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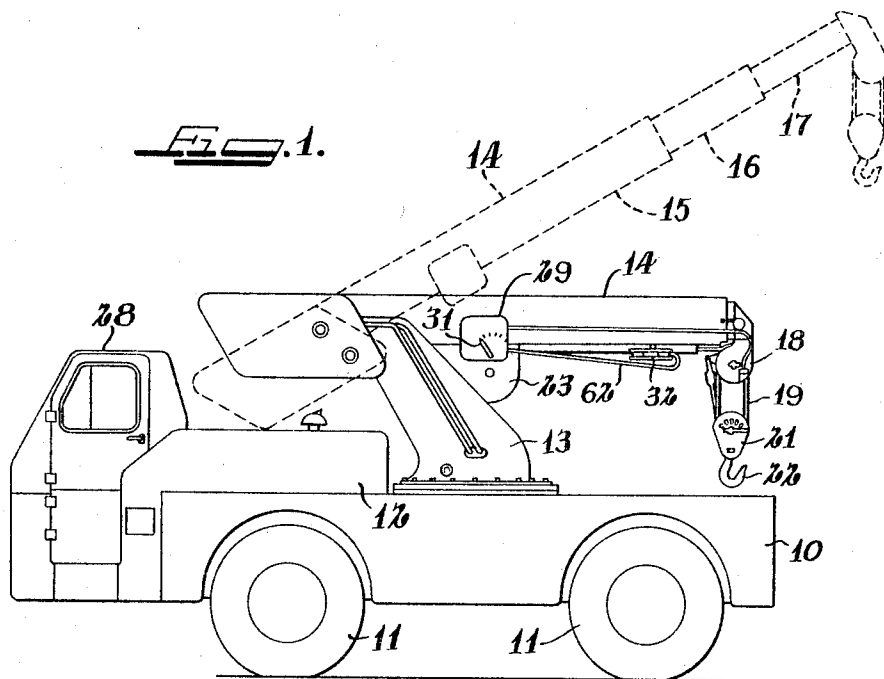
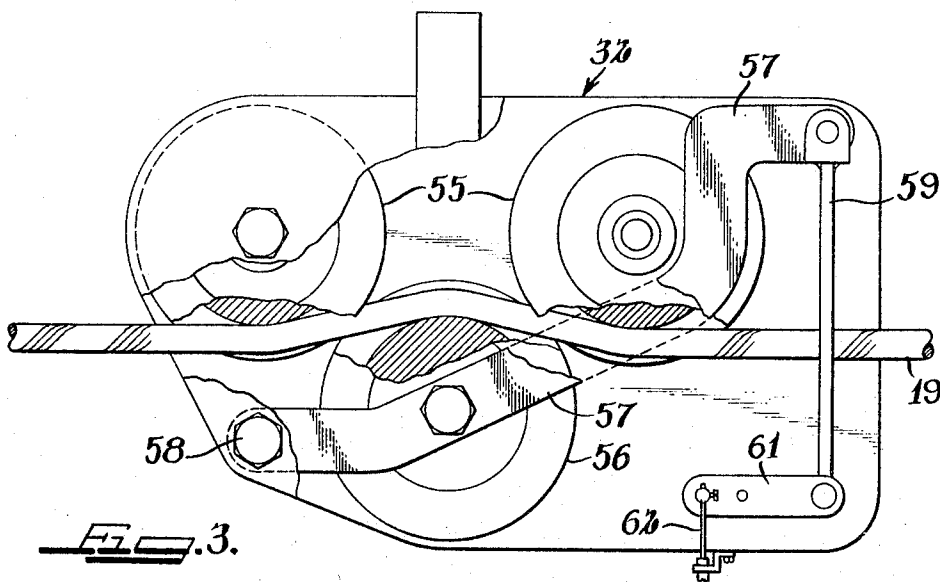
S. G. KNIGHT

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SAFETY CONTROL FOR EXTENSIBLE BOOM CRANES

Original Filed Dec. 26, 1964

4 Sheets-Sheet 1



INVENTOR
SIDNEY G. KNIGHT

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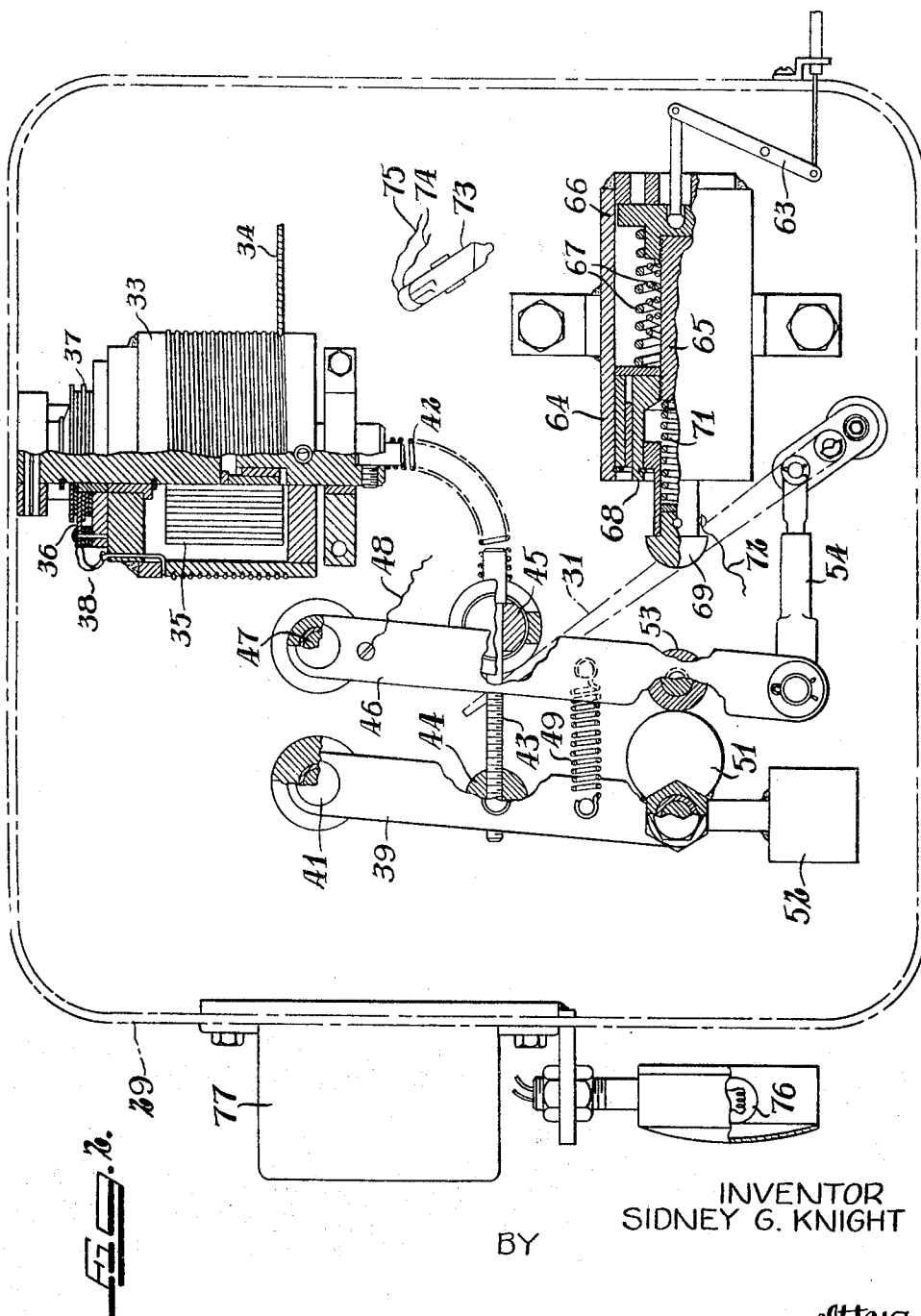
S. G. KNIGHT

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SAFETY CONTROL FOR EXTENSIBLE BOOM CRANES

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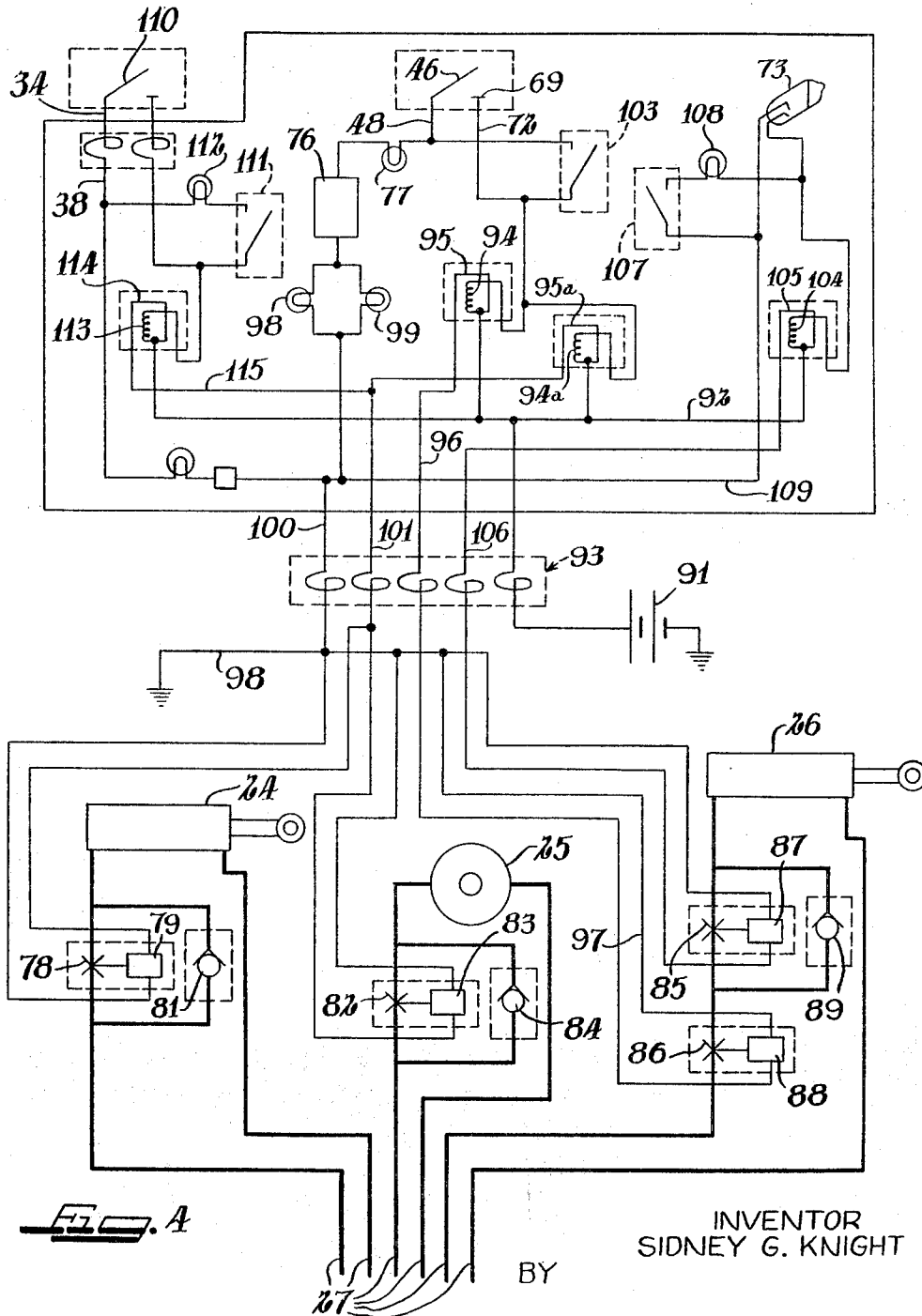
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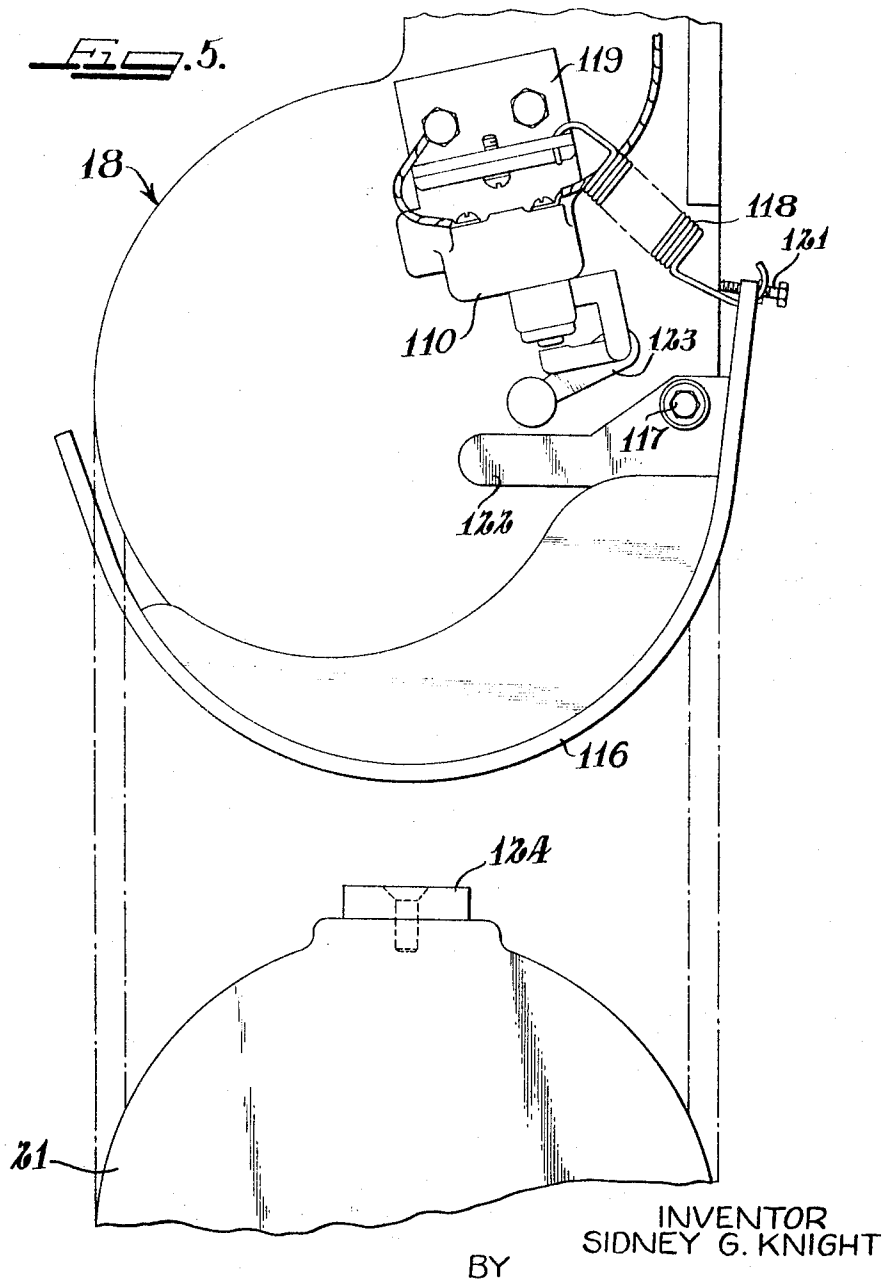
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SAFETY CONTROL FOR EXTENSIBLE BOOM CRANES

Sidney G. Knight, Schofield, Wis., assignor to Drott Manufacturing Corporation, Milwaukee, Wis., a corporation of Wisconsin

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4 Claims. (Cl. 212—39)

The application is a division of application Serial No. 421,396, filed December 26, 1964.

This invention relates to a safety control for cranes and more particularly to controls for self-propelled cranes having extensible booms.

In the operation of cranes and specifically of self-propelled cranes suspended on wheels or tracks, there are several conditions which can lead to danger of upsetting the crane or damage to portions of the crane mechanism. The first and most common of these conditions is overloading of the crane which could result in overturning thereof with damage to the apparatus and possible injury to the operator or other persons adjacent to the crane. The amount of load which may safely be lifted depends not only on the weight of the load, but also on the length and elevation of the boom which determine the moment arm so that measurement of the load being lifted by the device cannot alone determine when an unsafe condition is being created.

A second condition which occurs arises through excessive elevation of the boom. This could result in moving the load over the apparatus or in bumping and damaging portions of the apparatus by the load as well as damaging of the boom and the lifting mechanism therefor.

A third condition which can arise results if the lifting cable is attempted to be reeled in or if the boom is attempted to be extended further after the load has been raised into contact with the end of the boom. This could result in cable breakage or other damage to the apparatus.

It is accordingly an object of the present invention to provide a safety control means for cranes which operates automatically to prevent any of the several different dangerous conditions mentioned above from arising in operation of the crane.

According to a feature of the invention, automatic controls are provided responsive to the degree of extension, angle of elevation of the boom and the load being lifted to control power means which operates to reel in the cable and to elevate the boom to prevent an operation which might tend to produce overturning of the apparatus. In addition, the control means is operated when the load engaging block is raised to the end of the boom to prevent operation of the power means for extending the boom or reeling in the cable.

Another object is to provide safety control means for cranes in which the boom and cable are operated by hydraulic motors and control valves are provided in the connections to the motors to cut off the supply of operating fluid thereto when a dangerous condition is approached. The control valves may be bypassed by check valves which permit operation in a direction to correct the dangerous condition when the control valves are closed.

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The above and other objects and features of the invention will be more readily apparent from the following description when read in connection with the accompanying drawings, in which:

FIG. 1 is a side elevation of a self-propelled crane embodying the invention;

FIG. 2 is a view of the control mechanism with parts broken away and in section;

FIG. 3 is a side elevation with parts broken away and in section of the mechanism for measuring the load on the cable;

FIG. 4 is a diagram of the control circuit; and

FIG. 5 is a side elevation of the blocks and the control means operated thereby.

The safety control means of the present invention is illustrated as embodied in a self-propelled crane having a frame or chassis 10 supported on wheels 11. A suitable power plant, such as an engine, is carried by the frame or chassis, as indicated at 12, and may be connected to the wheels to drive the same in any desired manner as through either a mechanical or hydraulic transmission.

The vehicle frame carries a crane comprising a base section 13 which is mounted on the frame for rotation about a vertical axis and which extends upwardly from the upper surface of the frame. An extensible boom, indicated generally at 14, is pivoted at the upper end of the base section 13 to swing in a vertical plane. The boom preferably comprises two or more sections, as indicated at 15, 16 and 17 in dotted lines in FIG. 1, which fit telescopically together for extension or retraction to produce any desired length of boom. The boom is preferably controlled hydraulically to extend and contract the same.

For picking up a load the outer end of the end boom section 17 carries a fixed block 18 over which a cable 19 is threaded. The cable 19 is threaded over sheaves in a load engaging block 21 which may carry a hook 22 or similar device for engaging and raising a load. The cable 22 is reeled in and out by a drum contained in a housing 23 on the boom so that the load may be raised or lowered, as desired.

The raising and lowering of the boom, the extension and retraction thereof and the reeling in and out of the cable are preferably controlled hydraulically through hydraulic motors, as illustrated in FIG. 4. Extension and contraction of the boom is effected through a cylinder and piston type hydraulic motor 24 which is preferably mounted in the boom itself and which is supplied with operating fluid at its left end, as seen in FIG. 4, to extend the boom and at its right end to retract the boom. The drum on which the cable is reeled up or from which it is unreeled is driven by a rotary hydraulic motor 25. Raising and lowering of the boom is controlled by a cylinder and piston type motor 26 which is preferably concealed within the base section or mast 13 so that it is not seen in FIG. 1. The engine on the crane drives a hydraulic pump from which operating fluid is supplied to the several motors through lines indicated at 27 and which are provided with manually operated control valves so that the operator can easily and accurately control the several operations of which the boom is capable. The operator may be enclosed in a cab 28 within which the controls for movement of the vehicle and for the several operations of the crane itself are housed.

The safety control apparatus of the present invention is preferably enclosed within a housing 29 which is mounted on the base section of the boom. This housing may be formed at one side with an indicating scale over which a pointer 31 is movable and which is controlled, as hereinafter described, to indicate the degree of extension of the boom. The tension on the cable 19 is measured by a measuring device 32 described more fully hereinafter and which is mounted on the boom, as shown.

The safety control apparatus is more particularly shown in FIG. 2. As there illustrated the degree of extension of the boom is measured by a rotatable drum 33 on which a light cable 34 is wound. The drum is urged to reel up the cable 34 by a spring 35 and the cable 34 is secured to the end section 17 of the boom so that when the boom is extended the cable will be withdrawn from the drum and will rotate the drum. The cable 34 also serves as an electrical conductor for preventing so-called "double blocking," that is further raising of the load lifting block after it has been moved up in engagement with the stationary block 18. For this purpose, the cable is connected to an electrical wiper 36 which wipes over a conductor disc 37 connected to an electrical lead 38.

The rotation of the drum 33 is adapted to adjust the angular position of an arm 39 which is pivoted at 41 and which normally extends generally downward from its pivot mounting. For this purpose, the drum is connected through a flexible shaft 42 to a screw 43 which is threaded into a rotatable block 44 on the arm 39, the screw 43 being held against lengthwise movement in a swivel mounting 45 carried by the housing 29. As the screw 43 is turned, it will therefore cause the arm 39 to assume an angular position about the pivot 41 which is proportional to the degree of extension of the boom.

The arm 39 controls the angular position of a second arm 46 which is pivoted at 47 and which is connected into an electrical circuit by a conductor 48. The arm 46 is urged toward the arm 39 by a spring 49 until it engages a cosine cam 51 which is rotatably mounted on the lower end of the arm 39. The angle of the cosine cam is determined by the angle of elevation of the boom, for which purpose a pendulum weight 52 is connected to the pivotal mounting of the cosine cam and will always hang vertically therefrom. Preferably an antifriction roller 53 is carried by the arm 46 to ride against the cam thereby to minimize friction. With this construction, the angle of the arm 46 about its pivotal mounting will be dependent on both the degree of extension and the angle of elevation of the boom. As shown, the pointer 31 is connected to the lower end of the arm 46 through a link 54 to give a visual indication of these conditions.

The load being lifted by the boom is dependent upon the degree of tension in the cable which is measured by the device 32, as best seen in FIG. 3. As shown in this figure, the cable 19 runs over a pair of fixed sheaves 55 which are spaced longitudinally of the cable and is engaged by a third sheave 56 located lengthwise between the two sheaves 55. The sheave 56 is carried by a lever 57 which is pivoted at 58 and whose free end is connected to a link 59 which is connected at its free end to one end of a lever 61. The lever 61 is pivoted intermediate its ends and is connected at its other end to a Bowden cable 62.

As seen in FIG. 2, the other end of the cable 62 is connected through a lever 63 to the movable member 65 of a control device which includes a fixed cylinder 64 longitudinally into which the shiftable member 65 fits. The member 65 is connected at one end to an annular plate 66 slidable in the cylinder 64 and which is urged to the right in the cylinder by springs 67. It will be noted from FIG. 2 that a plurality of springs 67 of different lengths are provided to become successively effective as the member 65 moved to the left so that any desired characteristic can be obtained in the operation.

The member 65 is connected to a head 68 which is slidable toward and away from the arm 46. Preferably an

outer contact portion 69 is slidable in the head 68 and is urged outwardly thereof by a light spring 71 so that in the event of excessive movement the parts will not be damaged. When the outer head portion 69 engages the lever 46 it functions as a switch to complete an electrical circuit between the lead 49 and the lead 72 connected to the head portion 69.

The housing 29 also includes a mercury switch 73 provided with leads 74 and 75 and which is positioned at an angle in the housing, as shown. With the boom in a horizontal, or generally horizontal position the mercury switch will be tipped to a position in which its contacts are open, but as the boom is raised it will eventually raise to an angle at which the mercury will flow lengthwise of the envelope of the switch to complete a circuit therethrough at some predetermined angle. The housing 29 may also carry warning devices, such as a lamp 76 and a buzzer or similar audible signal 77 and similar signals may, if desired, be placed in the operator's cab.

Operation of the circuit will best be understood by reference to FIG. 4. As shown in this figure, one of the hydraulic lines 27 is connected directly to the small or piston end of the boom extending cylinder 24 while another hydraulic line is connected to the large end of the cylinder 24 through a shut off valve 78 which is normally open but is closed by a solenoid 79 when the solenoid is energized. A check valve 81 opening away from the hydraulic cylinder bypasses the valve 78, as shown.

The rotary hydraulic motor 25 for operating the cable reel is directly connected at one side to one of the hydraulic lines 27 and is connected at its other side to another hydraulic line 27 through a shut off valve 82 which is normally open and which is closed by solenoid 83 when the solenoid is energized. The valve 82 is bypassed by a check valve 84 which opens in a direction away from the hydraulic motor 25.

The hydraulic motor 26 for lifting the boom is connected directly at its small or piston rod end to one of the lines 27 and is connected to another of the lines 27 at its large end through two shut off valves 85 and 86 in series. The valve 85 is closed by a solenoid 87 and the valve 86 is similarly closed by a solenoid 88. The valve 85 is bypassed by a check valve 89 which opens in a direction away from the hydraulic motor.

The several solenoids 79, 83, 87 and 88 are controlled electrically by the switches above described through an electrical circuit, as illustrated in FIG. 4. The circuit may be powered from any desired source of current, such as a battery 91, which is grounded at one side and is connected at its other side to a power lead 92. Preferably swivels, as generally indicated at 93, are included in the power lead and in the various other leads extending to the control switches on the boom to accommodate rotation of the boom on the vehicle frame. For control of overload on the beam tending to tilt the vehicle, the leads 48 and 72 are connected, as shown, with the lead 72 going through a relay coil 94 to the power lead 92. The relay coil 94 when energized closes a normally open switch 95 which connects the power lead directly to a lead 96 going to one side of the valve solenoid 86. The other side of the valve solenoid 86 is connected through a lead 97 to a ground bus bar 98. The lead 48 is connected through a signal lamp 77 and audible signal 76 and through a pair of indicator signal lamps 98 and 99 to a lead 100 which goes to the ground bus 98. A coil 94a in parallel with the coil 94 closes a switch 95a which connects the power lead directly to a lead 101 which goes to one side of each of the valve operating solenoids 79 and 83.

A test switch 103 is provided directly interconnecting the leads 48 and 72 and shunting the contact between member 69 and lever 46 for testing the circuit.

In the normal condition of the circuit the contacts 46 and 69 are open and the coils 94 and 94a de-energized so that the switches 95 and 95a are open. At this time, no circuit connections will be completed. When

the test switch is closed for testing the circuit or when contact element 69 engages the lever 46 a circuit will be completed from the power lead 92 through the relay coils 94 and 94a, contact 69, lever 46, lead 48, and lead 100 to the ground bus 98 to energize the coils and close the switches 95 and 95a. Closing the switch 95 will complete a circuit from the power lead 92 through switch 95 to the lead 96 to energize the valve solenoid 86. Closing the switch 95a will complete a circuit from the power lead 92 to lead 101 to energize the valve solenoids 79 and 83. Simultaneously with closing of the test switch or contacts 69 and 46 a circuit will be completed through the signal lamp 77, audible lamp 76 and signal lamps 98 and 99 to indicate that the circuit is functioning properly in the event of test or that the boom is overloaded in the event the circuit is completed between contact element 69 and 46.

At the same time, energizing of the solenoids 79, 83 and 88 will close the valves 78, 82 and 86. Closing of the valve 78 will prevent fluid under pressure from being supplied to the left end of the cylinder 24 so that under these conditions the boom cannot be extended further. However, due to the check valve 81, fluid under pressure can be supplied to the right end of the cylinder 24 with the return passing the check valve so that the boom can be retracted. It will be noted that retraction or shortening of the boom will decrease the moment arm thereby tending to create a safe condition.

Energizing of the solenoid 83 will close the valve 82 to prevent actuating fluid from being supplied to the left side of the motor 25. The motor 25 is therefore prevented from operating the reel in a direction to reel up the cable so that the excessive load cannot be raised further. However, fluid can be supplied to the right side of the motor 25 and exhaust from the left side thereof past the check valve 84 to operate the motor in a direction to unwind the cable and lower the load thereby tending to create a safe condition.

Energizing of the solenoid 88 closes the valve 86 which will prevent any operation of the cylinder 26 either to elevate or lower the boom. It will be noted in this connection that elevation of the boom would tend to raise the load and would contribute to the unsafe condition while lowering of the boom would lengthen the moment arm of the load also increasing the tendency to overturn the crane. It is desirable when an overload is encountered to prevent any movement of the boom in either direction.

If the boom should be raised to the desired maximum upper limit the mercury switch 73 would be tilted in a direction to close its contacts. One of the switch contacts is connected through a relay coil 104 to the power lead 92 and also through a switch 105 which is closed by the coil 104 when it is energized to a lead 106 connected to one side of the valve solenoid 87. The other side of the valve solenoid is connected to the ground bus bar 98. A test switch 107 is connected in parallel with the switch 73 and may be provided with a signal lamp 108 in series therewith to indicate the condition of the circuit when the test switch is closed. When either the switch 73 or the test switch 107 is closed, the valve solenoid 87 will be energized to close the valve 85. Closing of either switch will complete a circuit from the power lead 92 through the coil 104 and through the switch and back through a lead 109 to the ground bus bar 98. The coil 104 will therefore be energized to close the switch 105 which will complete a circuit through the lead 106 to the valve solenoid 87 to energize it. The relay 104, 105 is preferably utilized in this circuit to reduce the current flow through the switch 73 or test switch 107 so that only a light current is required to flow through these switches and so that relatively fine wire can be run from the switch 107 which is mounted on the boom to the relay.

Closing of the valve 85 will prevent supply of actuating fluid to the left end of cylinder 26 thereby to stop

further elevation of the boom. However, fluid can be admitted to the right end of the cylinder 26 and can return from its left end past the check valve 89 so that the boom can be lowered.

Double blocking or engagement of the lower block 21 against the upper block 18 is controlled by a switch mechanism as particularly shown in FIG. 5. As illustrated in FIG. 5, the upper block 18 has an arcuately curved actuator arm 116 pivoted on a pivot 117. As shown, the arm 116 extends beneath the block 18 and is normally urged downwardly by a spring 118 connected to an upper extension of the arm and to a bracket 119 mounted on the block. An adjustable stop screw 121 is threaded into the upper end of the arm to engage the block for limiting turning of the arm 116 in a downward direction. An extension arm 122 secured to the arm 116 and projecting radially inwardly thereof engages an operating lever 123 for a switch 110 when the lever is moved upwardly. The lower block 21 carries a bar 124 which will engage the arm 116 when the lower block moves into close proximity to the upper block. At this time the switch 110 will be closed.

Closing of the switch 110 or of a test switch 111 in parallel therewith and which is connected through a signal light 112 will complete a circuit from the power lead 92 through a relay coil 113 to the lead 38 to the ground bus bar 98. The relay coil 113 will therefore be energized to close a switch 114 which completes a circuit from the power lead 92 through a lead 115 to the lead 101. A circuit will be completed through this lead to each of the valve actuating solenoids 79 and 83 to close the same, thereby to prevent extension of the boom or reeling up of the cable in the same manner as described above when an overload occurs. It will be noted that the circuit through the switch 114 is in parallel with the circuit through the contact element 69 and lever 46 so that it will produce the same actuation. However, closing of the switch 114 will not energize either of the valve solenoids 87 or 88 so that the boom can be raised and lowered, as desired, when the switch 110 is closed. Also, because of the check valves 81 and 84 the boom can be retracted which will have the effect of unreeling the cable or the cable can be unreeled by operating the motor 25 to lower the load engaging block 21 from the end of the boom.

While one embodiment of the invention has been shown and described herein, it will be understood that it is illustrative only and not to be taken as a definition of the scope of the invention, reference being had for this purpose to the appended claims.

What is claimed is:

1. Safety control means for cranes in combination with a crane having an extensible boom, power means to extend and retract the boom, a cable running over a block at the end of the boom, a second block supported by the cable, power operated drum means to extend and retract the cable thereby to lower and raise the second block, the safety control means comprising a control device operated by the block when the second block moves into close proximity to the first block, and means operated by the control device when it is operated to prevent operation of the power means in a direction to extend the boom.

2. The control means of claim 1 in which the last named means also prevents operation of the drum means in a direction to retract the cable.

3. Safety control means for cranes in combination with a crane having an extensible boom, reversible fluid operated power means connected to the boom to extend and retract it, a block at the tip of the boom, a cable running over the block, a second block supported by the cable, a reel driven by second fluid operated power means to reel the cable in and out thereby to raise and lower the second block, the safety control means comprising

a control device operated by the blocks when the second block moves into close proximity to the first block, and a valve actuated by the control device when it is operated to prevent supply of operating fluid to the first named power means in a direction to extend the boom. 5

4. The safety control means of claim 3 further including a second valve actuated by the control means when it is operated to prevent supply of operating fluid to second fluid operated power means in a direction to reel in the cable.

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EVON C. BLUNK, *Primary Examiner.*

10 A. L. LEVINE, *Assistant Examiner.*