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[54] **MECHANISM FOR POSITIONING AND RESTRICTING CRANE CONTROL LEVERS TO PREVENT DANGEROUS LOAD CONDITION**

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[52] **U.S. Cl.** ..... **212/39 R,** 91/459, 340/267 C

[51] **Int. Cl.** **B66c 13/48**

[58] **Field of Search** .....212/39 R, 39 B, 39 MS, 212/39 DB, 39 A, 39 P; 340/267 C; 91/449, 459

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[57] **ABSTRACT**

A safe load sensing device on a crane produces a signal to which a control means responds to operate an actuator for a mechanism which automatically returns manual control levers on the crane to neutral. The mechanism restricts the movement of certain control levers in a direction which would increase unsafe crane loading.

17 Claims, 9 Drawing Figures

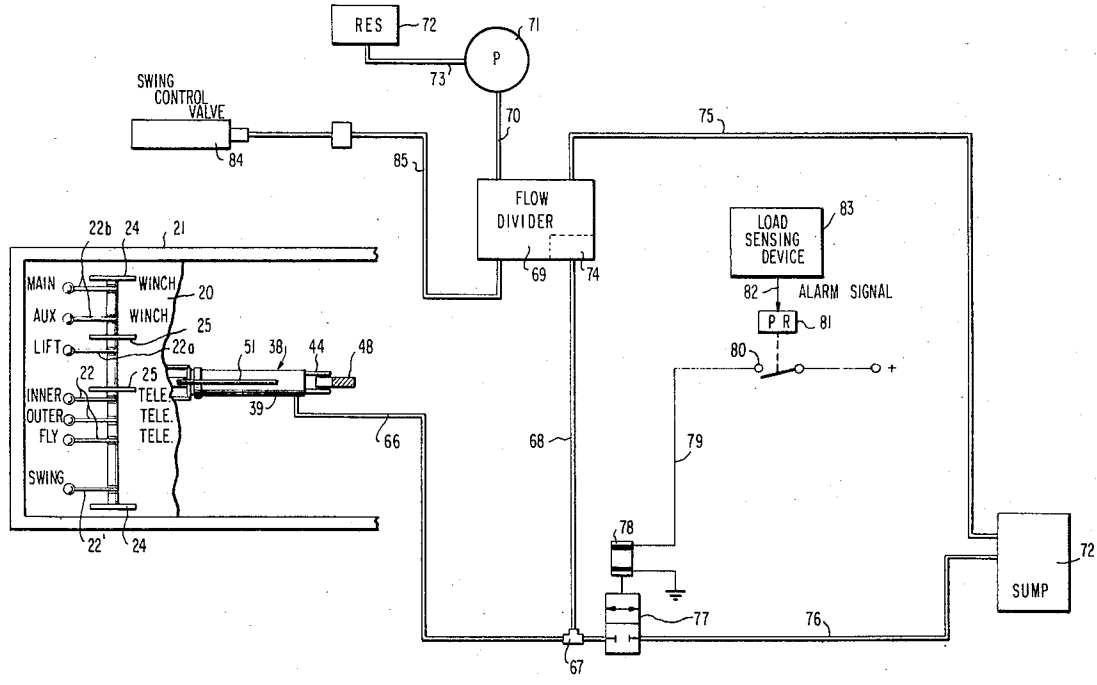


FIG. 1

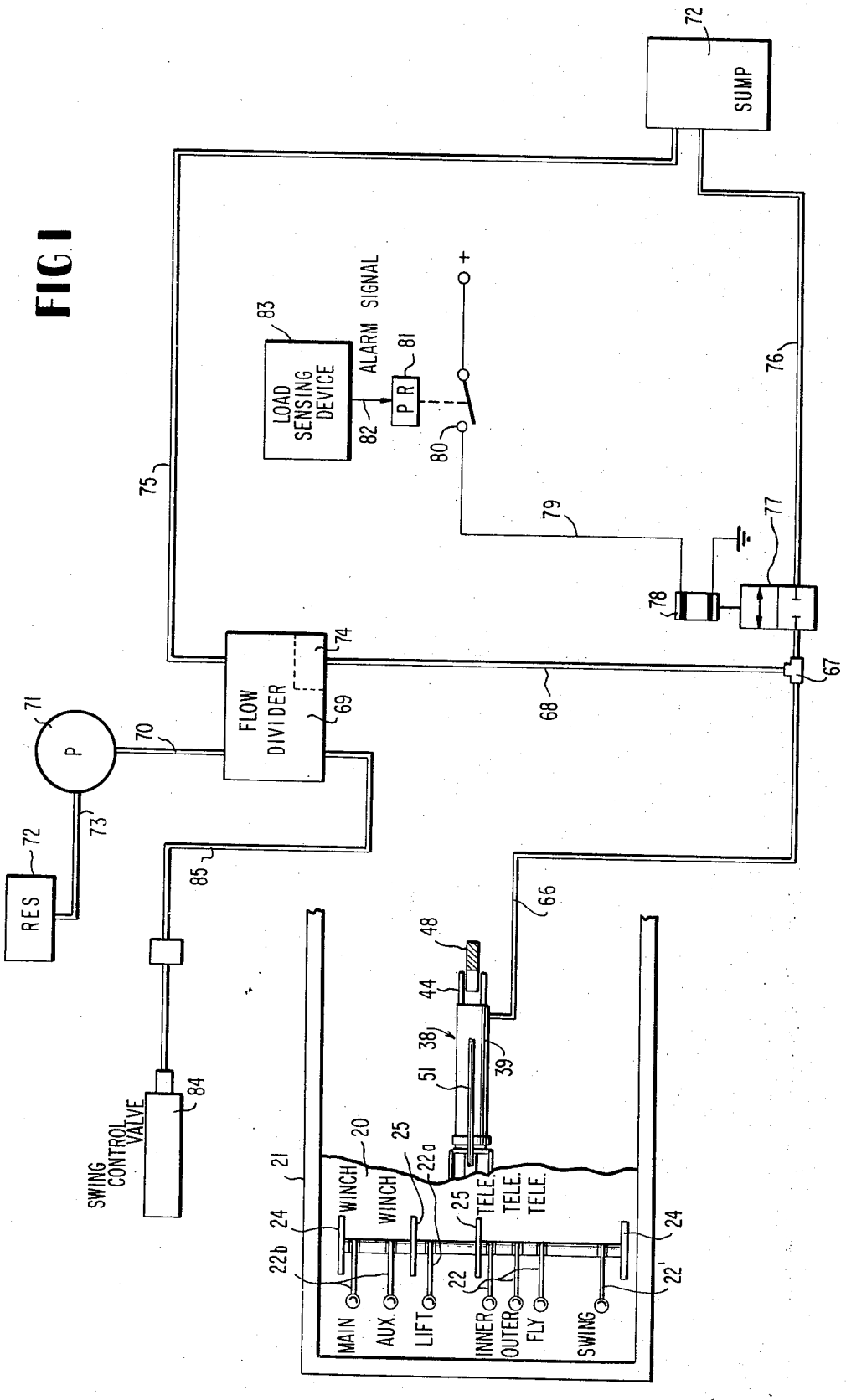

SUMP
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LOAD SENSING DEVICE
83
ALARM SIGNAL
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P R
82
80
+
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FLOW DIVIDER
69
71
P
70
73
RES
72
85
66
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39
51
84
SWING CONTROL VALVE
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22a
21
24
22b
WINCH
WINCH
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TELE.
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22'
MAIN
AUX.
LIFT
INNER
OUTER
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SWING

FIG. 2

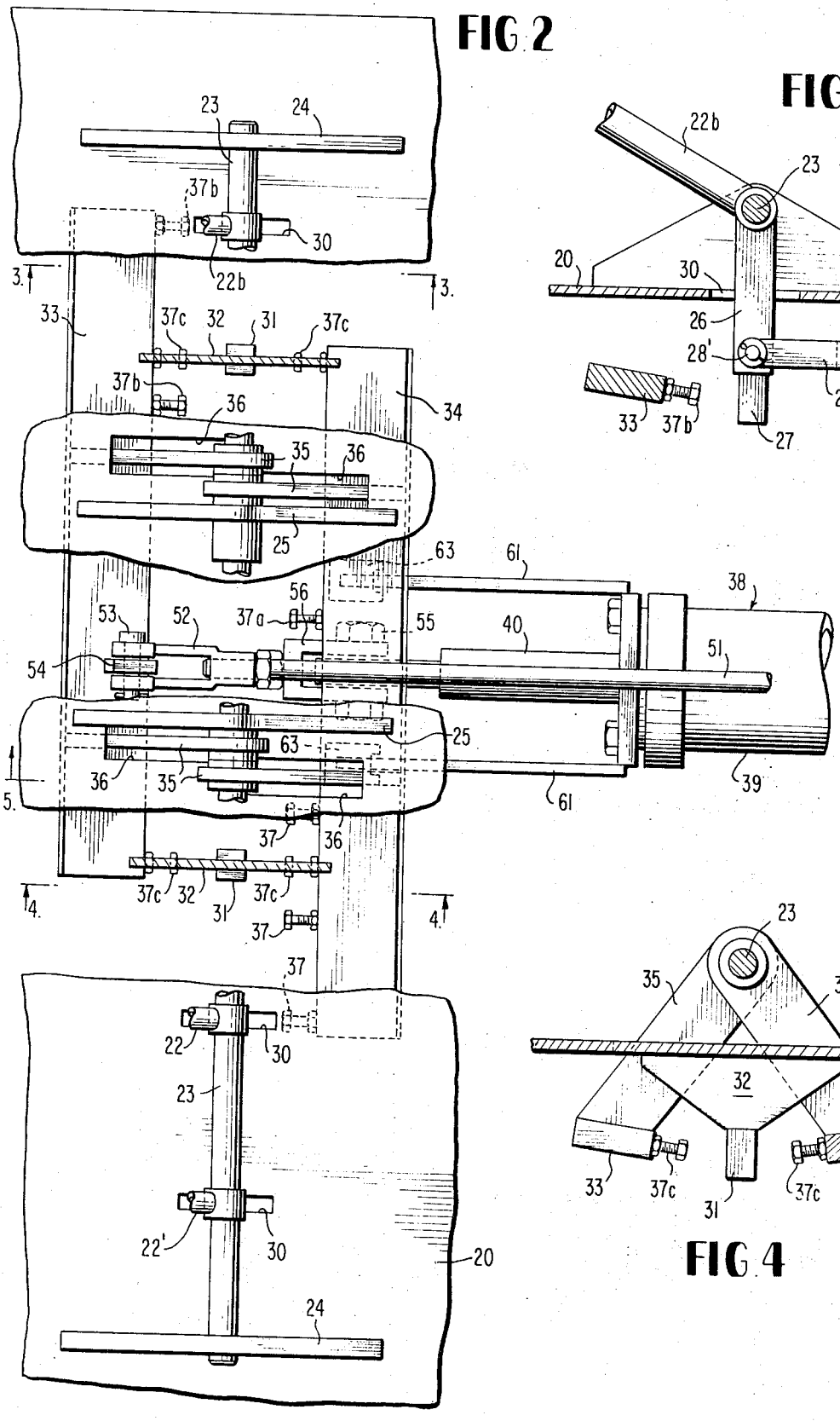


FIG. 3

FIG. 4

FIG. 5

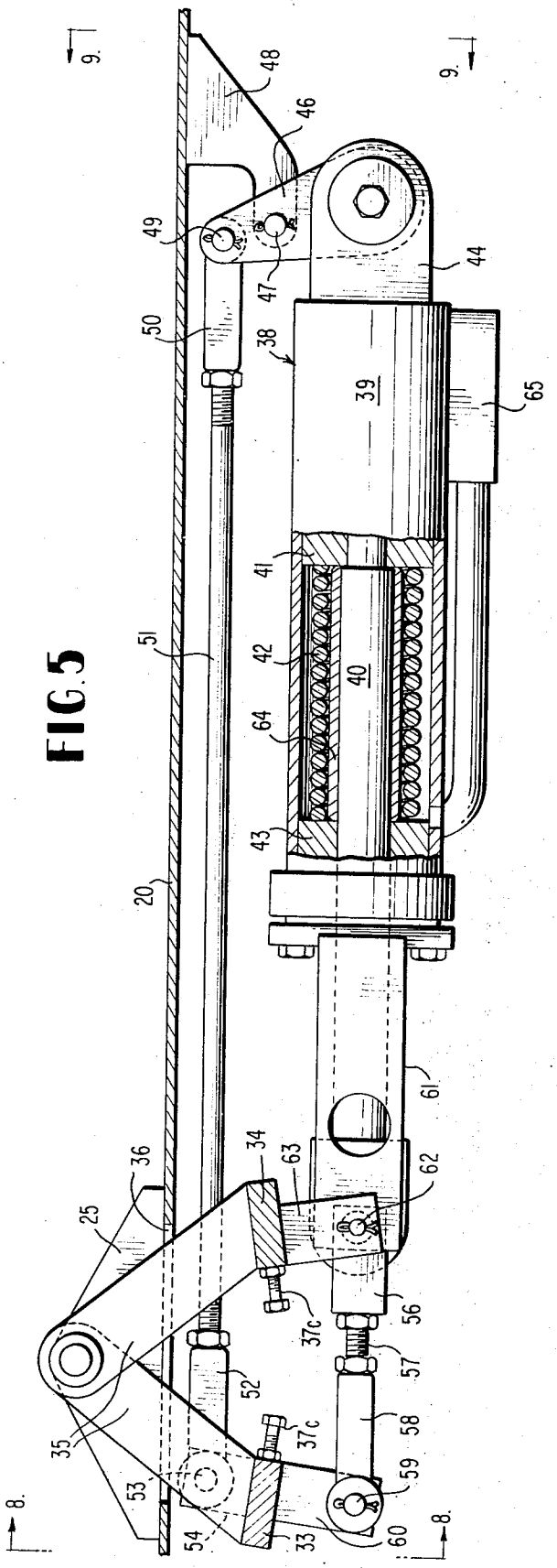
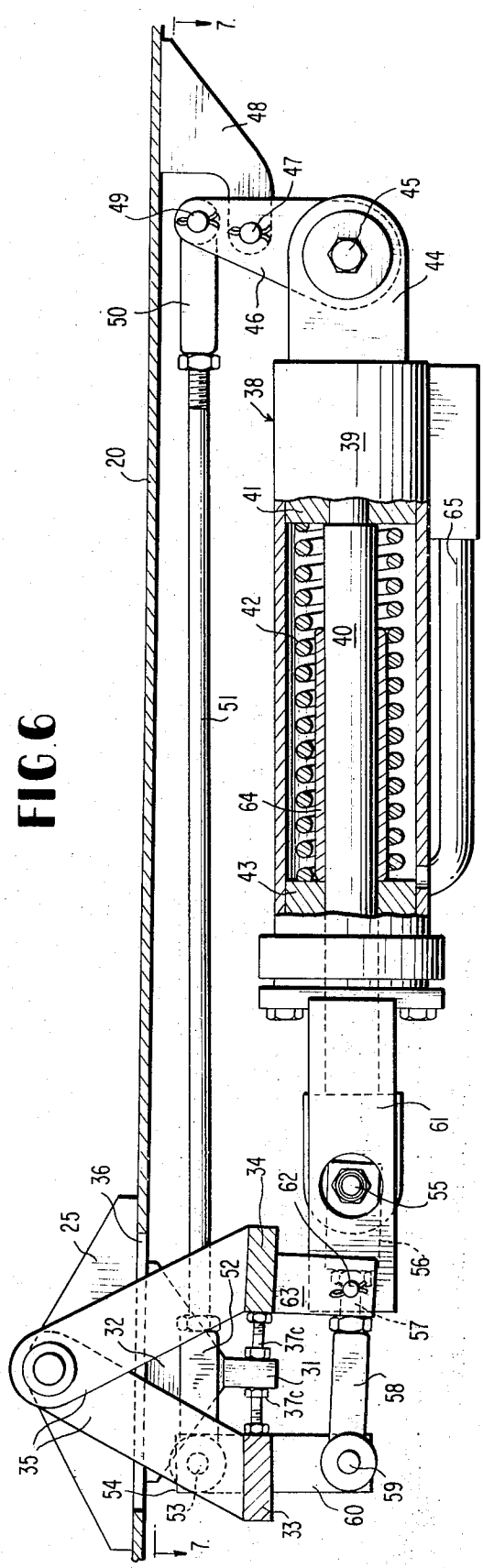
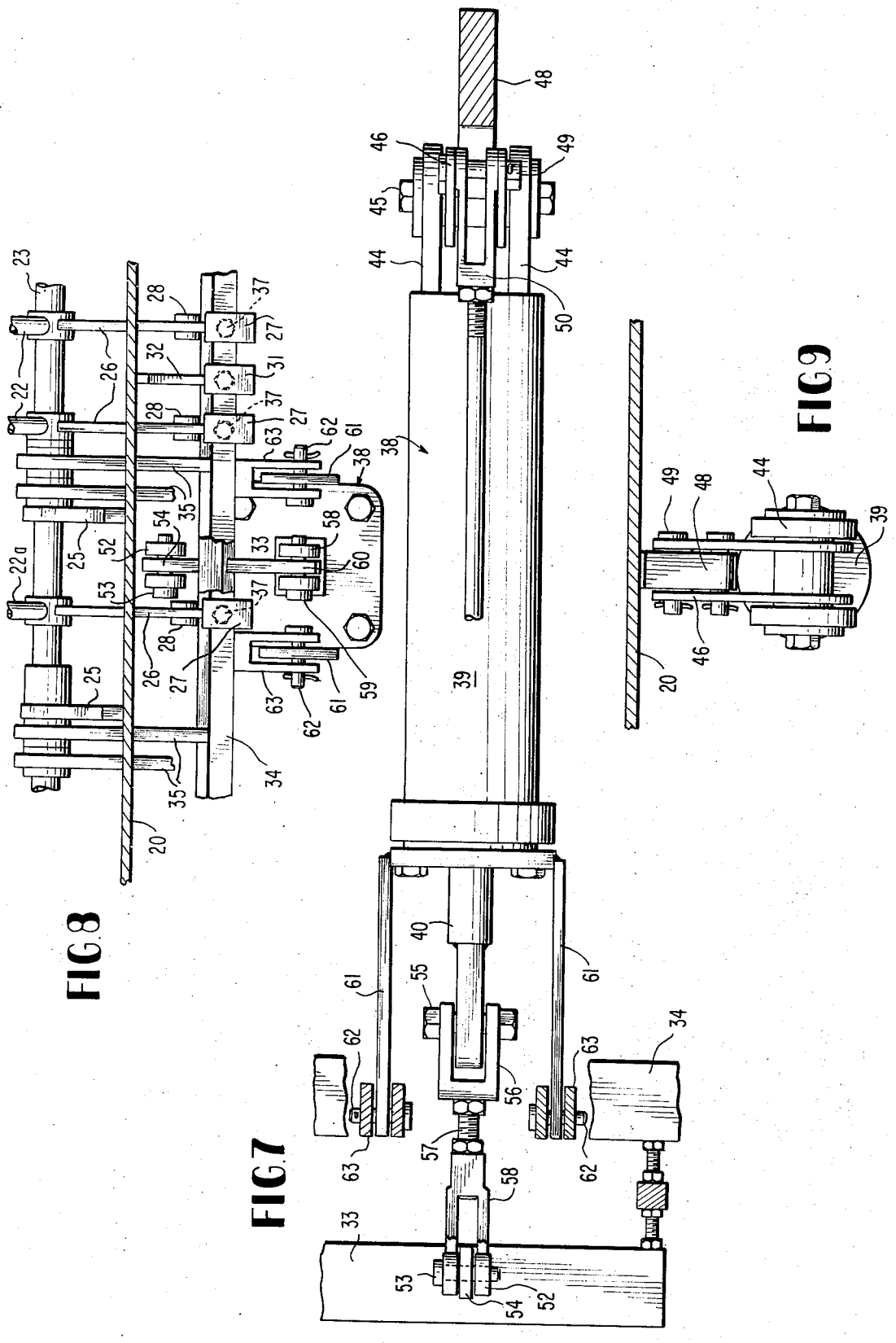

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FIG. 6


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22a
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FIG. 7
FIG. 8
FIG. 9

MECHANISM FOR POSITIONING AND RESTRICTING CRANE CONTROL LEVERS TO PREVENT DANGEROUS LOAD CONDITION

BACKGROUND OF THE INVENTION

In extensible boom cranes, a dangerous load condition can arise when the crane boom, under a given loading, is extended beyond a predetermined length while at a given angle of inclination, or when the boom under the same loading and while extended to the same degree is depressed below a certain angle of inclination. Excessive crane movements in either case can quickly produce a dangerous load moment which could tip the crane over.

Because of the existence of this problem, means have been devised in the art which will respond automatically to such a dangerous loading condition of the crane, and in the case of a hydraulically operated telescopic boom crane, the means in question will automatically disable certain parts of the crane hydraulic system so that the operator is unable by the use of manual controls to cause further extension or lowering of the crane boom, which would result in increasing the dangerous load condition.

The present invention embodies a significant advance in the art through the provision of a mechanism which responds automatically to the operation of the safe load sensing means on the crane and engages the manual control levers in the operator's cab and returns them to a neutral position, while at the same time locking certain levers against movement by the operator in a direction which would tend to increase an unsafe load condition. Other levers whose movement would not cause unsafe loading remain unrestricted by the mechanism.

The lever positioning and restricting mechanism includes a mechanical actuator which is biased to maintain the mechanism activated. This feature imparts to the mechanism a fail-safe capability, since failure of the crane's hydraulic or electrical systems cannot stop the activation of the mechanism. The mechanical actuator is hydraulically operated when safe loading of the crane prevails to deactivate the mechanism and release all crane control levers for normal use by the operator. In the disclosed embodiment of the invention, an electric safe load sensing device produces an output or signal when the crane approaches unsafe loading, and this electrical signal through a relay operates a solenoid valve in the hydraulic control circuit which causes the mechanism actuator to set the mechanism in the active lever-engaging position under influence of the biasing means in the actuator.

The mechanism and its control and operating means is essentially self-contained, fully automatic and reliable in operation. The mechanism is of a rugged type with adequate adjustment features and is comparatively economical to manufacture, install and service.

Other features and advantages of the invention will become apparent during the course of the following description.

BRIEF DESCRIPTION OF DRAWING FIGURES

FIG. 1 is a diagrammatic view of mechanism for positioning and controlling crane operating levers and of the electro-hydraulic control system associated with the mechanism;

FIG. 2 is a fragmentary plan view of the mechanism, partly broken away and partly in section;

FIG. 3 is a fragmentary vertical section taken on line 3—3 of FIG. 2;

FIG. 4 is a similar section taken on line 4—4 of FIG. 2;

FIG. 5 is a similar section taken on line 5—5 of FIG. 2;

FIG. 6 is a sectional view similar to FIG. 5 showing the control mechanism in a normal activated condition under the influence of a biasing spring, FIG. 5 showing the mechanism deactivated in response to a conditioning of the hydraulic control circuit by safe load sensing means;

FIG. 7 is a horizontal section taken on line 7—7 of FIG. 6, with parts broken away;

FIG. 8 is a fragmentary vertical section taken on line 8—8 of FIG. 5; and

FIG. 9 is a similar view taken on line 9—9 of FIG, 5.

DETAILED DESCRIPTION

Referring to the drawings in detail, wherein like numerals designate like parts, the numeral **20** designates a floor in the operator's cab **21** of a crane, which cab contains the manual control levers for the crane. As best shown in FIG. **1**, separate manual levers are provided for the crane components which must be under the control of an operator. These components are the main and auxiliary cable winches, main hydraulic lifting means for adjusting the angle of the crane boom, the hydraulic rams which control the extension and retraction of telescoping boom sections, and the means which control the swinging or sluing of the crane. Legends are provided in FIG. **1** adjacent to the several control levers to identify them. Continuing to refer to FIG. **1**, the three control levers on one side of the cab center line which control the extension and retraction of the telescopic boom sections are designated by the numeral **22.** Another control lever on the other side of the cab center line which controls the raising and lowering of the crane boom is designated by the numeral **22***a*. A pair of control levers for operating the main and auxiliary winches are designated **22***b* and still another lever for controlling the swinging or sluing of the crane has the numeral **22'** applied thereto.

The several manual levers above designated are connected with hydraulic control valves, such as spool valves, which regulate the operation of the crane hydraulic system to produce the necessary movements of the crane components. While the crane hydraulic system is conventional and need not be shown or described in this application for a full understanding of the invention, there is shown in FIG. **3** a typical connection between one manual lever **22**b and the associated hydraulic valve, not shown. This connection will be further described.

The several manual control levers **22, 22***a*, **22***b* and **22'** are gang-mounted pivotally on a common transverse horizontal shaft **23** located immediately above the cab floor **20** and fixedly supported thereon by end and intermediate upstanding bearing plates **24** an **25.** Each of the described manual control levers on the shaft **23** has a relatively short depending crank arm **26** rigid therewith and terminating at its lower end in a contact extension **27.** In FIG. **3,** a clevis **28** is shown pivoted at **28'** to the crank arm **26** of the lever **22***b* for

the main winch of the crane. The clevis **28** is adjustably connected with an operating rod **29** extending to a spool valve or the like, not shown, in the conventional crane hydraulic system. It should be understood that each crank arm **26** of each manual control lever **22**, **22***a*, **22***b* and **22'** is similarly connected by a clevis and rod to a control valve in the crane hydraulic system which regulates the operation of the crane components to which legends have been applied in FIG. **1** adjacent the several control levers. Each of the control levers is adapted to be pivoted on the shaft **23** in opposite directions from the neutral position shown in FIG. **3** for operating a particular crane part. For example, the lever **22***a* would be pushed forwardly by the operator to depress the crane boom and would be pulled rearwardly from neutral to elevate the boom. The levers **22** would be shifted in opposite directions to extend or retract the various telescopic boom sections. Each of the lever crank arms **26** is arranged for movement in a clearance slot **30** provided in the floor **20**.

A pair of positive stops **31** whose purpose will be fully described is fixedly supported slightly below the floor **20** by vertical plates **32** rigidly secured to the floor bottom. Arranged on opposite sides of these stops **31** and crank arms **26** is a pair of parallel opposing clamp or restraining bars **33** and **34** of sturdy construction which function in conjunction with certain actuating means to be described to automatically return all of the manual control levers to a neutral position and to restrict the movement of some levers whenever an unsafe loading condition of the crane is sensed.

The bars **33** and **34** which are parallel to the shaft **23** and are disposed beneath the floor **20** are bodily supported for swinging movement around the axis of the shaft **23** by pairs of support arms **35** having their lower ends rigidly secured to the bars **33** and **34** and their upper ends pivotally mounted on the shaft **23**. Additional slots **36** are provided in the floor **20** to allow the necessary movement of the support arms **35** as the bars **33** and **34** travel between their positions depicted in FIGS. **5** and **6**.

The two bars **33** and **34** carry on their inner opposing side arrangements of adjustable screw contact elements for engagement with the positive stops **31**, and with the extensions **27** on the several crane control levers. More particularly, the bar **33** carries adjustable contact elements **37***b* for engagement with the extensions **27** of winch control levers **22***b*. The opposite bar **34** similarly carries three spaced contact elements **37** aligned with the extensions **27** of control levers **22** which are associated with the telescoping sections of the crane boom. The bar **34** has another adjustable contact element **37***a* thereon for engagement with the extension **27** on lift control lever **22***a*. Additional contact elements **37***c* on both of the bars **33** and **34** are properly spaced and aligned to engage opposite sides of the rectangular positive stops **31** when the two bars move together as depicted in FIG. **6**. The swing control lever **22'**, FIG. **2**, lies outside of the area of the bars **33** and **34** and is not effected by the movement of the bars and their contact elements.

Movement of the bars **33** and **34** toward and away from each other is derived from a mechanical actuator **38** having a cylinder body **39** within which is mounted a rod **40** carrying a piston **41**. The piston and rod are strongly biased toward the rear of the cylinder **39**, FIG. **6**, by a coil spring **42** having its ends engaging the piston **41** and a fixed head **43** in the forward end of the cylinder. The rear end of the cylinder **39** carries rigid lugs **44** pivoted at **45** to a short crank arm **46**, in turn pivoted between its ends at **47** to a fixed depending support bracket **48** on the bottom of floor **20**. The upper end of crank arm **46** above the pivot **47** is pivotally secured at **49** to a rear adjustable clevis **50** on a connecting rod **51**, whose forward end carries another clevis **52**, pivotally connected by a pin **53** to a fixed aperture lug **54** on top of the bar **33**. The connecting rod **51** lies beneath the floor **20** and extends longitudinally of the cylinder **39**.

The forward end of piston rod **40** is pivotally secured at **55** to an adjustable clevis **56**, connected by a short rod **57** to another clevis **58** having its forward end pivotally connected by a pin **59** to a depending rigid lug **60** on the bar **33**. A pair of side extension plates **61** rigidly secured to the forward end of cylinder **39** and projecting forwardly thereof on opposite sides of the rod **40** have their leading ends pivoted to pins **62** carried by fixed depending brackets **63** on the bar **34**.

A rigid spacer sleeve **64** surrounds the rod **40** inside of coil spring **42** and serves to positively limit the movement of piston **41** forwardly toward the fixed head **43**, FIG. **5**. The spring **42**, as stated, biases the mechanism to the active position in FIG. **6**, FIG. **5** showing the inactive position of the mechanism relative to the manual control levers **22**, **22***a* and **22***b*. The space in the cylinder **39** between the piston **41** and fixed head **43** is vented to atmosphere by a venting means **65**.

Referring to FIG. **1**, the cylinder **39** is connected near its rear end with a hydraulic line **66** through which pressurized fluid is delivered to the cylinder at proper times to shift the piston **41** to the position shown in FIG. **5** for deactivating the lever control mechanism. The line **66** is supplied with fluid through a T-fitting **67** from another line **68** leading from a flow divider **69**. The flow divider receives fluid through a line **70** from a pump **71** connected with a reservoir **72** by a line **73**.

The flow divider **69** may have a self-contained pressure relief valve **74** as indicated schematically. Another fluid line **75** leads from the flow divider to a sump **72**, and a line **76** leads from the sump to a spool valve **77** operated by a solenoid **78**, electrically connected through wiring **79** with contacts **80** of a relay **81**. This relay receives an electrical signal at **82** from a safe load sensing device **83** on the crane. This device may be of any prior art type and, for example, may be the device or system disclosed in allowed copending application Ser. No. 785,145, filed Dec. 19, 1968 now Pat. No. 3,641,551, for SAFE LOAD CONTROL SYSTEM FOR TELESCOPIC BOOM CRANES, or equivalent system or device. A swing control valve **84** which controls the sluing of the crane in response to movements of the lever **22'** is connected with the flow divider **69** by a hydraulic line **85**. The arrangement of the control valve **77** in the hydraulic circuit is such that the valve has no effect on that part of the circuit having the swing control valve **84** therein.

OPERATION

Diagrammatic FIG. **1** shows the valve positioned as when the crane is operating in a safe load situation. The hydraulic circuit between the single fluid inlet and exhaust port of the cylinder **39** connected with the line **66** and leading to the sump **72** is closed by the valve **77**. Consequently, pressurized fluid delivered from the

pump 71 through the flow divider 69 and lines 68 and 66 to the cylinder 39 effectively moves the piston 41 to the mechanism deactivating position shown in FIG. 5, where the spring 42 is compressed and the piston is bottomed against the rigid sleeve 64. At this time, the bars 33 and 34 are fully separated and their contact elements 37, 37*a*, 37*b* and 37*c* are spaced from the control lever extensions 27 and the positive stops 31. At this time, all of the manual levers 22, 22*a* and 22*b* are free for normal usage by the crane operator and the mechanism is not restricting the use of any crane controls while the safe load condition exists. The swing control levers 22' is always unrestricted by the mechanism, lying beyond the bar 34, FIG. 2, and the pump 71 is delivering fluid through the flow divider 69 to the swing control valve 84.

When the crane is approaching an unsafe load condition, the automatic sensing device 83, also termed a load moment indicator, produces an electrical signal which pulls in relay contacts 80 and energizes solenoid 78 to shift spool valve 77 to the position where the hydraulic circuit from the cylinder 39 to the sump 72 is opened. When this occurs, the spring 42 shifts the piston 41 to the rear of cylinder 39 forcing the hydraulic fluid from the cylinder through the lines 66 and 76 to the sump. This movement of the piston 41 to the position of FIG. 6 activates the lever positioning and restricting mechanism, as shown. The bars 33 and 34 are shifted toward each other until their contact elements 37*c* engage the fixed stops 31 which limits the movement of the two bars.

Simultaneously, the contact elements 37 on bar 34 will engage the extensions 27 of control levers 22 and return these levers automatically to neutral and prevent any manual movement of the three levers 22 in the direction which would increase the unsafe load condition. In a similar manner and simultaneously, the element 37*a* will return the lever 22*a* to neutral and will prevent any further manual movement of this lever in a direction which would further lower the angle of the boom. The elements 37*b* carried by bar 33 similarly engage the extensions 27 of winch control levers 22*b* and return these levers to neutral and prevent further lever movement in the direction which would increase a dangerous load condition. It will be understood that the above automatic movement of the control levers by the mechanism will operate the spool valves in the crane hydraulic system through the linkage elements 28 and 29 of each lever. While certain of the control levers are restricted against movement in one direction by the mechanism, they are entirely free to be moved in a direction which cannot increase the dangerous load condition but, on the contrary, will reduce the condition. The mechanism also makes it unnecessary for the operator to manually return the control levers to neutral when a dangerous load condition is sensed by the device 83.

When the necessary crane movements have been effected to eliminate the unsafe load condition, the automatic sensing device 83 will produce a reverse signal opening relay contacts 80 and de-energizing solenoid 78, causing valve 77 to return to the flow blocking position shown in FIG. 1. When this occurs, fluid pressure will build up behind piston 41 and move the piston back to its position of FIG. 5 where the lever control mechanism is deactivated and all of the levers are freed for regular use by the operator and may be shifted to either side of their neutral positions. When the piston 41 bottoms against the sleeve 64, the pressure behind the piston builds up until it reaches a degree at which the relief valve 74 will pass the pressurized fluid back to the sump through the line 75. the swing control valve 84 which in conjunction with the manual lever 22' controls the sluing of the crane is isolated from the hydraulic circuit containing the valve 77 and therefore is not effected by the action of this valve.

With respect to the operation of the lever positioning and restraining mechanism per se, the following occurs. When the valve 77 shifts to enable the spring 42 to force fluid out of the cylinder body 39 and move the piston 41 to the rear of the cylinder body, FIG. 6, the resulting retraction of the rod 40 with clevises 56 and 58 will pull the lug 60 and the bar 33 rearwardly or toward the bar 34. However, simultaneously, this rearward movement of the bar 33 with its upstanding lug 54 will shift the connecting rod 51 rearwardly causing the crank arm 46 to turn clockwise on its pivot 47 to the position of FIG. 6. When this occurs, the floating cylinder body 39 is pushed forwardly and with it the extension plates 61 move forwardly and due to their connections with the brackets 63 cause the bar 34 to move forwardly simultaneously with the rearward travel of the bar 33. Thus, the mechanism causes the two bars 33 to move toward and away from each other in unison and for similar distances. When the elements 37*c* on the two bars engage the opposite sides of the fixed stops 31, FIGS. 2 and 6, the mechanism will remain locked in this active position until a safe loading condition is sensed by the device 83.

The terms and expressions which have been employed herein are used as terms of description and not of limitation, and there is no intention, in the use of such terms and expressions, of excluding any equivalents of the features shown and described or portions thereof but it is recognized that various modifications are possible within the scope of the invention claimed.

I claim:

1. A mechanism for positioning and restraining manual control levers on a crane or the like, comprising opposing members movable toward and away from each other between mechanism active and inactive positions relative to said control levers, control lever contact elements on said members engageable with said control levers in said mechanism active position and returning the levers automatically to a neutral position and restraining said levers against movement in directions which would produce a dangerous load condition on a crane, an actuator means for said mechanism, a control means for said actuator means responding to the operation of a safe load sensing means, and a support means for gang mounting said control levers pivotally on a common pivot axis, said levers having crank extensions extending between said opposing members, and said contact elements on the members being aligned with the crank extensions and contacting the latter when the members move toward each other in said mechanism active position.

2. The structure of claim 1, and fixed stop means extending between said members and being aligned with certain of the contact elements on the members, whereby such contact elements will engage opposite sides of the fixed stop means in said mechanism active position.

3. The structure of claim 1, and said contact elements comprising laterally spaced adjustable screw contacts on each of the members disposed for engagement with one side of the crank extensions of particular control levers in said gang.

4. The structure of claim 1, and additional control linkage means connected with said crank extensions of said levers and adapted to operate control valves in a crane hydraulic system to thereby regulate basis crane movements.

5. The structure of claim 1, and a floor member forming a part of a crane cab or the like, said support means for said gang of control levers comprising a support shaft for the pivotal mounting of said levers above the floor member, said members having said contact elements disposed beneath the floor member, support arms for said members having pivotal connections with said shaft above the floor member, and said floor member having slots receiving said crank extensions and arms.

6. A mechanism for positioning and restraining manual control levers on a crane or the like, comprising opposing members movable toward and away from each other between mechanism active and inactive positions relative to said control levers, control lever contact elements on said members engageable with said control levers in said mechanism active position and returning the levers automatically to a neutral position and restraining said levers against movement in directions which would produce a dangerous load condition on a crane, an actuator means for said mechanism, a control means for said actuator means responding to the operation of a safe load sensing means, and a fixed support shaft, a gang of said control levers pivotally mounted on said support shaft and having crank extensions disposed between said opposing members and being aligned with said contact elements on the members, supporting arms for the members pivotally secured to said support shaft, said actuator means comprising an extensible and retractable device, one relatively movable part of said device having a connection with one of said members and the other relatively movable part of said device having a connection with the other member in such a way that the extension and retraction of the device causes simultaneous movements of the members toward and away from each other.

7. The structure of claim 6, and fixed stop means for said members when the members are shifted by said device toward each other to said mechanism active position.

8. The structure of claim 6, and said device comprising a cylinder-piston unit with the piston rod of said unit connected to one of said members, and an actuating linkage interconnecting the cylinder of said device to said other member.

9. The structure of claim 8, and said actuating linkage comprising a crank arm having a fixed pivot between its ends, one end of said crank arm pivotally connected to said cylinder and supporting the cylinder, and a connecting rod pivotally attached to the other end of the crank arm and extending to and connecting with the member with which the piston rod of said unit is connected.

10. The structure of claim 8, and a biasing spring in the cylinder of said unit bearing on the piston of the unit and causing the unit to normally maintain the mechanism in said active position relative to said control levers.

11. In a crane or the like, a gang of manual control levers arranged in side-by-side spaced relationship for convenient manipulation by an operator, a common support shaft for said gang of levers of which they are all pivotally mounted, a pair of opposing elongated bar members spanning said gang of levers transversely thereof and in parallel relation to said shaft, one bar member of the pair disposed on each side of the gang of levers in unattached relationship thereto, said bar members being movable in unison toward and away from each other and toward and away from opposite sides of the gang of levers, a common actuator means for said pair of bar members causing them to move in unison between inactive separated positions relative to the gang of control levers and active engaging positions relative to the gang of control levers, and an automatic control means for said common actuator means responding to the operation of a safe load sensing means on a crane or the like.

12. The structure of claim 11, and said actuator means being resiliently biased in said active engaging position.

13. The structure of claim 11, and plural spaced individual control lever contact elements on said bar members engageable with selected control levers to return the same to neutral positions and to restrain selected control levers from movement in directions which would produce a dangerous load condition on a crane or the like.

14. The structure of claim 12, and said actuator means comprising an extensible and retractable mechanical actuator, and a linkage having connections with said mechanical actuator and said bar members and operable to move said bar members in unison.

15. The structure of claim 14, and said actuator means comprising a cylinder-piston unit having a fluid inlet and outlet on one side of the piston of said unit, said biasing means comprising a spring engaging the other side of the piston and opposing movement of the piston in response to fluid pressure on said one side thereof.

16. The structure of claim 15, and said control means comprising a valve, and a fluid conduit leading from the valve to said inlet and outlet of the cylinder-piston unit.

17. The structure of claim 16, and said valve being a solenoid-operated valve, and a relay electrically connected with the solenoid of said valve and also connected with said safe load sensing means and responding to an electrical signal from said sensing means.

* * * * *