Jan. 4, 1966 M. P. VISCEGLIA 3,228,019

ADJUSTABLE BOOM ANGLE WARNING DEVICE

Filed Sept. 30, 1963 5 Sheets-Sheet 1

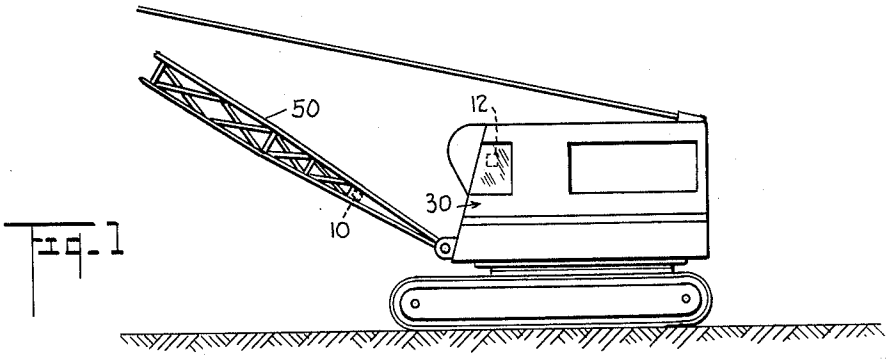

Fig. 1

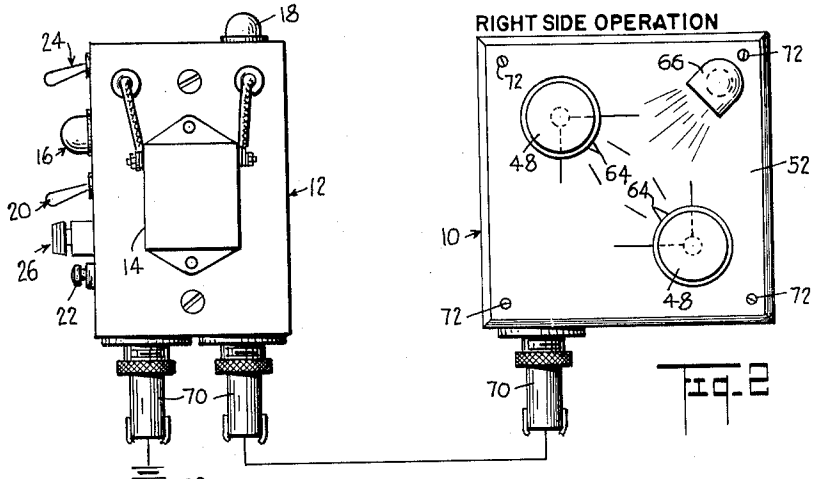

Fig. 2

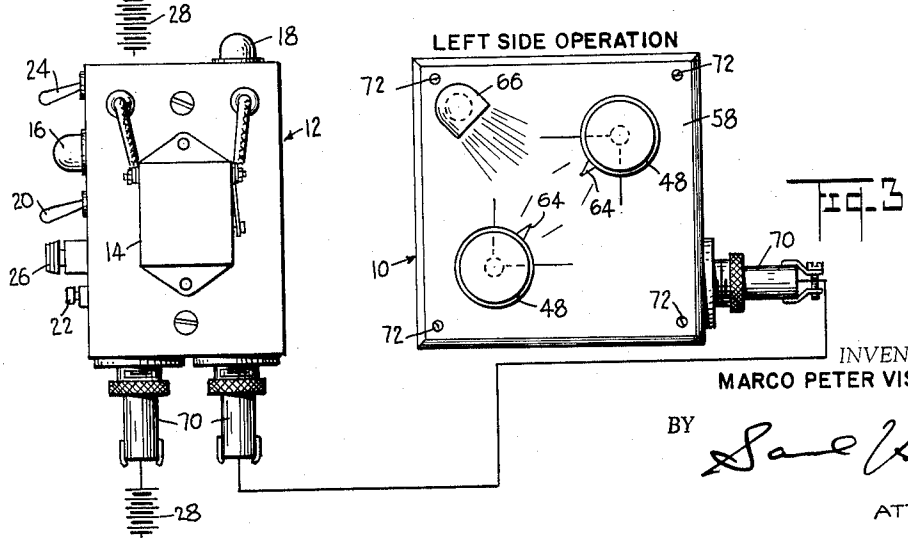

Fig. 3

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ADJUSTABLE BOOM ANGLE WARNING DEVICE

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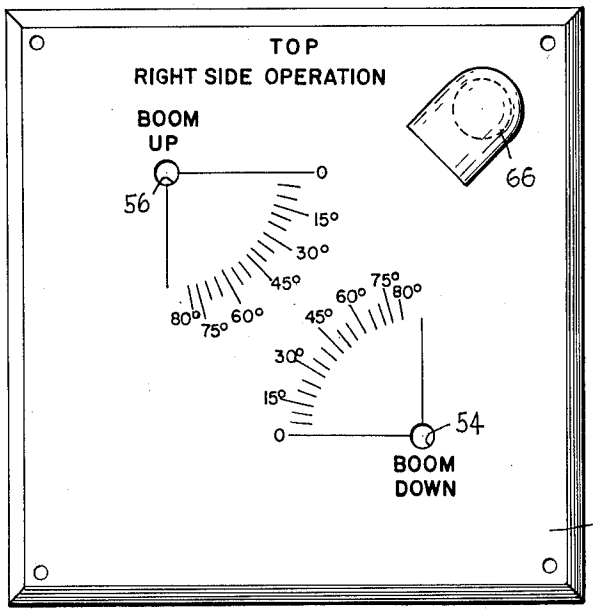

Fig. 4

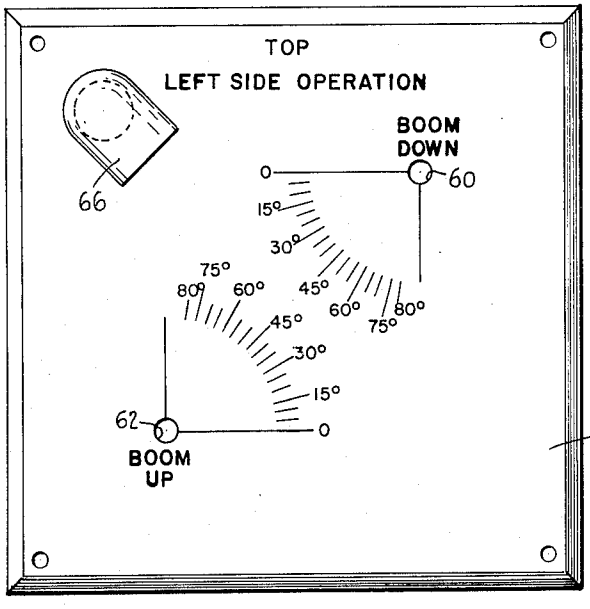

Fig. 5

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ADJUSTABLE BOOM ANGLE WARNING DEVICE

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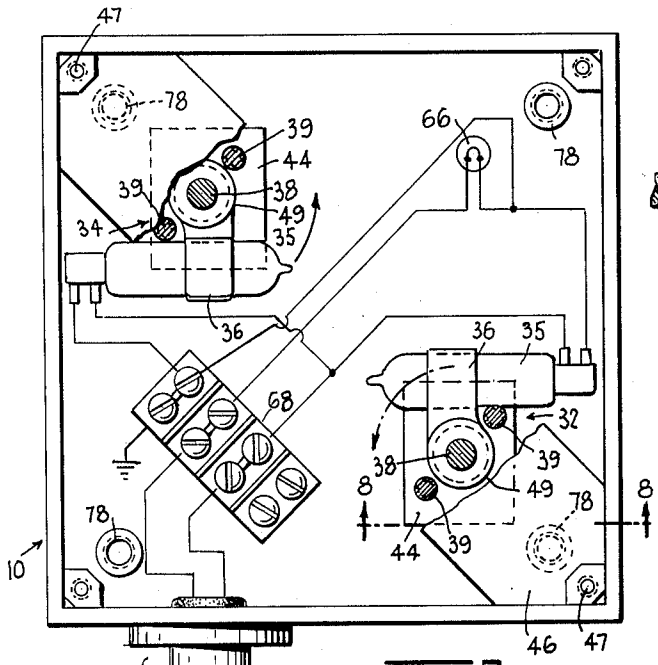


FIG. 6

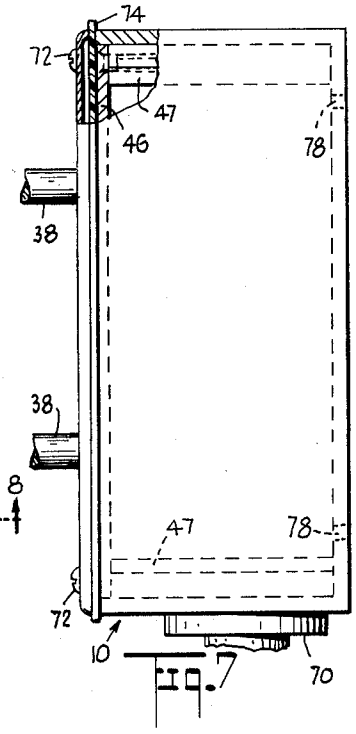
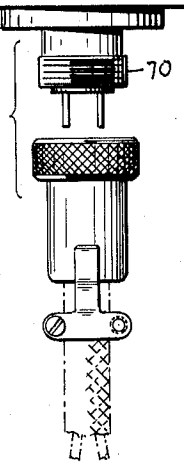


FIG. 7



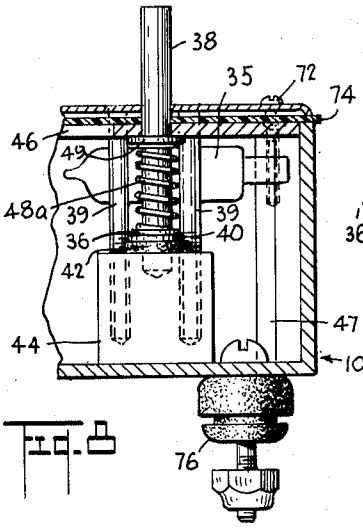


FIG. 8

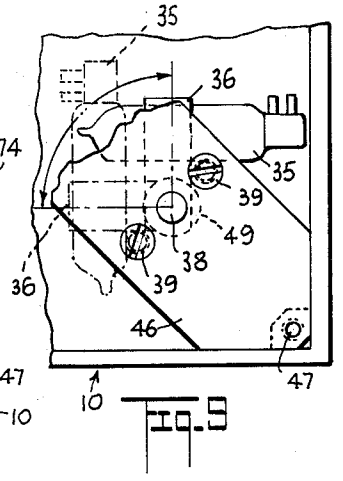


FIG. 9

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ADJUSTABLE BOOM ANGLE WARNING DEVICE

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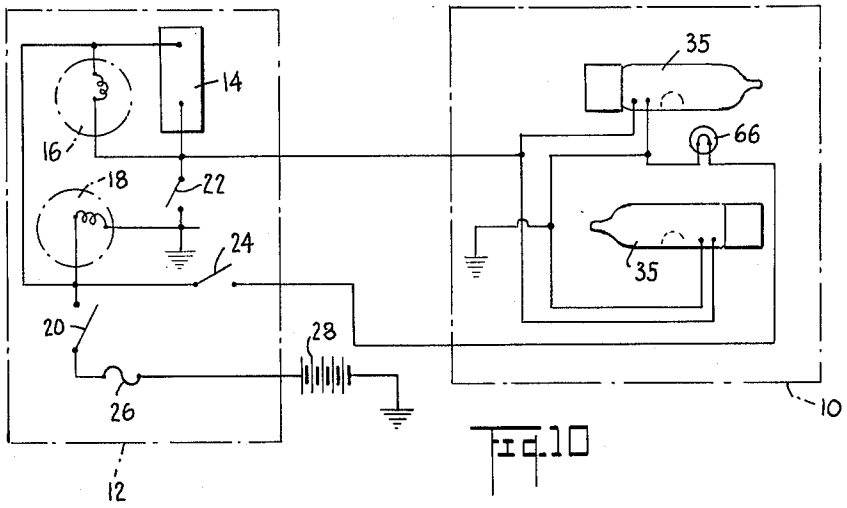

Fig. 10

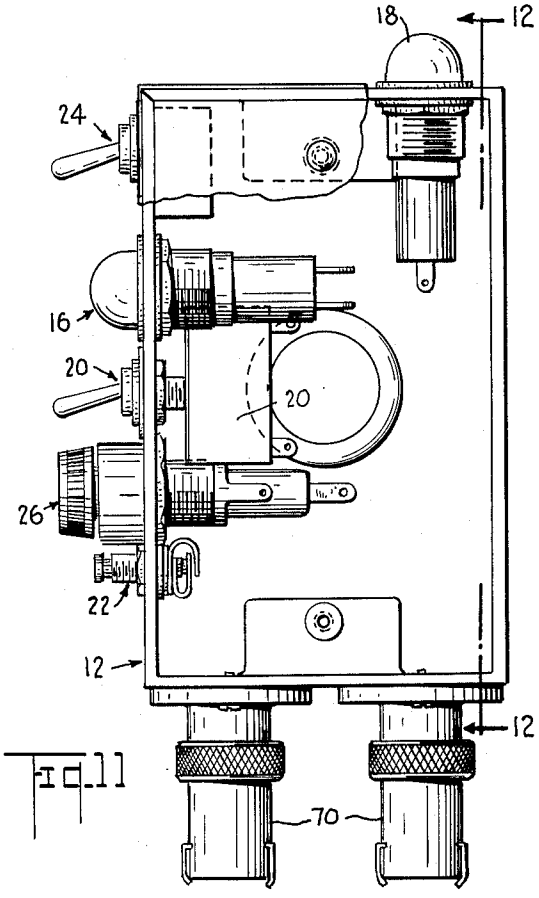

Fig. 11

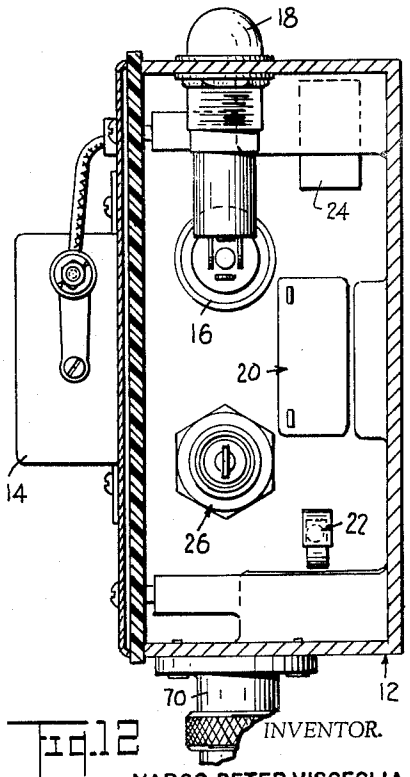

Fig. 12

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Jan. 4, 1966 M. P. VISCEGLIA 3,228,019

ADJUSTABLE BOOM ANGLE WARNING DEVICE

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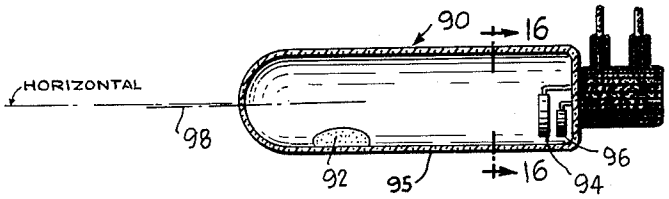

Fig. 13

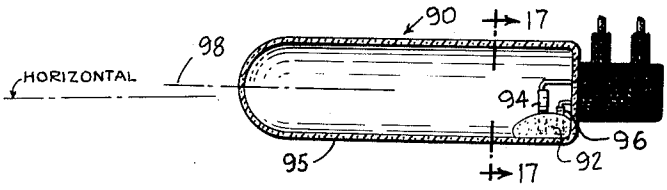

Fig. 14

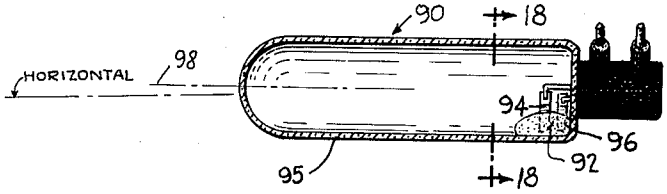

Fig. 15

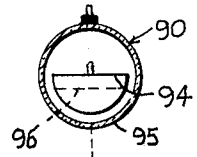

Fig. 16

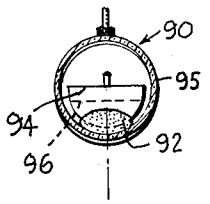

Fig. 17

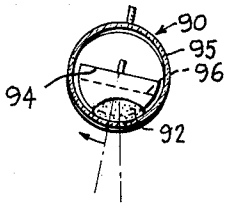

Fig. 18

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United States Patent Office

3,228,019

Patented Jan. 4, 1966

3,228,019

ADJUSTABLE BOOM ANGLE WARNING DEVICE

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Filed Sept. 30, 1963, Ser. No. 312,516
3 Claims. (Cl. 340—267)

The present invention comprises a warning device for indicating unsafe angles of the booms of cranes.

As the boom of a crane is lowered until it approaches the horizontal, a considerable moment is exerted about the crane support, usually a crawler or truck body until, with an excessive load and/or a very small angle with respect to the horizontal, the entire crane will tilt or topple over. Similarly, as the boom approaches a vertical orientation, the counterweight mounted on the rear of the cab of the crane will cause the crane to topple over backwards. It is obvious that such conditions are highly undesirable and dangerous. Furthermore, the critical angles, that is, the angles of the boom beyond which the crane will topple over, are highly variable, changing with every new load lifted and changing as the cab and boom rotate about a vertical axis from a position parallel to the longitudinal axis of the crawler or truck to a position perpendicular with same.

Heretofore, only futile efforts have been made to provide the operator of the crane with some idea of when the boom is approaching a critical angle. Included are simple pendulums mounted on the boom to merely tell the operator what the boom angle is with respect to the vertical and cable actuated devices connected between cab and boom which merely determine the angle of the boom with respect to a position fixed in the cab. The latter device is highly susceptible to being deactivated by cable breakage and the exposed cables provide a hazard to workmen and the operator. Furthermore, the angle recorded being fixed with respect to the cab, and such angle remaining constant when the boom and cab topple over as a unit, no warning can be provided to tell when the tilting is occurring and, in fact, the angle so indicated can be reduced below its critical value as the crane continues to topple over.

Accordingly, the present invention provides a positive warning device for indicating unsafe and improper boom angles for all types of cranes.

The present invention also provides a warning indicator which measures boom angles with respect to both the horizontal and the vertical and not with respect to the cab.

The present invention further provides easily adjustable critical angle indicators and both audible and visual warning devices for infallibly informing the operator of when a critical angle has been approached or past. A test circuit is provided to check the warning circuit at any time independent of boom angle.

The present invention still further provides for simple installation without need for skilled installers, and may be removed at any time for use on other cranes.

The present invention may be adapted to a wide variety of uses. For example, boats and ships having cargo derricks and cranes may be fitted with the boom angle warning device described herein to provide safe conditions when hoisting objects over the side. The rocking of the ship increases the dangers noted above and further limits the ability of the operator to estimate safe working angles of the boom. A typical application might be the crane of a buoy tender, which is generally a ship of limited

size required to raise and lower relatively heavy buoys over its side in open, rolling seas.

In the drawing:

FIGURE 1 is a side view of a conventional crane with the warning indicator installed thereon.

FIGURE 2 is a front view of both the cab mounted box and the boom mounted box for a crane having an operator's cab to the right of the boom.

FIGURE 3 is a front view of both the cab mounted box and the boom mounted box for a crane having the operator's cab to the left of the boom.

FIGURE 4 is a front view of the face plate of the boom mounted box for a crane having the operator's cab to the right of the boom.

FIGURE 5 is a front view of the face plate of the boom mounted box for a crane having the operator's cab to the left of the boom.

FIGURE 6 is a front view of the interior of the boom mounted box showing the electrical connections schematically.

FIGURE 7 is a side view of the boom mounted box.

FIGURE 8 is a sectional view of a mercury switch and mounting as taken along line 8—8 of FIGURE 6.

FIGURE 9 is a front view of a mercury switch and mounting also showing the switch in a 90° rotated position in phantom view.

FIGURE 10 is a schematic representation of the electrical circuit.

FIGURE 11 is a front view of the interior of the cab mounted box.

FIGURE 12 is a sectional view of the cab mounted box as taken across line 12—12 of FIGURE 11.

FIGURE 13 is a sectional view of a mercury switch wherein the section is taken longitudinally of the switch and wherein the longitudinal axis of the switch is tilted slightly from the horizontal such that the electrode end of the switch is above the opposite end thereof.

FIGURE 14 is a sectional view of a mercury switch wherein the section is taken longitudinally of the switch and wherein the longitudinal axis of the switch is tilted from the horizontal such that the electrode end of the switch is below the opposite end thereof.

FIGURE 15 is a view of the mercury switch of FIGURE 14 wherein the switch has been rotated about its longitudinal axis.

FIGURE 16 is a sectional view taken along line 16—16 of FIGURE 13.

FIGURE 17 is a sectional view taken along line 17—17 of FIGURE 14.

FIGURE 18 is a sectional view taken along line 18—18 of FIGURE 15.

Referring to the drawing, the boom angle indicator is housed primarily in two boxes, a boom-mounted box **10** and a cab-mounted box **12**. Cab box **12** contains a warning buzzer **14**, a red warning light **16**, an amber pilot light **18**, a main power switch **20**, a test switch **22**, a face plate light switch **24** and a fuse and fuse holder **26**. Pilot light **18** mounted on the top of cab box **12** is "on" whenever main switch **20** is "on" and power source **28** is connected. Main switch **20**, test switch **22**, light switch **24**, and fuse **26** are all mounted on the side of cab box **12** which normally faces the crane operator, cab box **12** being normally mounted on one side of cab **30**. Warning light **16** is also on the side of cab box **12**, which normally faces the operator for maximum attention-attracting effectiveness. Warning buzzer **14** may be mounted in any con-

venient location, the front of cab box 12 being deemed most appropriate.

Boom box 10 has two identical switching units 32, 34. Each switching unit 32, 34, has a glass tube type mercury switch 35, which is mounted rigidly on a clamp 36. Clamp 36 is firmly affixed to a rotatable shaft 38, which shaft 38 protrudes through the front of boom box 10. Two mounting screws 39 are disposed parallel to and on opposite side of shaft 38 and screw into a mounting block 44 which protrudes forwardly from the rear of boom box 10. Mounting block 44 has a shallow hole which receives and positions the rearmost end of shaft 38. A metal washer 40 and a rubber or fiber washer 42 ride the rearward end of shaft 38, rubber washer 42 bearing against the forward surface of mounting block 44 and metal washer 40 bearing against the forward side of rubber washer 42. Clamp 36 bears against the forward side of metal washer 40.

A mounting plate 46 extends diagonally across the interior of boom box 10 parallel to and adjacent the front face thereof. Mounting plate 46 is secured by the four mounting screws 39 which firmly position mounting plate 46 against two oppositely disposed corner posts 47 of boom box 10. The two shafts 38 pass through mounting plate 46 and are positioned in parallel relation with each other by mounting plate 46 and mounting blocks 44.

A compression coil spring 48*a* surrounds each shaft 38 and bears between clamp 36 and a washer 49 which is behind and adjacent mounting plate 46. Each shaft 38 is hence prevented from rotating too easily by the pressure of spring 48 causing a substantial amount of friction between clamp 36 and washers 40 and 42 therebehind. Although each shaft 38 (and clamp 36 affixed thereto) may be rotated by hand, once a desired position is attained, it will remain in such position notwithstanding the effects of shock and vibration to which the entire boom angle indicator is subject.

Screws 39 are positioned on either side of each shaft 38 such that they act as stops limiting the angular rotation of each clamp 36 and its mercury switch 35 to an arc of 90 degrees as shown in FIGURE 9. The 90-degree sectors swept by the rotation of mercury switches 35 are positioned such that the perpendicular lines defining each sector are parallel to corresponding lines of the other sector. In the preferred embodiment, the sectors face each other and the perpendicular defining lines of each sector, if extended, will meet to form a rectangle.

Shafts 38 protrude forwardly from the front of boom box 10 to provide mounts for two control knobs 48, one of which is positioned securely on each shaft 38. Mercury switches 35 are rotated by manual manipulation of control knobs 48.

Cranes are conventionally made with one of two orientations of operator's cab 30, cab 30 being either to the right of the boom 50, herein referred to as right side operation, or to the left of boom 50, herein referred to as left side operation. For right side operation, boom box 10 is mounted on the right side of boom 50 facing the operator; for left side operation boom box 10 is mounted on the left side of boom 50 facing the operator. For both right and left side operations, shafts 38 must be positioned such that their longitudinal axes are parallel to the pivot axis of boom 50; conventionally such pivot axis is horizontal.

For ease in describing the positions and rotations of mercury switches 35, two plane polar coordinate systems will be assumed, one to be positioned with its origin on the axis of rotation of each shaft 38, the plane of each coordinate system to be parallel to the front face of boom box 10. The zero reference polar axis of each system is a line extending from the origin of that system horizontally to the right thereof as viewed when looking at the front face of boom box 10. Rotation in each system counter-clockwise about the origin thereof defines quadrant sectors as follows: from 0 degrees to 90 degrees is the first quadrant, from 90 degrees to 180 degrees is the second quadrant, from 180 degrees to 270 degrees is the third quadrant, and from 270 degrees to 360 degrees (0 degrees) is the fourth quadrant.

For right side operation, with boom 50 vertical, boom box 10 is positioned on boom 50 such that clamp 36 of switching unit 32 rotates in the second quadrant and clamp 36 of switching unit 34 rotates in the fourth quadrant. With boom box 10 in this position, a face plate 52 for said box may be inscribed as shown in FIGURE 4. The word TOP indicates that end of boom box 10 which is closest to the upper end of boom 50. Shaft 38 of switching unit 32 passes through face plate 52 at the hole 54 labeled BOOM DOWN. Shaft 38 of switching unit 34 passes through face plate 52 at the hole 56 labeled BOOM UP. Quadrants about each shaft 38 are inscribed with degrees of arc, the inscriptions reading from 0 degrees clockwise to slightly less than 90 degrees. For convenience, with reference to the quadrants defined above, the BOOM DOWN degree inscription is in the second quadrant and the BOOM UP degree inscription is in the fourth quadrant.

For left side operation, with boom 50 vertical, boom box 10 is positioned on boom 50 such that clamp 36 of switching unit 32 rotates in the third quadrant and clamp 36 of switching unit 34 rotates in the first quadrant. With boom box 10 in this position, a face plate 58 for said box 10 may be inscribed as shown in FIGURE 5. The word TOP indicates that end of boom box 10 which is closest to the upper end of boom 50. Shaft 38 of switching unit 32 passes through face plate 58 at the hole 60 labeled BOOM OWN. Shaft 38 of switching unit 34 passes through face plate 58 at the hole 62 labeled BOOM UP. Quadrants about each shaft 38 are inscribed with degrees of arc, the inscriptions reading from 0 degrees counter-clockwise to slightly less than 90 degrees. For convenience, with reference to the quadrants defined above, the BOOM DOWN degree inscription is in the third quadrant and the BOOM UP degree inscription is in the first quadrant.

Control knobs 48 have pointers 64 for aiding the selection of a switch position.

As can readily be seen, the mechanism in boom box 10 is the same regardless of whether it is used for right or left side operation. All that is done, in going from right side operation to left side operation, is to rotate boom box 10 90 degrees in a counter-clockwise direction, and to use a new face plate.

The power supply for the warning circuit is power source 28 of the crane, usually a battery of 12, 24, or 32 volts. One side of power source 28 is grounded, and the other side is connected through fuse 26 to main switch 20. Warning buzzer 14 and warning light 16 are wired in parallel with each other such that failure of one warning component will not affect the other. A first side of the parallel group is connected to main switch 20; the second side is connected to mercury switches 35. Mercury switches 35 are wired in parallel relation with each other, a first side of the parallel group being connected as described to the second side of the warning component parallel group, the second side being grounded back to power source 28.

When either mercury switch 35 makes contact (by the mercury shorting the switch electrodes, both warning components (warning buzzer 14 and warning light 16) are activated.

Test switch 22 connects the second side of the warning component parallel group to ground for purposes of testing the operability of the warning components.

Connected in parallel with each other to the side of main switch 20 away from fuse 26 are pilot light 18 and light switch 24 in series with face plate light 66. This parallel combination is then connected to ground.

Actual connections within boom box 10 are made to a terminal strip 68 the four corner screws of which are

mounting screws for affixing terminal strip 68 to boom box 10. Standard cable connecting plugs 70 are used to connect exterior cables to both boom box 10 and cab box 12.

In operation, the BOOM DOWN knob is rotated to that setting which corresponds to the smallest angle with respect to the horizontal to which boom 50 may safely be lowered, such angle being determined by such factors as load, length of boom, type of crane and the like. Similarly, taking into account the aforementioned factors, the BOOM UP knob is rotated to that setting which corresponds to the largest angle with respect to the horizontal to which boom 50 may safely be raised.

With boom 50 angularly disposed between the BOOM DOWN and the BOOM UP settings, mercury switches 35 are positioned such that they are in the "off" position. As boom 50 is lowered until its angle with respect to the horizontal approaches the BOOM DOWN setting, mercury switch 35 of switching unit 32 approaches its "on" position. When boom 50 reaches that angle with respect to the horizontal which corresponds to the BOOM DOWN setting, mercury switch 35 of switching unit 32 is in its "on" position, thereby closing the circuit through the warning components and causing warning buzzer 14 to give audible warning and warning light 16 to give visual warning to the crane operator of the position of boom 50.

Similarly, as boom 50 is raised such that its angle with respect to the vertical approaches the BOOM UP setting, both mercury switches 35 are in their "off" positions until, when said angle corresponds with said setting, mercury switch 35 of switching unit 34 is in its "on" position, closing the circuit through the warning components and causing warning buzzer 14 to give audible warning and warning light 16 to give visual warning to the crane operator of the position of boom 50.

Face plates 52 and 58 are secured to boom box 10 in any conventional manner such as by four corner screws 72 which screw into corner posts 47. A waterproofing gasket 74 may be placed between boom box 10 and the face plate secured thereto.

Boom box 10 may be secured to boom 50 in any conventional manner, a bolt and rubber O-ring 76 being shown in bolt hole 78. Boom box 10 may be entirely enclosed within a weather and vandal-proof enclosure for additional protection.

Although any suitable mercury switch 35 may be used, the preferred type of such switch is designed in such manner that rotation about the longitudinal axis of said mercury switch 35 will not alter the angle (of its longitudinal axis with respect to the horizontal) at which said mercury switch 35 opens nor alter the angle (of its longitudinal axis with respect to the horizontal) at which said mercury switch 35 closes.

What is meant by opens is that point at which the mercury breaks contact with one or both of the electrodes of mercury switch 35. What is meant by closes is that point at which the mercury makes contact with both of the electrodes of mercury switch 35. A mercury switch having such a characteristic has its container or tube and its electrodes designed in such manner that rotation about its longitudinal axis alone does not alter the relation between the mercury and the electrodes. Mercury switch 90 is an illustration of such a mercury switch.

Mercury switch 90 has mercury 92 and two electrodes 94 and 96 enclosed within a glass tube 95. Glass tube 95 is substantially cylindrical, such cylinder having a longitudinal axis 98. Electrodes 94 and 96 are semicircular disks positioned at one end of glass tube 95 perpendicular to longitudinal axis 98 and having their centers on said axis.

Since glass tube 95 and electrodes 94 and 96 are radially equidistant from each other and from longitudinal axis 98 over the arcuate extent of said electrodes 94 and 96, rotation of mercury switch 90 about said longitudinal axis 98 does not alter the relation between mercury 92 and electrodes 94, 96.

While the foregoing is illustrative of a preferred form of the invention, it will be understood that such form may be modified and that other forms may be provided within the broad spirit of the invention and the broad scope of the claims.

What is claimed is:

1. A warning indicator for indicating unsafe angular positions of the boom of a crane with respect to the horizontal or the vertical, comprising:

a boom mounted enclosure, two mercury switches mounted in said enclosure, one of said switches being rotatable about an axis of rotation, such axis of rotation being parallel to the pivot axis of said boom, the longitudinal axis of said switch being positioned in the plane of rotation, the other of said switches being similarly rotatable about a similar axis of rotation and being similarly positioned, one of said switches being rotated to such an orientation as to be "on" when the boom is so angularly disposed as to be at or below a first selected angle with respect to the horizontal and to be "off" when the boom is above said first selected angle, the other of said switches being rotated to such an orientation as to be "on" when the boom is so angularly disposed as to be at or above a second selected angle with respect to the horizontal and to be "off" when the boom is below said second selected angle,

two selector knobs, said selector knobs being rotatably mounted on said enclosure and each having suitable inscriptions for indicating its function and angular position, one of said selector knobs controlling the rotation of one of said switches and selecting the orientation thereof, the other of said selector knobs controlling the rotation of the other of said switches and selecting the orientation thereof,

a cab mounted control box,

indicators, said indicators being mounted on said control box so as to be able to communicate a signal to the operator of the crane, and

electric circuitry connecting said switches with said indicators such that when either of said switches is "on," said indicators are actively signaling the crane operator, and when both of said switches are "off," said indicators are not so signaling each of said switches comprising a cylindrical bulb-shaped container for retaining the mercury, and

two electrodes,

each electrode being a substantially semi-circular disc positioned within and at one end of said cylindrical container and so oriented as to be perpendicular to the longitudinal axis of said cylindrical container,

one such electrode behind the other in spaced relation to and in alignment with each other,

said electrodes being concentric with said cylindrical container,

so that the switch may be rotated to a limited extent about its longitudinal axis without affecting the angle at which the mercury will make contact with both electrodes.

2. A warning indicator for indicating unsafe angular positions of the boom of a crane with respect to the horizontal or the vertical in accordance with claim 1, wherein said indicators comprise:

a warning buzzer for communicating an audible signal to the crane operator, and

a warning light for communicating a visible signal to the crane operator.

3. A warning indicator for indicating unsafe angular positions of the boom of a crane with respect to the horizontal or vertical in accordance with claim 2, wherein said electric circuitry comprises:

connecting said buzzer and said light in a first parallel group with each other,

connecting said switches in a second parallel group with each other,

connecting said first parallel group and said second parallel group in a series with each other, and

connecting said series group to a source of power.

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NEIL C. READ, *Primary Examiner.*