Dec. 20, 1966 J. M. EITEL 3,293,381

CONTACT MECHANISM WITH ROTATABLE AND SLIDABLE SWITCH ACTUATORS

Original Filed Sept. 6, 1962 4 Sheets-Sheet 1

Fig. 1

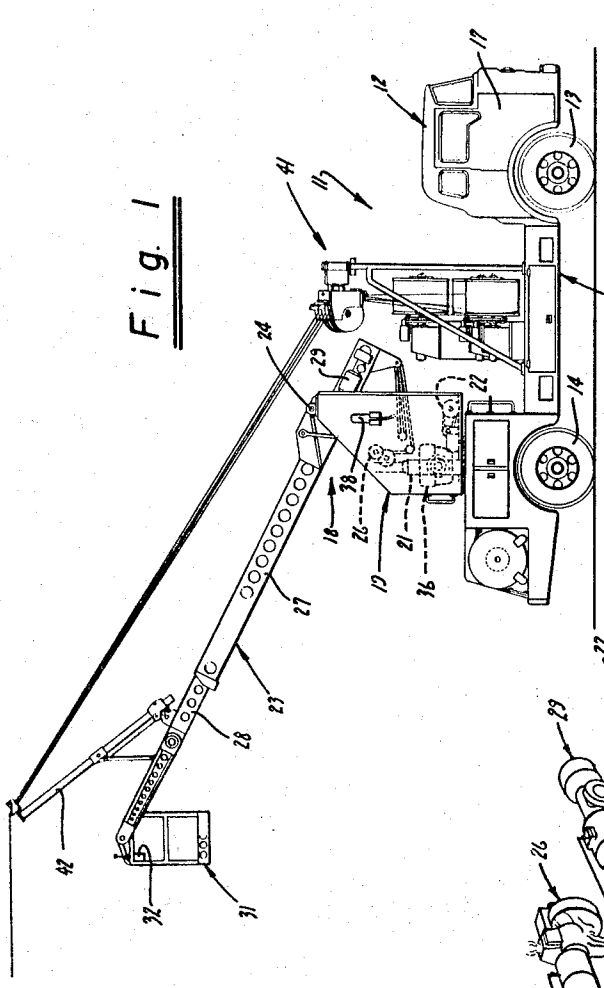


Fig. 6

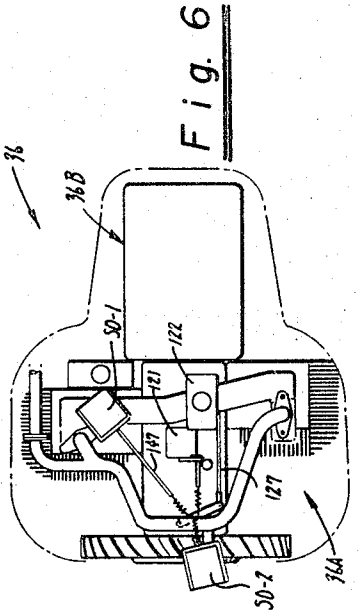
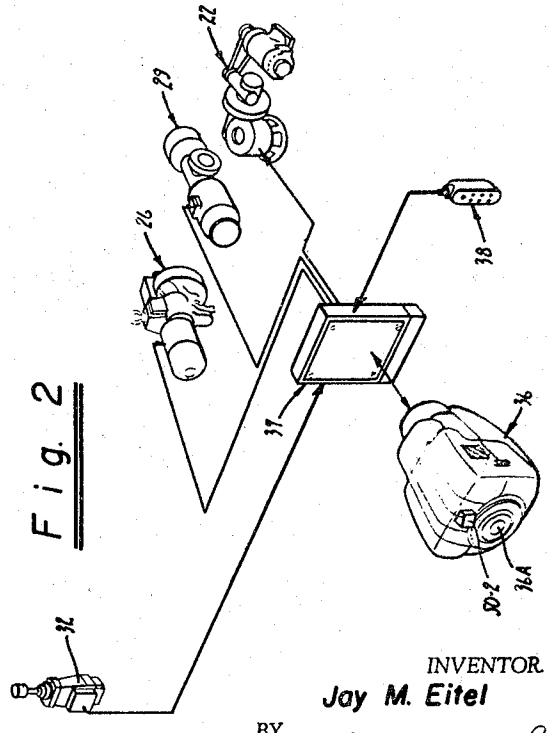


Fig. 2



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CONTACT MECHANISM WITH ROTATABLE AND SLIDABLE SWITCH ACTUATORS

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Fig. 3

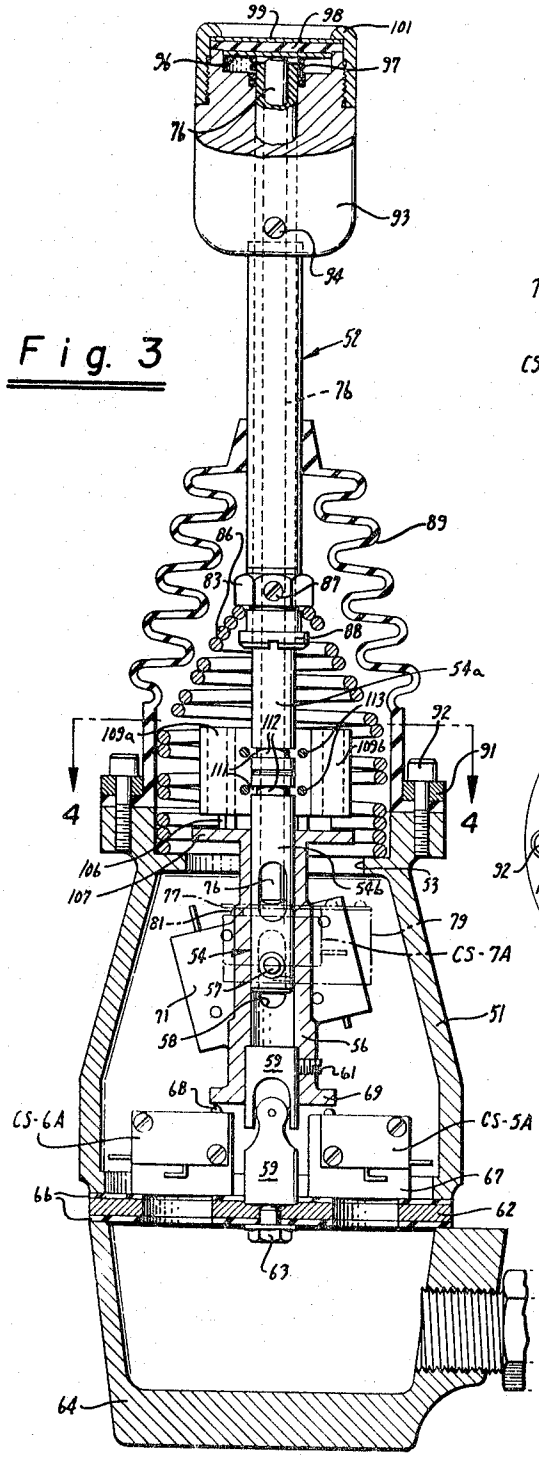
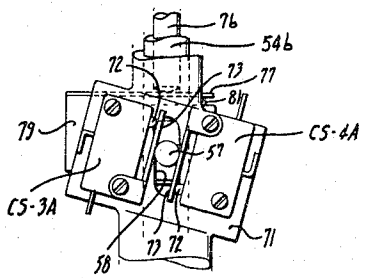


Fig. 5



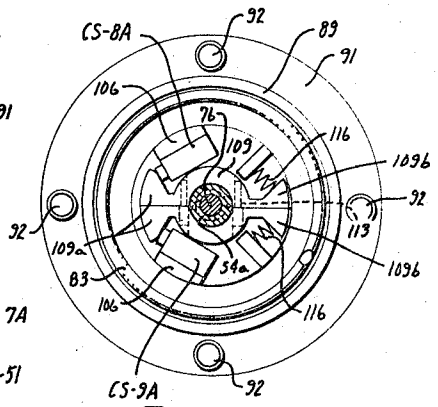


Fig. 4

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CONTACT MECHANISM WITH ROTATABLE AND SLIDABLE SWITCH ACTUATORS

Original Filed Sept. 6, 1962 4 Sheets-Sheet 3

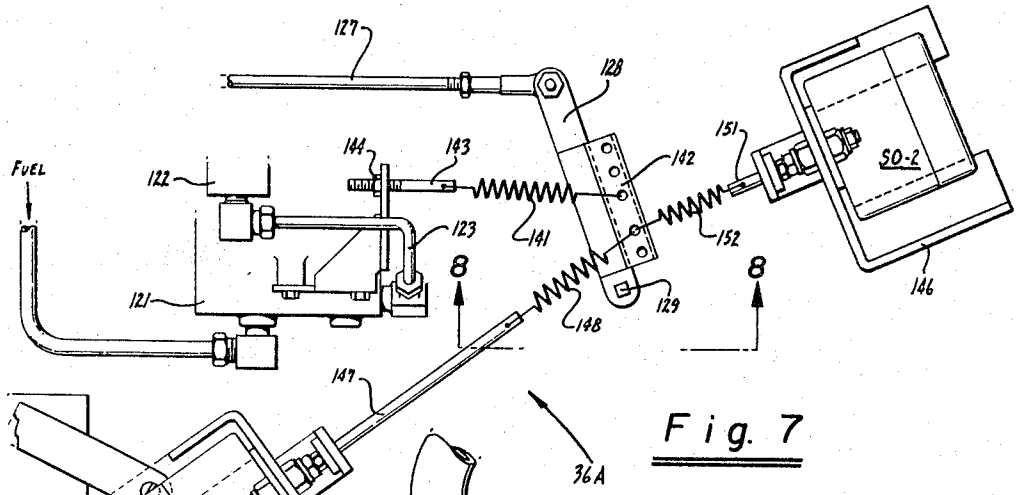

Fig. 7

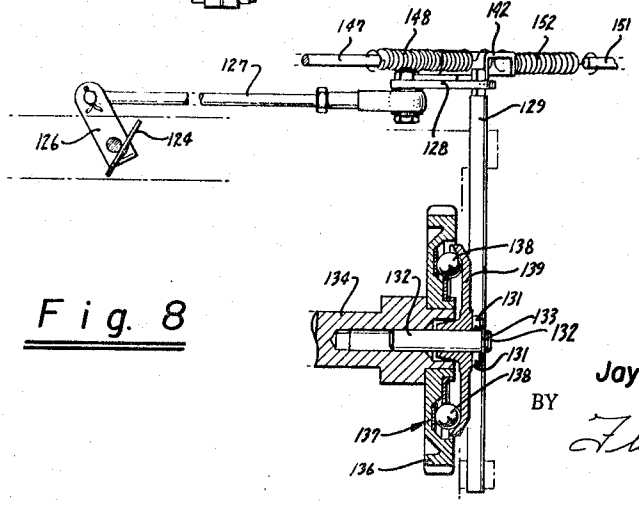

Fig. 8

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CONTACT MECHANISM WITH ROTATABLE AND SLIDABLE SWITCH ACTUATORS

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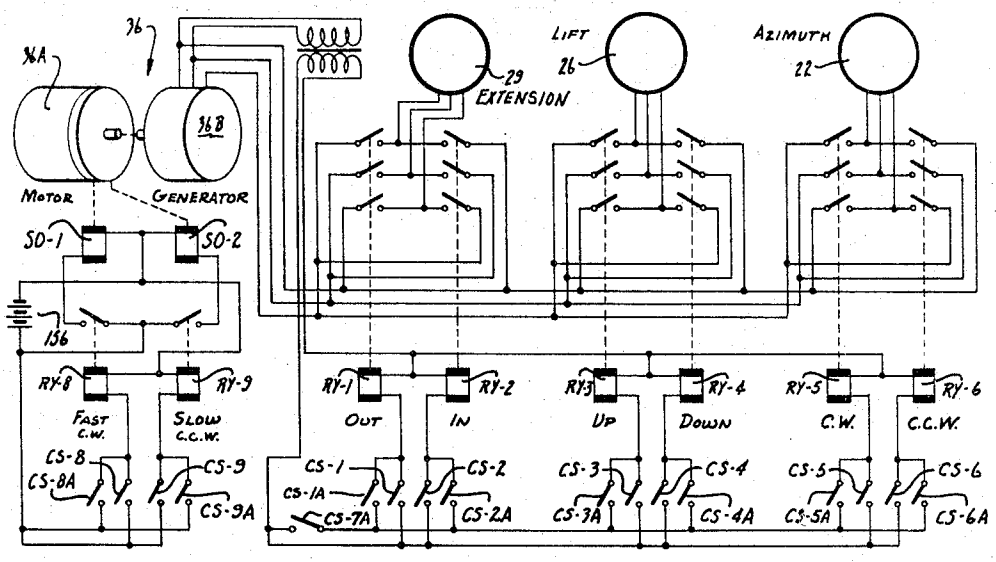

Fig. 9

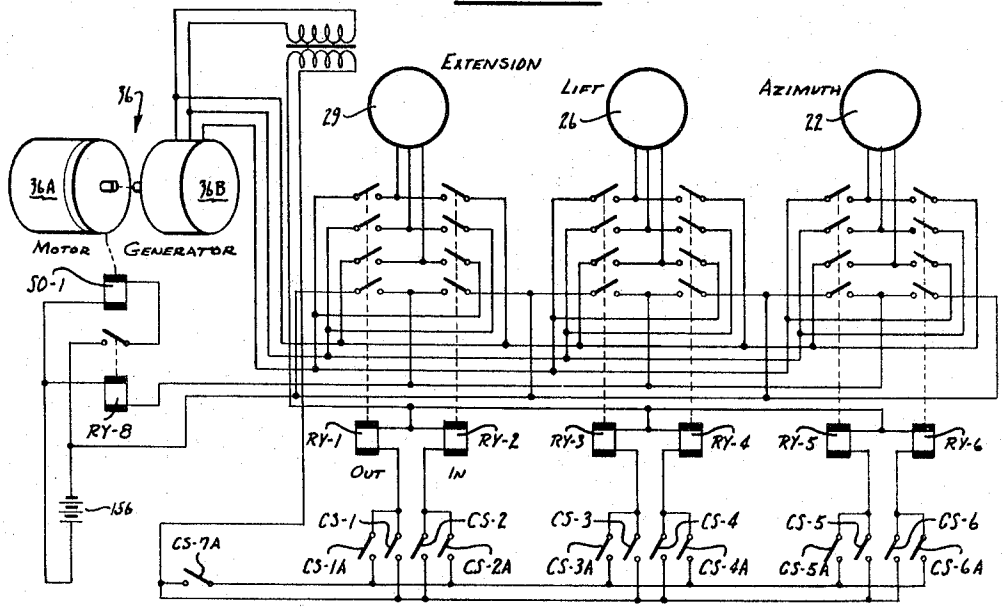

Fig. 10

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Patented Dec. 20, 1966

3,293,381

CONTACT MECHANISM WITH ROTATABLE AND SLIDABLE SWITCH ACTUATORS

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Original application Sept. 6, 1962, Ser. No. 221,693. Divided and this application Mar. 28, 1966, Ser. No. 537,741

5 Claims. (Cl. 200—6)

This application is a division of application Serial No. 221,693, filed September 6, 1962.

This invention relates to a control or contact mechanism, and more particularly to a control or contact mechanism for controlling the movement of a boom structure.

In the operation of aerial lifts in which a boom structure has a workman's basket pivotally mounted on its outer end, it is often desirable to have available more than one rate of speed for moving the boom structure. For example, in the initial raising or moving of the boom structure from its at-home position into a general location in which it is desired to perform work, it is often desirable to accomplish this portion of the movement of the boom structure very rapidly because precise movement at this stage is not required. However, as the workman's basket or platform approaches the general work area, it is generally desirable to slow down the movement and to approach the work area at a slower speed. Then, for very precise positioning of the workman's basket, it is often desirable to be able to move the boom structure and the workman's basket connected thereto at a relatively slow speed so that the workman's basket can be precisely positioned without danger of damaging the structure on which work is to be performed or of damaging the workman's basket or the boom structure. Such precise control may be particularly desirable when working in proximity to high voltage power lines, etc. At the present time, such equipment is not available.

In general, it is an object of the present invention to provide a control mechanism in which it is possible to change the speed of movement of the boom structure.

Another object of the invention is to provide a control mechanism of the above character which can be utilized for increasing or decreasing the speed of movement of the boom structure.

Another object of the invention is to provide a control mechanism of the above character in which the operator in the workman's platform can change the speed of movement of the boom structure.

Another object of the invention is to provide a control mechanism of the above character which can be incorporated with relatively minor changes in conventional aerial lifts.

Additional objects and features of the invention will appear from the following description in which the preferred embodiment is set forth in detail in conjunction with the accompanying drawings.

Referring to the drawings:

FIGURE 1 is a side elevational view of an aerial lift incorporating my control mechanism.

FIGURE 2 is a diagram illustrating a control mechanism and system incorporating my invention.

FIGURE 3 is a side elevational view in cross-section of a control mechanism incorporating my invention.

FIGURE 4 is a cross-sectional view taken along line 4—4 of FIGURE 3.

FIGURE 5 is a partial cross-sectional view on the side opposite the side shown in FIGURE 3.

FIGURE 6 is an enlarged detail view of a portion of the system as shown in FIGURE 2.

FIGURE 7 is a still further enlarged detail view of a portion of the system shown in FIGURE 6.

FIGURE 8 is an enlarged cross-sectional view taken along line 8—8 of FIGURE 7.

FIGURE 9 is a circuit diagram of my system.

FIGURE 10 is a circuit diagram of a modification of my system.

In general, my system for controlling the movement of a boom structure in an aerial lift consists of a power supply and motor drive means for moving the boom structure. Control means is provided for connecting the motor drive means to the power supply. The control means includes means for changing at least one of the characteristics of the output of the power supply so that said output characteristic has at least two values. The output characteristic is one which, when its value is changed, the speed of operation of the motor drive means is changed.

My control mechanism and system for controlling the movement of a boom structure can be incorporated in any suitable aerial lift. For example, as shown in FIGURE 1 of the drawings, it can be incorporated in a mobile aerial lift **11** which consists of a self-propelled vehicle **12** having front and rear wheels **13** and **14**. A framework **16** is supported by the front and rear wheels. A cab **17** of conventional construction is mounted on the front portion of the framework **16**.

A lifting equipment **18** is mounted on the rear portion of the framework **16** and includes a lift supporting structure or turret **19** which is rotatably mounted upon a vertical support post **21** carried by the frame **16**. Motor drive means **22** is provided for rotating the lift supporting structure **21** about the vertical axis formed by the post **21**.

An extensible boom structure **23** is pivotally mounted at **24** in the lift supporting structure **19** for swinging movement or raising and lowering of the outer end of the boom structure **23** about the horizontal axis provided by the pivot **24**. Motor operated means **26** is mounted within the lift supporting structure **19** and is provided for swinging the boom structure **23** about the horizontal axis.

The boom structure **23** consists of an outer boom **27** and an inner boom **28** which telescopes within the outer boom. Motor drive means **29** is provided for extending and retracting the inner boom **28** with respect to the outer boom **27**. A workman's basket **31** is pivotally mounted on the outer end of the inner boom section **28** and carries a control mechanism **32** for controlling the movement of the boom structure **23** as hereinafter described.

The aerial lift also includes a motor generator set **36** which is mounted within the lift supporting structure **19** and a control panel **37** which is also mounted within the lift supporting structure **19**. In addition to the control mechanism **32** which is provided on the workman's basket, there is a control mechanism **38** which is removably secured to the exterior of the lift supporting structure **19** and which has a long control cable. The control mechanism **38** can be used for ground control or control from the vehicle itself when the vehicle is moving to control the boom structure.

A cable guiding and cable carrying apparatus **41** is mounted on the vehicle intermediate the ends of the same and is of the type described in my copending application Serial No. 93,684, filed March 6, 1961, now Patent No. 3,226,087. Additional cable guiding means **42** is mounted on the boom structure and also is of the type described in my above mentioned patent.

All portions of the aerial lift **11** thus far described are disclosed in issued patents and copending applications. Reference may be made to my Patents 2,841,404; 2,896,750; 2,936,847; and 3,055,459.

The control mechanism **32** which forms a part of my

system for controlling movement of the boom structure will first be described. Portions of the control mechanism are similar to the control mechanism for electrically driven apparatus disclosed in Patent No. 2,627,560 and in the control mechanism described in Patent No. 2,841,659. The control mechanism consists of an upper housing **51** formed of a suitable material such as an aluminum casting. A control lever **52** extends upwardly through a centrally disposed opening **53** provided in the upper portion of the housing **51**. The control lever **52** consists of an outer tubular member **54** which is formed in two parts, an upper part **54***a* and a lower part **54***b*. The two parts **54***a* and **54***b* are maintained in alignment and the upper part **54***a* is rotatable with respect to the part **54***b* for a purpose hereinafter described. The lower part **54***b* is slidably mounted in a tubular member **56** and is provided with a horizontally extending pin **57** which extends through a slot **58** provided in the tubular member **56** to limit the relative longitudinal movement between the tubular member **54** and the tubular member **56**. The lower end of the tubular member **56** is secured to one end of a universal joint **59** by suitable means such as a screw **61**. The universal joint is secured to a base plate **62** by suitable means such as a cap screw **63**. The base plate **62** and a lower housing **64** are secured to the upper housing **51** by suitable means such as cap screws (not shown). Sealing gaskets **66** are provided between the base plate **62** and the upper housing **51** and the lower housing **64**.

A plurality of microswitches, namely four, identified as CS–3A, CS–4A, CS–5A and CS–6A, are disposed in a horizontal plane within the upper housing **51** and are secured to the base plate **62** by suitable means such as brackets **67**. The microswitches CS–3A through CS–6A are provided with operating levers **68** which are adapted to be engaged and operated by a horizontally extending flange **69** carried by the lower portion of the tubular member **56** as the control lever **52** is swivelled or pivoted in much the same manner as a joy stick.

A mounting block **71** is formed as a part of the tubular member **56** and carries a pair of microswitches CS–1A and CS–2A which have operating arms **72** adapted to be engaged by operating levers **73**. These operating levers **73** are adapted to be engaged by the pin **57** as the tubular member **54** is raised and lowered as described in my Patent No. 2,841,659 to operate the switches CS–1A and CS–2A.

The control lever **52** also includes a central rod **76** which is slidably mounted in the tubular member **54** for movement longitudinally of the tubular member. The lower extremity of the rod **76** is adapted to engage a leaf spring member **77** which extends into an elongate vertical slot **78** provided in the lower part **54***b* of the tubular member **54**. This spring member is mounted on a block **79**. A microswitch CS–7A is also mounted upon the block **79** and is provided with an operating lever **81** which is engaged by the spring member **77** and which is adapted to be operated by vertical movement of the rod **76** and the spring member **77**.

Means is provided for yieldably retaining the control lever **52** in a vertical position within the housing **51** and consists of a coil spring **83** which has its lower end seated within the upper extremity of the upper housing **51** and which has its upper and smaller end secured to the control lever **52** is provided with an outer cylindrical covering **84** which is mounted over the tubular member **54**. The upper end of the coil spring **83** is secured to the lower extremity of this cover **84** by a nut **86** which is threaded onto the lower end of the covering **84** and retained thereon by a set screw **87**. A collar **88** is also threaded onto the lower extremity of the covering **84** and serves to provide a space between it and the nut **86** which retains the upper end of the spring **83**. A protective conical corrugated spring-like covering **89** formed of a suitable material such as rubber or Neoprene has its upper extremity frictionally engaging the covering **84** and has its lower extremity secured to the upper portion of the upper housing **51** by a retaining ring **91** and screws **92**.

A control knob **93** also forms a part of the control lever **52** and is secured to the upper part **54** of the tubular member **54** by suitable means such as a set screw **94**. A horizontal pressure plate **76** is mounted within the knob **63** and is adapted to engage the upper extremity of the control rod **76** so that it can be depressed against the force of a spring **97** disposed over the end of the control rod **76**. A disc **98** of suitable material such as Neoprene overlies the pressure plate **96** and is held in place by a plate **99** which overlies the disc **98** and a cap **101** which is threaded onto the knob **93**.

This part of the construction of my control mechanism, with the exception of formation of the tubular member **54** in two separate parts **54***a* and **54***b*, is very similar to the construction disclosed in my Patent No. 2,841,659.

At least one and preferably two or more additional microswitches are incorporated in my new and improved control mechanism. In the embodiment shown in the drawing, two additional microswitches identified as CS–8A and CS–9A have been added. These microswitches CS–8A and CS–9A are supported upon brackets **106** mounted upon the horizontally extending flange **107** provided on the upper end of the tubular member **56** as shown particularly in FIGURE 3. These microswitches are provided with levers **108**. Means is provided for operating levers **108** and also for providing a slip joint for the upper and lower parts **54***a* and **54***b* of the tubular member **54** and consists of a pair of members **109** which are provided with a pair of vertical spaced semi-circular flanges **111** which are slidably seated in horizontal grooves **112** provided in the lower end of the upper part **54***a* and the upper end of the part **54***b*. Suitable means is provided for securing the two members **109** about the tubular member **54** and consists of bolts **113**.

Each of the members **109** is provided with an enlarged portion **109***a* which is adapted to engage the operating lever **108** of the associated microswitch as shown particularly in FIGURE 4. Means is provided for retaining the tubular member **54** and the control rod in a neutral position with respect to microswitches CS–8A and CS–9A and consists of compression springs **116** mounted between portions **109***b* of the members **109** and brackets **117** secured to the flange **107** of the member **56**.

Operation of this control mechanism will be described in conjunction with my system. My system, in addition to the control mechanism **32**. includes a pair of solenoids SO–1 and SO–2 which are mounted upon the motor **36A** of the motor generator set **36**. They are utilized for controlling the output frequency of the generator **36B** as hereinafter described. The motor generator set forms the power unit for the motive drive means **22**, **26** and **29**.

Although I have shown electrically operated motor drive means for my lift, it is readily apparent that, if desired, hydraulic control means can be provided. In this event, hydraulic motors can be utilized for the motor drive means **22**, **26** and **29** and a motor driving a hydraulic pump supplying hydraulic fluid to the hydraulic motors can be utilized for the power supply. The solenoids SO–1 and SO–2 could then be utilized for controlling the pressure at which fluid is supplied to the hydraulic motors and thus vary the speed of rotation of the hydraulic motors. The pressure supplied to the hydraulic motors can be readily controlled by changing the pressure at which the fluid is returned to the reservoir for the hydraulic fluid.

Assuming that electrically operated motive drive means is utilized, the motor generator set can be of any suitable type. For example, it can be Model No. 305 CCK–5R manufactured by D. W. Onan & Sons, Inc. of Minneapolis, Minn., which is a 3.5 kw. generator that supplies 3 phase 60 cycle 230 volt A.-C. at 1800 r.p.m.

The generator is provided with a saturated field which has inherent voltage regulation. Alternatively, the motor generator set can be Model No. 5RM51 manufactured by Kohler which has a similar output but which is provided with a controllable field.

Assuming that an Onan type motor generator set is utilized as shown in the drawings, the solenoids SO–1 and SO–2 are mounted on the motor 36A so that they can control the operation of the governor for the motor. As is well known to those skilled in the art, such a motor generator set is provided with a fuel pump 121 which supplies fuel to a carburetor 122 through a fuel line 123. The carburetor is provided with a throttle plate 124 for controlling fuel flow. This throttle plate is secured to a throttle arm 126. The throttle arm is pivotally connected to a link 127. This link 127 is pivotally connected to an arm 128 which has its other end secured to a governor control rod 129. The governor control rod 129 is provided with a substantially U-shaped yoke 131 which engages opposite sides of a center pin 132 of the governor. A snap ring 133 is provided on the center pin 132 for retaining the yoke 131 in engagement with the pin. The center pin 132 is retained in a cam shaft 134 which rotates as the motor operates. A cam shaft gear 136 is affixed on the cam shaft 134 and rotates with the cam shaft. It is provided with a race 137 in which are disposed a plurality of governor fly balls 138. A governor cup 139 is mounted on the center pin 132 so that the center pin can rotate with respect to the governor cup. As can be seen from FIGURE 8, the outer extremities of the governor cup are tapered inwardly toward the cam shaft gear so that as the speed of the cam shaft gear is increased, the governor fly balls will be thrown centrifugally in a radial direction to urge the governor cup 139 outwardly to move the linkage 127 to the right as viewed in FIGURES 7 and 8 to change the positioning of the throttle valve 124 and to decrease the fuel supplied to the carburetor 122. It will be noted that the force of the governor fly balls must overcome the effect of a spring 141 which has one end secured to an adjustable mounting bracket 142 and the other end secured to a pin 143 which is affixed to the fuel pump 121.

The governor on this motor operates in a conventional manner to drive the generator at a relatively constant speed as, for example, the 1800 r.p.m. specified. The positioning of the spring 141 on the bracket 142 determines the sensitivity of the governor and the speed of the governor is controlled by adjusting the nut 144 provided on the pin 143. Increasing the tension on the spring 141 increases the force which the governor must overcome and, therefore, increases the speed at which the motor 36A must operate before the governor throttles the speed. Similarly, decreasing the tension on the spring 141 decreases the speed at which the governor will throttle the operation of the motor.

The solenoids SO–1 and SO–2 are provided with means whereby they can affect the operation of the governor and thereby control the speed of the motor. Thus, the solenoids SO–1 and SO–2 have been mounted in brackets 146 which are mounted on the motor 36A on opposite sides of the arm 128 of the governor control linkage. The solenoid SO–1 is provided with an operating arm 147. A spring 148 has one end attached to the operating arm 147 and has the other end secured to the bracket 142 of the arm 128. Similarly, the solenoid SO–2 is provided with an arm 151. A spring 152 has one end secured to the arm 151 and has the other end secured to the bracket 142 at substantially the same point as the spring 148. When either of the solenoids SO–1 and SO–2 are energized, the springs 148 and 152 counterbalance each other and thus have no effect on the normal operation of the governor. However, when one of the solenoids is energized, it will affect the operation of the governor. For example, when SO–1 is energized, the spring 148 will be tensioned to a greater extent to aid the spring 141 so that the governor must exert additional force to overcome the additional force created by the spring 148 before it can throttle the motor 36A. This means that the motor will be operating at a higher governed speed. When the solenoid SO–2 is energized, and the solenoid SO–1 is in a deenergized condition, the additional tensioning of the spring 152 will create a force opposite to that created by the spring 141 so that less force must be exerted by the governor before it can throttle the motor 36A. This means that the motor 36A will operate at a lower governed speed than would be the case when solenoid SO–2 is not energized.

A simplified version of the circuitry utilized in my system for controlling the boom structure 23 is shown in FIGURE 9. The microswitches provided in the control mechanism 32 are indicated on the circuit diagram. The corresponding microswitches in the control station 38, with the exception of the microswitch CS–7A which is omitted from the ground control station 38, are indicated as CS–1 through CS–9. The relays associated with these switches are indicated as RY–1 through RY–9. No relay is associated with the microswitch CS–7A. The relays are provided with the contacts shown which are connected to the three phase lines from the generator 36B and which are adapted to drive the associated motor as indicated in the circuit diagram. These relays which also may be called contactors are adapted to be energized from a single phase transformer which is connected across two of the lines from the generator 36B to supply a low voltage, e.g., 12 volts, to the relays. A separate battery 156 is provided for energizing the relays associated with the motor generator set.

Operation of my control mechanism and system for controlling the movement of the boom structure 23 may now be briefly described as follows. Let it be assumed that the boom structure is mounted in a position in which it extends over the cab of the vehicle and that it is now desired to utilize the same. The ground control station 38 can be removed from the lift supporting structure or turret 19 to move the boom structure to a position so that the basket is close to the ground so that an operator can step into the basket. If it is desired to accomplish this and with the normal speed of operation of the generator 36, the desired switches of the switches CS–1 through CS–6 are operated. For example, if it is desired to raise the boom structure, the switch CS–3 is operated. Thereafter, when the boom structure has been raised sufficiently, the switch can be released and the boom structure can be rotated in a clockwise or counter-clockwise direction by operating either the switch CS–5 or CS–6 to move the boom structure out to the side of the vehicle. Thereafter, the boom structure can be lowered by operation of the switch CS–4.

If it is desired during these operations to move the boom structure more rapidly, the switch CS–8 can be moved to a closed position during the same time. Closing of this switch will energize the relay RY–8 to close its contacts to energize the solenoid SO–1. Energization of the solenoid SO–1 tensions the spring 148 to aid the spring 141 and to, therefore, make it necessary for the motor 36A to increase the governor speed before the governor can throttle the engine. Increasing the speed of the motor 36A will increase the output frequency of the generator 36B as well as the output voltage. In increasing the speed of the motor, it is desirable to change at least one of the characteristics of the output from the generator. It is desirable that the characteristic which is changed be one which will also change the speed of rotation of the drive motors which are being operated to move the boom structure. Thus, for example, the rod 147 connected to the solenoid SO–1 can be adjusted so that the spring 148 applies sufficient force so that the motor will operate at a speed which will cause the generator to produce an output frequency of 75 cycles rather than the

normal 60 cycles. This will cause the drive motor being utilized for operating the lift to be rotated at a substantially faster speed and thereby increase the speed of movement of the boom structure.

If it is desired to move the boom structure more slowly than the normal speed, the switch CS–9 can be operated to energize the relay RY–9 and the solenoid SO–2. Energization of the solenoid SO–2 tensions the spring **152** to reduce the force applied by the spring **141** so that the motor **36**A of the motor generator set will be controlled sooner and at a lower speed by the governor. This will decrease the frequency output of the generator as well as reduce the voltage. This reduction of the frequency of the generator will reduce the speed of rotation of the drive motor which is being operated.

Thus, it can be seen by the operation of these switches in the ground control station **38**, the boom structure may be moved at its normal speed by operating the generator at 60 cycles, a faster speed by operating the generator so that it produces 75 cycles, or at a lower speed by operating the generator so that it produces a frequency of 45 cycles.

Now let it be assumed that the boom structure has been positioned so that the workman can readily enter the workman's basket **31**. Thereafter, the workman in the workman's basket can assume control of the operation of the boom structure by utilizing the control mechanism **32**. He can operate the drive motors **22**, **26** and **29** at their normal speeds by grasping the control lever **52** by the hand and utilizing the thumb to depress the pressure plate **96** to operate the rod **76** which closes the microswitch CS–7A. After this has been accomplished, any of the desired microswitches in the control mechanism may be operated. For example, if it is desired to raise the boom structure, the control lever **52** is lifted so that the tubular member **54** and the pin **57** connected thereto is lifted to operate the microswitch CS–3A. Operation of switch CS–3A causes energization of the relay RY–3 and closing of the contacts associated therewith to operate the lift motor to raise the outer end of the boom structure. Conversely, the boom structure can be lowered by moving the control lever downwardly so that the pin **57** operates the microswitch CS–4A.

The boom structure can be extended or retracted by operation of the microswitches CS–1A and CS–2A. The switches are operated by moving the control lever **52** forwardly or rearwardly to shift the cam plate **69** to operate the operating levers **68** of the microswitches. The boom structure can be rotated by operation of the control lever **52** to one side or the other. For example, it can be moved in a clockwise direction by shifting the control lever to the right to operate microswitch CS–5A. Conversely, the boom structure can be moved in a counterclockwise direction by operation of the microswitch CS–6A by moving the control lever to the left as viewed in FIGURE 3.

If it is desired to move the boom structure more rapidly in the direction in which it is being moved, it is only necessary to rotate the control lever **52** in a clockwise direction to energize the microswitch CS–8A which energizes the relay RY–8 which, in turn, energizes the solenoid SO–1 to cause the motor to operate at a faster speed so that the generator will supply an output having a higher frequency. As explained above, this causes the drive motor being operated to operate at a greater speed.

After the boom structure has been initially moved rapidly to the general location desired, the control lever can be allowed to return to its normal position under the urging of the springs **116** and the boom structure can thus be allowed to approach the desired position at its normal speed. Thereafter, if it is desired to precisely position the boom structure after it has once arrived at the general location, it may be desirable to operate the boom structure at a lower rate of speed. This can be accomplished by rotating the control lever in a counterclockwise direction to cause the operation of switch CS–9A which causes energization of the relay RY–9 and the solenoid SO–2 so that the motor will be operated at a lower speed and decrease the output frequency from the generator **36**B. This will cause the drive motors being utilized for driving the boom structure to be operated at a slower speed and will make it possible to precisely position the boom structure without danger of accidentally moving the boom structure into undesired locations or in damaging the boom structure of the workman's basket.

A more simplified embodiment of my system for controlling the boom structure **23** is shown in FIGURE 10. In this embodiment, a control mechanism of the type described in my Patent No. 2,841,659 can be utiilzed. One of the solenoids SO–1 or SO–2, with its associated spring, can be omitted depending upon whether an increased speed or a decreased speed is desired. Let it be assumed that an increased speed is desired. If such is the case, solenoid SO–2 and its associated spring **152** can be omitted.

Relay RY–8 is provided for energizing the solenoid SO–1. The relay RY–8 is connected to an extra set of contacts which is provided for each of the relays RY–1 through RY–6 as shown in FIGURE 10. Thus, when any one of the switches CS–1 through CS–6 and CS–1A through CS–6A is closed, the associated relay will be operated to close its contacts to energize the associated drive motor for the boom structure. At the same time, as soon as one of the relays RY–1 through RY–6 is energized, the relay RY–8 will be energized to close its contacts to energize the solenoid SO–1. Energization of the solenoid SO–1 will tension the spring **148** to apply additional force to the arm **28** which aids the spring **141** so that the motor **36**A must operate at a faster speed before the governor controls the speed of the motor.

It, therefore, can be seen that with this arrangement, each time one of the drive motors **22**, **26** and **29** is energized, the solenoid SO–1 will be energized so that the generator **36** will increase its output frequency to thereby increase the speed of movement of the boom structure. If desired, the solenoid SO–2 can be operated instead of the solenoid SO–1 to provide an arrangement in which the boom structure will be operated at a slower speed.

In both of the circuit diagrams shown in FIGURES 9 and 10, there will be a relatively smooth transition from one speed of movement to the other because the output frequency from the generator will not be increased instantaneously but rather will be increased or decreased gradually as the motor **36**A increases or decreases its speed. Therefore, there will not be any abrupt or jerky movements of the boom structure which makes it possible to control the movement of the boom structure very precisely with the desired amount of speed and accuracy.

It is apparent from the foregoing that I have provided a new and improved control mechanism which is particularly adapted for controlling the movement of boom structures. Although I have limited my description to controlling the movement of boom structures, it is readily apparent that this same control mechanism can be utilized for controlling other types of apparatus if desired. Also, as pointed out above, although I have generally limited my description primarily to electrically driven drive means, it is readily apparent that the same teaching can be applied to other types of drives as, for example, hydraulic means as explained above.

I claim:

1. In a control mechanism, a housing, a control lever mounted on the housing for generally pivotal movement therein, a portion of the control lever being rotatable axially with respect to the remaining portion, switch means movable between open and closed positions mounted on the remaining portion of the control lever, and means carried by the rotatable portion of the control lever for moving said switch means between said open and closed positions in any pivotal position of the con-

trol lever by rotational movement of the rotational portion of the control lever.

2. In a control mechanism, a housing, a control lever having one end pivotally mounted in said housing, a plurality of switches disposed in a horizontal plane in said housing, the control lever comprising a lower tubular member and an upper member, the upper member being slidably mounted in said lower tubular member for axial movement with respect to said lower tubular member, means for pivotally connecting the lower end of said lower tubular member to said housing to permit tilting movement of said control lever in a radial direction, means carried by the lower tubular member adapted to operate said switches as the control lever is tilted, a plurality of switches mounted on said lower tubular member, means carried by said upper tubular member adapted to operate said last named switches as the upper member is moved axially, switch means mounted on said upper member, one portion of the upper member being rotatable with respect to the other portion of the upper member, means carried by the rotatable portion of the upper member for operating said switch means in any axial position of the upper member and in any tilted position of the control lever.

3. A control mechanism as in claim 2 together with an additional switch mounted on said upper member, an operating rod slidably mounted in said upper member and having means engaging said additional switch for operating said additional switch.

4. A control mechanism as in claim 2 together with means for yieldably retaining said rotatable portion in a normal position in which said switch means is not operated.

5. In a control mechanism, a housing, a control lever, means mounting said control lever in said housing to permit rotational and sidewise movement of the control lever mounted in the housing for movement therein, a plurality of switches movable between open and closed positions disposed in a generally horizontal plane and mounted on said housing and adapted to be moved between the open and closed positions by the control lever upon sidewise movement of the control lever, a portion of the control lever being rotatable axially with respect to the remaining portion of the control lever, additional switch means movable between open and closed positions carried by one of the portions of said control lever, and means carried by the other portion of said control lever for moving said additional switch means between open and closed positions as said other portion of said control lever is rotated axially in any sidewise position of said control lever.

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