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Brownell et al.

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[54] CRANE CONTROLS

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 794,042, Jan. 27, 1969.

[52] **U.S. Cl.** ..... **212/39 R**

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

[58] **Field of Search** ..... 212/39, 39 I, 39 MS; 280/6; 180/104

[56] **References Cited**

UNITED STATES PATENTS

3,265,220 8/1966 Knight 212/39

3,489,293 1/1970 Sallow 212/39

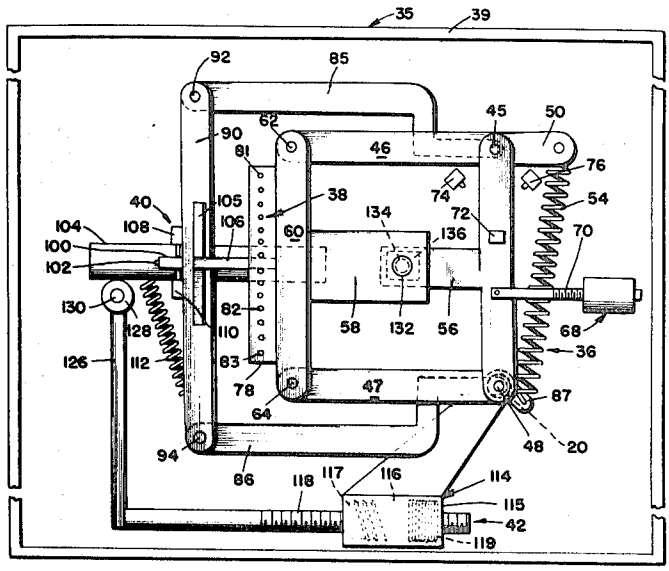
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[57] ABSTRACT

A control for a crane boom mounted on a self-propelled vehicle for pivotable movement about vertical and horizontal axes, the control including first control means for controlling boom movement about a horizontal axis and second control means for controlling boom extension. Connecting means cooperating with said first and second control means are provided for actuating one of said first and second control means upon actuation of the other to maintain the free end of the boom in a predetermined vertical or horizontal plane. Vehicle orientation compensating means also may be included, as well as ground level reference means to reference the boom relative to a remote point.

10 Claims, 5 Drawing Figures



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SHEET 1 OF 4

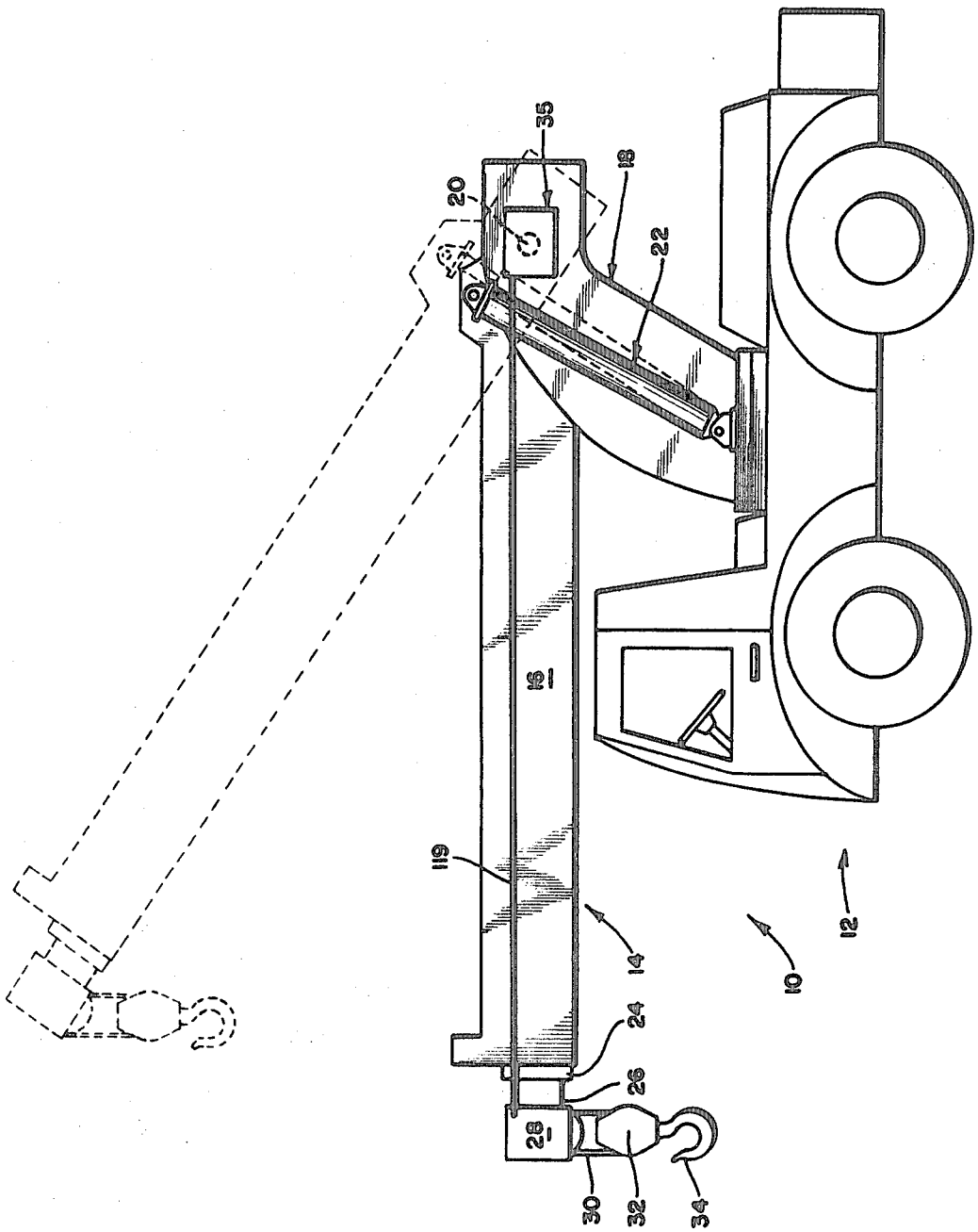


FIG. 1

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FIG.2

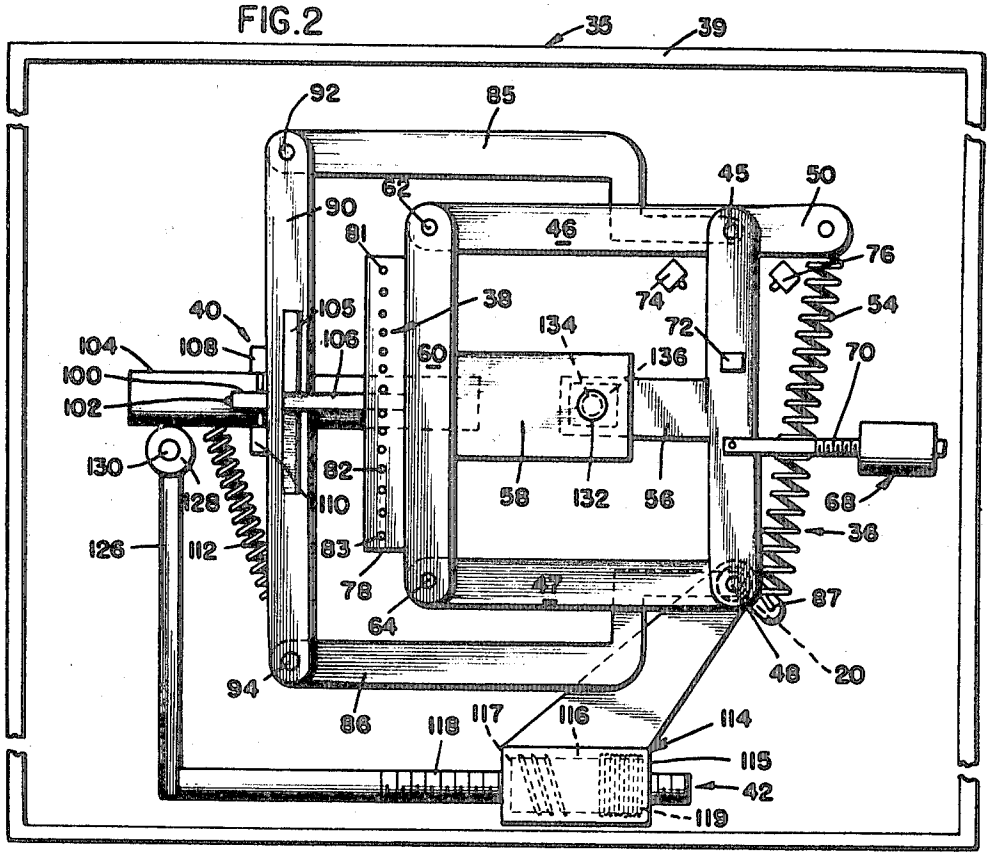
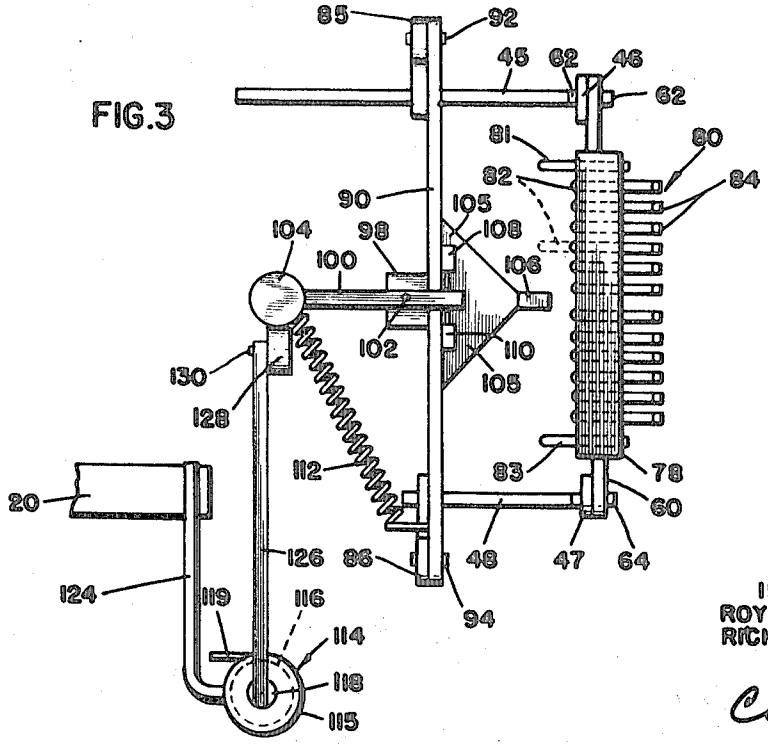


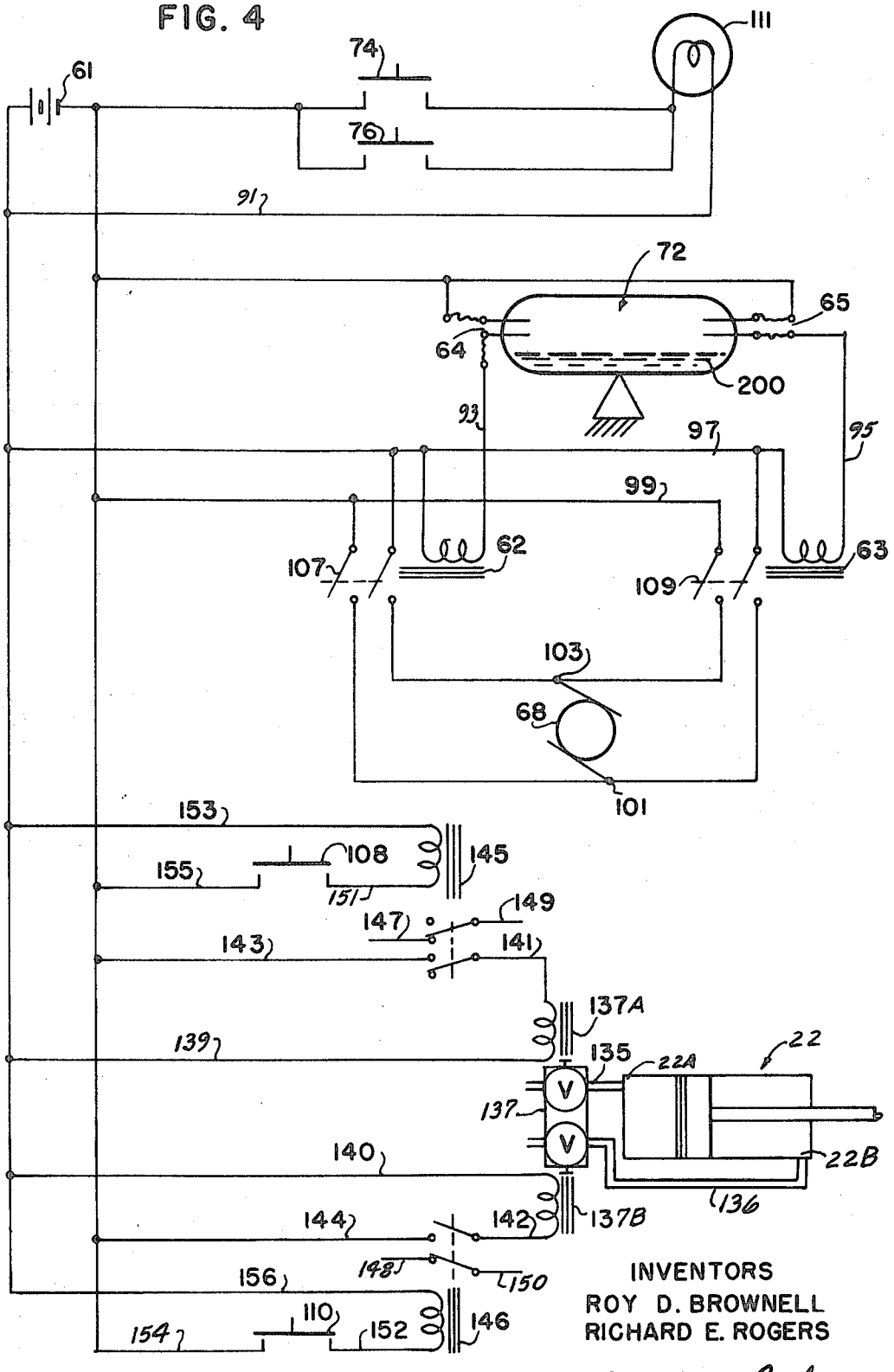
FIG.3



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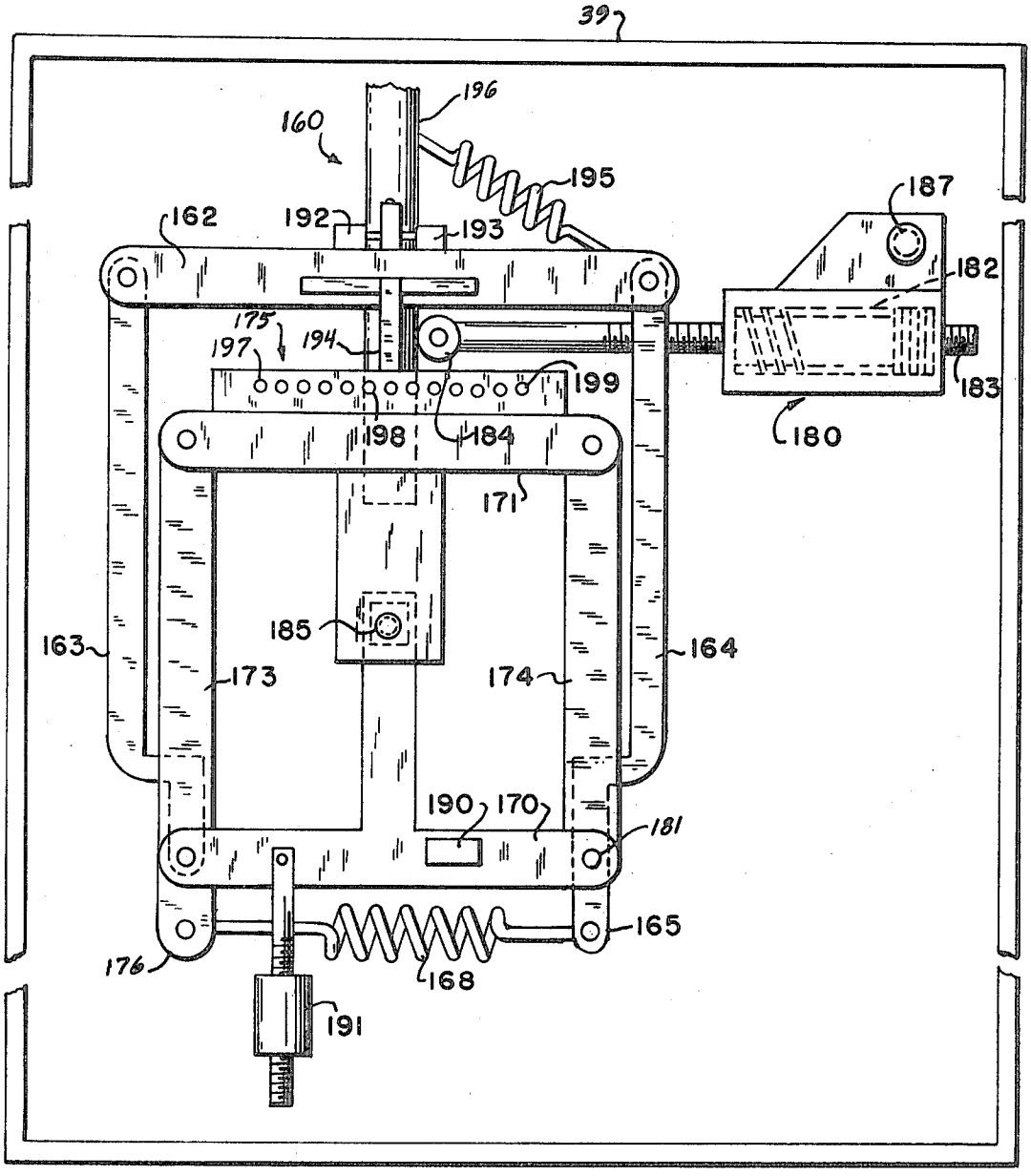
FIG. 4



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FIG. 5



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CRANE CONTROLS

This is in part a continuation of co-pending application Ser. No. 794,042 entitled "IMPROVEMENTS IN CRANE CONTROLS" filed Jan. 27, 1969.

BACKGROUND OF THE INVENTION

This invention relates to cranes and more particularly to controls for automatically controlling the orientation of crane booms.

In Applicants' copending application entitled "Improvements in Tree Harvesting" filed Jan. 27, 1969 a novel control mechanism is disclosed which, although described in connection with controlling the orientation of a boom supported tree harvester, has significant applicability to cranes in general. In crane operation, it is sometimes desirable to assure that the free end of the crane or load is maintained in, or does not exceed a predetermined elevation relative to some point remote from the crane. Although automatic controls have heretofore been provided to limit boom elevation or working radius to assure stable or safe crane operation, these controls are not generally satisfactory for maintaining or restricting the movement of the free end of a boom to a predetermined plane referenced to a remote point. This is because the prior art controls have not included suitable means to establish and compensate for all the variables which may be determinative of relative boom orientation, such as boom angle, boom length, vehicle orientation, and relative location of a remote point which is to be utilized as a reference or bench mark.

BRIEF DESCRIPTION OF THE INVENTION

In this light, the present invention provides a control for a crane boom pivotally supported on a vehicle for movement about vertical and horizontal axes, the control including first control means for controlling boom elevation movement about the horizontal axis and second control means for controlling boom extension. Connecting means cooperating with the first and second control means upon actuation of the other for maintaining the free end of the boom in a predetermined plane. The control may further include vehicle orientation compensation means for compensating for vehicle misorientation and reference means for referencing the boom relative to any point within its working radius.

BRIEF DESCRIPTION OF THE DRAWINGS

A more thorough understanding of one embodiment of the present invention may be gained by reference to the accompanying drawings wherein:

FIG. 1 is a schematic elevational view of a self-propelled crane including one embodiment of a boom control according to the present invention;

FIG. 2 is a schematic fragmentary side view one embodiment of the crane control shown in FIG. 1; and

FIG. 3 is a schematic fragmentary front view of a portion of the crane control shown in FIG. 2.

FIG. 4 is a schematic drawing of electrical circuitry for the operation of the device;

FIG. 5 is a schematic fragmentation side view of a second embodiment of the crane control shown in FIG. 1.

DETAILED DESCRIPTION OF THE INVENTION

Referring in more detail to FIG. 1 of the drawings, a control according to the present invention is adapted for use on a conventional mobile, selfpropelled crane **10**. The crane **10** includes a motorized wheeled vehicle **12** on which is supported a longitudinally extensible boom assembly **14** mounted for pivotable movement about vertical and horizontal axes. The boom assembly **14** comprises the base section **16** pivotally connected to a boom support **18** for pivotal movement about a horizontally disposed pivot pin **20**. An extensible fluid motor **22** is connected between the boom base section **16** and the boom support **18** for pivotally moving the boom assembly **14** in a vertical direction. The boom support **18** is pivotally connected to the vehicle **10** for pivotal movement about a vertical axis which may be effected by a rotary fluid motor, not shown. The boom assembly **14** further includes at least first and second extensible sections **24** and **26** telescopically received in the base section **16** and adapted to be longitudinally extended or retracted by extensible fluid motors, not shown. On the outer end of the second extensible section **26**, a fixed sheave block **28** is provided over which a cable **30** is threaded for suspending a moving sheave block **32** supporting a load engaging hook **34**. A conventional manually operable fluid control, not shown, is provided for controlling boom movement about the horizontal axis and for controlling longitudinal extension of the boom.

To maintain the free end of the boom assembly **14** in a predetermined plane, in spite of contrary actuation of the manually operable boom control, the present invention provides a unique boom control assembly **35** which will now be discussed.

With reference to FIG. 2 of the drawings, the basic components of the boom control assembly **35** may be summarized as follows. A boom elevation and length follower assembly **42** which is automatically moveable in accordance with vertical pivoting and extension or retraction of the boom assembly **14** is provided to read boom movement. Movement of the follower assembly causes corresponding movement of a switch bar assembly **40** which is spring-loaded to the "boom up" condition and which is connected to the manually operable boom fluid motor control. An elevation stop pin bank assembly **38** is selectively adjustable to limit boom height to a predetermined elevation by limiting movement of the switch bar assembly **42** and thereby controlling actuation thereof. To permit referencing or indexing the control to any point within the working radius which is to serve as a bench mark from which boom movement may be gaged, an elevation referencing assembly **43** is provided. Additionally, to compensate for fore and aft misalignment of the vehicle, a vehicle orientation compensating linkage assembly **36** is included. These assemblies are mounted in a housing **39** which may include a hinge door to provide access thereto.

More specifically, the vehicle orientation compensating linkage assembly **36** comprises a first vertical link **44**, the upper end of which is pivotally connected by an upper pivot pin **45** to the housing **39**. An upper horizontal link **46** is pivotally mounted on the upper pivot pin **45** and a lower horizontal link **47** is pivotally mounted on a lower pivot pin **48** pivotally connected to the lower end of the first vertical link **44**. The upper

horizontal link **46** is provided with a lateral extension **50**, the free end of which supports a spring **54**. A first ear **56** extends from one lateral side intermediate the length of the vertical link **44**, the ear **56** overlapping a second ear **58** fixed intermediate the length of a second vertical link **60**. A vehicle orientation compensating motor **68** is pivotally supported on the housing **39** for rotating a threaded shaft **70** in either rotary direction. The free end of the shaft **70** is connected to the first vertical link **44**. A conventional orientation responsive gage and mercury switch **72** is mounted on the vertical link **44** for actuation of the motor **68**.

An appropriate circuitry for the actuating of motor **68** is shown in FIG. **4**. Lead **91** from a power source such as a battery **61** connects to both ends **64** and **65** of switch **72** which contains mercury **200**. Lead **93** out of end **64** of switch **72** is connected to the coil of relay **62** and lead **95** out of end **65** is connected to the coil of relay **63**. Lead **97** completes the circuit between the coils of relays **62** and **63** and battery **61**. Misorientation of link **44** which causes mercury **200** to complete the circuit of end **64** of switch **72** will energize relay **62**. Similarly, misorientation of link **44** which causes mercury **200** to complete the circuit of end **65** will energize relay **63**. Relay **62** operates a double pole switch **107** which connects leads **97** and **99** from battery **61** to poles **103** and **101** respectively of motor **68**. Relay **63** operates a similar double pole switch **109** which connects leads **97** and **99** to poles **103** and **101** in the reverse order of switch **107**. Consequently, actuation of one end of switch **72** will connect motor **68** to battery **61** to operate motor **68** in one direction and actuation of the other end of switch **72** will reverse the polarity of the battery **61** to operate motor **68** in the opposite direction.

Returning now to FIG. **2**, it can be seen that orientation of the vehicle **12** in an unlevel fore and aft condition induces the vertical link **44** to assume a vertically inclined position. Such an inclined position causes the mercury switch **72** to actuate the motor **68** to move the threaded shaft **70** in an appropriate direction to return the vertical link to an absolutely vertical condition. A pair of maximum vehicle misorientation electric switches **74** and **76** are positioned in the extremities of the path of swinging movement of the vertical link **44** whereby, upon contact with the link, the switches may actuate a warning device, such as light **111** to indicate an extreme or impractical orientation for operating the crane **10**. A circuit whereby the operation of either switch **74** or **76** will permit a current to flow between battery **61** and light **111** is clearly shown in FIG. **4** such that further explanation is unnecessary.

The maximum elevation stop pin bank assembly **38** permits the crane operator to select an elevational plane which the free end of the boom assembly is to be maintained. The bank assembly **38** is mounted on the second vertical link **60** and comprises a bank housing **78** in which a plurality of equally vertically spaced, rearwardly extending stop pins **80** are mounted. Upper and lower stop pins **81** and **83** are fixedly mounted in the housing **78** and establish the upper and lower limits of boom movement at one reference point. Ten moveable stop pins **82** are provided, each corresponding to a boom elevation somewhere between allowable extremes and each being adapted to be moved from a retracted position, shown in full lines in FIG. **3**, to an extended position shown in phantom lines by an individual stop pin solenoid **84** selectively operable by the operator of the vehicle **12**. The number of stop pins **80** may be varied as desired to provide any number of boom operational planes. Of course, other stop arrangements, such as a one including a single moveable stop pin of an adjustable elevation, may be alternately utilized which provide any desired increment of stop adjustment.

The switch bar assembly **40** which follows movement of the boom follower assembly **42**, comprises second upper and lower horizontal links **85** and **86**, the inner ends of which are pivotally connected on the upper and lower pivot pins **45** and **48**, respectively. The inner ends of the second lower horizontal link **86** is provided with an extension **87** connected to the extension **50** on the first upper horizontal link **46** by the spring **54** whereby the stop pin bank **38** is urged to rotate upwardly or in a clockwise direction as shown in FIG. **2** and the switch bar assembly **40** is urged downwardly or in a counterclockwise direction. Connected between the outer ends of the second upper and lower horizontal links **85** and **86** by pivot pins **92** and **94** is a third vertical link **90**. With reference to FIG. **3** of the drawings, from the rear face of the third vertical link **90**, a switch pivot ear **98** projects. A horizontal pivot or switch arm **100** is pivotally connected to the ear **98** by of horizontal pivot pin **102** and a horizontally extending bar **104** is fixed in a perpendicular relation to the rear end fo the pivot arm **100**. On the front face of the third vertical link **90**, a triangular projection **105** is provided to the front end of which a laterally extending, horizontal arm **106** is fixed to extend laterally into the path of the stop pins **80**. Fixedly positioned, the front face of the third vertical link **90** in the path of pivotal movement of the switch arm **100**, is a pair of upper and lower switches **108** and **110** for activating the boom fluid control, which may be of a conventional electrohydraulic type for controlling movement of the boom hoist cylinder **22**. Circuitry for these switches is shown in FIG. **4** and will be explained later. A spring **112** connects the horizontal bar **104** and the lower end of the link **90** to urge the horizontal arm **106** in a counterclockwise direction, as shown in FIG. **3**, to thereby actuate the upper switch **108**. It is seen that the control **35**, when activated, is normally in the boom up position.

As can be seen in FIG. **4**, the boom hoist cylinder **22** is extended by energizing solenoid **137A** to operate hydraulic valve **137** to allow pressurized fluid from a source such as a pump (not shown) to enter the base **22A** of cylinder **22** through line **135**. The solenoid **137A** of valve **137** is connected to battery **61** by leads **139, 141** and **143** through relay **145**. Relay **145** may include a double pole double throw switch adapted to lock out manual controls which might conflict the operation of the device by opening the circuit between lines **147** and **149**. The solenoid of relay **145** is connected to battery **61** through switch **108** by means of lines **151, 153** and **155**. Closing switch **108** breaks the circuit between lines **147** and **149** and allows pressurized fluid to flow through line **135** extending cylinder **22** and elevating the boom. Conversly, cylinder **22** is retracted by energizing solenoid **137B** to allow pressurized fluid to enter the rod end **22B** of cylinder **22** through line **136**. Valve **138** is connected to battery **61** through relay **146** by leads **140, 142** and **144**. Relay **146** also includes a double pole double throw switch for opening the circuit between lines **148** and **150** while

closing the circuit to solenoid 137B to lock out conflicting manual controls. Leads 152, 154 and 156 connect the coil of relay 146 through switch 110 to battery 61 such that actuation of switch 110 open the circuit between leads 148 and 150 and simultaneously allows pressurized fluid to flow through line 136 to lower the boom.

The boom elevation and length follower assembly 42 shown in FIG. 3 comprises a spring-tensioned cable drum assembly 114 adapted to extend or retract a threaded shaft 118 in accordance with extension or retraction of the boom assembly 14. The cable drum assembly 114 comprises a cylindrical housing 115 in which is positioned a cable drum 116 which threadedly receives the threaded shaft 118. A helical spring 117 urges the drum 116 to reel in a cable 119 reaved thereabout. The free end of the cable 119 is connected to the fixed block 28 on the second extensible section 26 of the boom assembly 14 whereby extension of the boom assembly moves the threaded shaft 118 towards the left, as shown in FIG. 2, and retraction of the boom assembly moves the threaded shaft 118 towards the right. The cylindrical housing 115 is fixedly connected to the lower end of support 124. The upper end of the support 124 is pivotally mounted through the boom pivot pin 20 so that the housing 115 pivots around the horizontal axis in accordance with the pivotal movement through a vertical plane of the boom assembly 14. On the outer end of the threaded shaft 118 is a vertical leg 126. A roller 128 is rotatably mounted on the upper end of the vertical leg 126 by a roller pin 130 and contacts the horizontal bar 104 at a point somewhere along its length. It should be noted that the roller 128 moves horizontally and vertically in accordance with movement of the fixed sheave block 28 and carries the horizontal bar 104 of the switch assembly 40 along with such movement.

The elevation referencing assembly 43 comprises a referencing lock solenoid 132 positioned on the front face of the second ear 58 provided on the second vertical link 60. A friction element or surface 134 is provided on the rear face of the solenoid 132, the element being spring-loaded into engagement with a cooperating friction element 136 or on the front face of the first ear 56 on the first vertical link 44. In this manner, the first and second vertical links 44 and 60 are normally locked together. However, when it is desired to reference the control to any point within the working radius of the boom assembly 14, the solenoid 132 may be actuated to overcome the spring load urging engagement of the friction elements to thereby free the second vertical link 60 for movement relative to the first vertical link 44. It should be apparent that any movement of vertical link 60 will be independent of the movement follower assembly 42 unless switch bar assembly 40 engages a pin stop of assembly 38.

Operation of the control assembly 35 according to the present invention is as follows. Assuming the crane 10 is positioned so that the vehicle 12 is oriented in an unlevel position from front to rear. This unlevel condition is sensed by the mercury switch 72 on the first vertical link 44 and the vehicle orientation compensating motor is accordingly actuated to return the first vertical link 44 to an absolute vertical condition. In this manner, the control assembly 35 is positioned in a base condition independent of vehicle orientation. Of course, if extreme adjustment of the first vertical link 44 is required to compensate for an extremely unlevel condition of the vehicle, the first vertical link 44 will be moved to a point wherein it actuates either of the maximum vehicle misorientation switches 74 and 76. A warning signal may thereby be actuated to indicate an impractical vehicle orientation necessitating vehicle relocation.

With the control 35 deactivated or placed in a condition wherein it will not oppose operation of the boom manual fluid control, the boom assembly 14 is moved by manual actuation of its fluid control until the fixed sheave block 28 is vertically aligned with a remote reference point which is to serve as a bench mark. Usually this point will correspond to ground level at some location within the working radius which, of course, may differ in elevation from ground level at the vehicle or the ground level roller at the preceding orientation of the vehicle The roller 128 is now referenced to ground level since its vertical position always proportionately corresponds to the vertical position of sheave block 28. Ground level referencing of the overall control is accomplished as follows. The brake solenoid 132 is activated to overcome the spring load urging engagement of the brake surfaces 134 and 136 on the first and second ears 56 and 58 on the first and second vertical links 44 and 60 thereby freeing the stop pin bank assembly 38 and the switch bar assembly 40 for independent movement relative to the first link 44. The stop pin bank assembly 38 and the switch bar assembly 40 are allowed to rotate either in a clockwise or a counterclockwise direction, depending upon preceding ground reference, until the action of spring 54 on the extension 50 of the upper parallel link 46 andon the extension 87 of the lower parallel link 86 urges the horizontal arm 106 to contact the lower stop pin 83. Simultaneously, the combined weights of these units, reduced partially by the action of spring 54 on extension 50, provides the force required to establish contact between the horizontal bar 106 and roller 128. The brake solenoid 132 is deactivated thereby permitting the spring loaded brake surface to return to engagement to lock together the first and second vertical links 44 and 60. At this point, the linkage is locked in a position referenced to ground level at the selected point. The operator then actuates an appropriate one of the pin solenoids 84 to move the associated pin 82 to the extended position, shown in phantom lines in FIG. 3, to thereby limit upward movement of the fixed sheave block to a selected plane between boom movement extremes, a desired distance above ground level elevation of the reference point.

The vehicle operator may then activate the control 35 to override the boom manual fluid control. Because the horizontal bar 104 is spring loaded to actuated the upper or "boom up" switch 108, theboom is automatically raised and such upward movement is continued until the roller 128 carries the spring loaded horizontal bar 104 to an elevation wherein the horizontal arm 106 contacts the extended stop pin 82. Any extension or elevation of boom assembly 14 which tends to move arm 106 relative to pin stop 82 will then actuate one of the switches 108 and 110 such that there is a fixed relationship between the position of stop pin 82 of assembly 38 and the plane or other complex path in which the boom is to be maintained. Further upward pivoting of the boom assembly 14 and consequential movement of the elevation follower 42 causes the pivot arm 100 to pivot

in a clockwise direction (as shown in FIG. 3) about pivot pin **102** against the action of the spring **112** to thereby actuate the lower of "boom down" switch **110.** Slight downward movement will occur until the boom is oriented as desired with the free end thereof in the preselected plane. Manual operation of the boom manual fluid control to cause further upward movement by either boom angling or extension causes upward movement of the elevation follower roller **128.** However, even slight upward movement of the roller **128** causes the lower of boom down switch **110** to be automatically activated thereby reversing manual control. In this manner, the free end of the boom is maintained in the desired plane. It should be noted that actuation of boom manual fluid control to effect elongation of the boom assembly causes compensating downward adjustment of boom angle. Consequently, the free end of theboom is moved in uni-planar forwardly direction thereby providing a "level crowd" feature which is particularly advantageous in some crane operations.

The disclosed control is easily modifiable to maintain the free end of the boom in a predetermined curve or complex path. To achieve these ends, it is merely necessary to shape the underside of the horizontal bar **104** to proportionately conform to the desired path. Such modification may be desirable when utilization of a crane in a confined area wherein the vertical or lateral limits of operating space are inconstant or defined by more than one simple horizontal or vertical plane.

Although utilization of one embodiment of the control assembly **35** has heretofore been described for maintaining the free end of a boom in a preselected horizontal plane, it should be noted that the control assembly may be modified to maintain the free end of a boom within other limitations such as a preselected vertical plane. Such may be accomplished merely by reorienting the control to impose the limitations desired. FIG. **5** shows a modification which would enable the control to maintain a constant boom radius which may be beneficial for exact repositioning of loads and to permit the vertical lifting of loads. The refencing mechanism would permit the positioning of loads relative to a chosen reference point.

As seen in FIG. **5,** switch bar assembly **160** consists of a vertical bar **196** mounted on horizontal link **162.** These two elements correspond to bar **104** and link **90** respectively as discussed with respect to the embodiment shown in FIG. **2.** The mounting of bar **196** to link **162** is similar to the mounting of bar **104** to link **90** such that bar **196** may move horizontally relative to link **162** to actuate one of two switch **192** and **193.** Link **162** is pivotally connected at one end to link **163** and at the other end to link **164.** Each of links **163** and **164** are pivotally connected to one end of link **170.** Extension **165** of link **164** is urged to the left by spring **168** such that switch bar assembly **160** is urged to the right to engage roller **184** of the boom extension and elevation following assembly **180.**

The stop pin bank assembly **175,** having stops **197, 198** and **199** is mounted on horizontal bar **171** which is maintained parallel to link **170** by pivot links **173** and **174.** Links **170, 173, 171** and **174** form a parallelogram to permit horizontal referencing of the stop pin bank assembly **175.** Spring **168** is connected to extension **176** of link **173** and urges the stop pin bank assembly **175** to the left. Solenoid **185** permits thelocking of parallelogram **170, 173, 171** and **174** against further movement after the stop pin bank assembly **175** has been referenced. Mercury switch **190** controls motor **191** to maintain the horizontal orientation of link **170** during misorientation of the vehicle.

The boom follower assembly **180** is pivoted with the boom at pivot pin **187.** Cable **119** is reaved about spool **182** such that extension or retraction of the boom assembly **14** cause rotation of the spool **182.** Spool **182** threadedly engages threaded shaft **183** such that rotation of spool **182** causes movement of threaded shaft **183** responsive to boom extension or retraction. Roller **184** is provided at the end of threaded shaft **183** to engage vertical bar **196** of the switch bar assembly **160.** Switch bar assembly **160** also includes arm **194** for engaging the stops of the stop pin bank assembly **175.** Switches **192** and **193** are actuated by movement of bar **196** relative to link **162** as switches **108** and **110** are actuated by movement of bar **104** relative to link **90** in FIG. **2.** Switch **192** actuates boom extension and switch **193** actuates boom retraction. Spring **195** urges bar **196** to the right. The device is pivotally mounted to the housing **39** at point **181.**

The operation of the assembly shown in FIG. **5** is substantially the same as the device shown in FIG. **2.** Spring **168** acts to maintain bar **196** of the switch bar assembly **160** in contact with roller **184** of the boom movement follower assembly **180.** Spring **195** actuates switch **192** to initiate extension of the boom assembly **14.** Extension of the boom assembly **14** extends cable **119** and rotates spool **182** to extend threaded shaft **183.** Boom extension continues until arm **194** of switch bar assembly **160** engages an extended pin **198** on switch bar assembly **175.** Further extension of shaft **183** causes bar **196** to move relative to link **162** to deactivate switch **192** and terminate boom extension. Any manual change in boom extension or boom elevation which changes working radius will tend to move bar **196** relative to pin **198** and thereby actuate one of the switches **192** and **193.** Actuation of one of the switches **192** and **193** will cause boom extension or retraction as needed to maintain a desired working radius.

Additionally, although the present invention has been described in a crane control environment, it should be apparent that the basic concept thereof is applicable to a crane boom movement indicator wherein control features are replaced by warning signals.

Further, various novel aspects of the present invention, alone or in combination, may be advantageously included in a crane boom control wherein conventional means are provided to read line load and accordingly control boom orientation to circumvent vehicle tipping, boom damage or line failure or unsafe loads in general.

Finally, although but two embodiments of the present invention have been disclosed, should be appreciated that various mechanical modifications or substitutions may be made without departing from the basic inventive concepts thereof to be ascertained from the following claims.

We claim:

1. A control device for a material handling apparatus including an extensible boom pivotally mounted for movement about horizontal and vertical axes, the device for controlling the boom movement within a predetermined complex path, the control device including:

first control means for controlling boom movement about the horizontal axis,

second control means for controlling boom extension,

a boom movement follower moveable according to movement of the boom about said vertical and horizontal axes,

a stop fixedly positioned relative to said complex path,

a first element engageable with said stop and responsive to movement of said boom movement follower,

a switch for actuating one of said first and second control means,

said first element being adapted to actuate said switch upon movement of said boom and said boom movement follower which tends to move said first element relative to said stop, and

further including a bar moveably mounted on said first element and engageable with said boom movement follower,

wherein said bar has a first surface shaped to proportionately conform to the shape of said complex path, and adapted to engage said boom movement follower.

2. A control device for material handling apparatus including an extensible boom pivotally mounted for movement about horizontal and vertical axes, a device for controlling boom movement within a predetermined complex path, the control device including:

first control means for controlling boom movement about the horizontal axis,

second control means for controlling boom extension,

a boom movement follower moveable according to movement of the boom about said vertical and horizontal axes,

a stop fixedly positioned relative to said complex path,

a first element engageable with said stop and responsive to movement of said boom movement follower,

a switch for actuating one of said first and second control means,

said first element being adapted to actuate said switch upon movement of said boom and said boom movement follower which tends to move said first element relative to said stop, and

further comprising a second element, said stop mounted on said second element, said second element moveable relative to said first element, means for referencing said second element and said stop to a point remote from the boom, and means for locking said second element against movement away from said reference position.

3. A control device for a material handling apparatus according to claim **7** wherein the movement of said first element is substantially parallel to the movement of said second moveable element.

4. A control device for a material handling apparatus according to claim **8** and further including a bar, said bar moveably supported on said first element, said bar engageable with said boom movement follower.

5. In a control device for a material handling apparatus including an extendible boom pivotally mounted for movement about horizontal and vertical axes, the control device including a boom movement follower moveable in accordance with the vertical and longitudinal movement of the boom, the improvement comprising a first element moveable independent of the movement of the boom movement follower, a stop mounted on said first element, means for referencing said first element and said stop to a point remote from the boom, means forlocking said first element against further movement, said boom movement follower cooperating with said stop to provide a signal responsive to boom movement relative to said remote point.

6. In a control device for a material handling apparatus according to claim **5** wherein said device includes a second element, said second element moveable responsive to said boom movement follower and adapted to engage said stop.

7. In a control device for a material handling apparatus according to claim **11** wherein said device further includes a switch, said switch being actuated upon movement of said boom movement follower which tends to move said second element relative to said stop.

8. In a control device for a material handling apparatus according to claim **10** wherein said said boom is mounted on a vehicle and said device further includes boom orientation means cooperating with said first element to compensate for misorientation of the vehicle.

9. In a control device for a material handling apparatus according to claim **8** wherein said boom orientation means is adapted to maintain said first element in a substantially horizontal orientation during misorientation of said vehicle.

10. In a control device for a material handling apparatus according to claim **13** wherein said boom orientation means is adapted to maintain said first element in a substantially vertical orientation during misorientation of said vehicle.

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