triggering means.

2. A logic control circuit as set forth in claim **1** wherein said conductive device is a silicon controlled rectifier, wherein the means responsive to operation of said first triggering means controls the path of conduction through said silicon controlled rectifier and wherein the means responsive to operation of said second triggering means applies a conduction-initiating

gate pulse to the gate of said silicon controlled rectifier during operation of said second triggering means.

3. A logic control circuit as set forth in claim 2 wherein said first and second triggering means each comprise a switch which is closed during operation thereof and open upon termination of operation thereof.

* * * * *