INDICATOR FOR DETERMINING THE BOOM ANGULARITY OF A CRANE

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This invention relates generally to hoists of the crane type and particularly to a device for determining the angularity of the crane's boom at all times by the operator thereof.

In particular, the invention is directed to an indicator and its attendant equipment for use with a boom rigged crane or comparable modifications thereof to enable an operator, during operation, to observe the exact angularity of the boom with respect to a reference plane, specifically the gravitational plane, regardless of any irregularity of the ground or other surface on which a crane is positioned.

It is well known that only within certain weight limits can a boom reach out, raise, and move a given object. The controlling factors are represented by the booms angularity with respect to the weight of the load, any supplemental bracing equipment such, for example, as front, rear, and side outriggers, and the reference plane of the crane.

Of course, in many instances the crane operator or supervisor knows that the angularity of the boom is of minimal importance, having in mind the lift capabilities of the crane and the weight of the objects to be lifted. However, in other circumstances, for example, the operator may not be able to view the object to be lifted and moved, and in addition may not know what extent he may safely extend or angle the boom to reach and pick up the object. This uncertainty has all too frequently resulted in over-loading with the result that the boom and crane are over-balanced and caused to tip over with the possible loss of life or injury to the operator and other workers in the vicinity.

It is true that devices have been developed for the purpose of keeping a crane operator advised of the angle at which his boom is rising or is set. However, insofar as applicant has determined, such devices have at least two pertinent objections. In some instances, the connections between the boom and an indicator are such that the boom angle may be distorted should the boom be directed in a direction other than directly forwardly or rearwardly of the crane carriage or support. In other instances it would seem that the operative parts as between boom and operator are such that the boom angle indicator must be located in a place or position such that the operator must divert his vision from the boom and object to the indicator to determine whether the boom is at a given angle and within the prescribed safety limits as defined by a chart.

The operator must divert to charts in his cab which designate a maximum load for a boom at a given angle in connection with the weight balance of the crane or any assisting supports for this purpose and this may well divert his attention, not only from the boom, but whatever indicator that may be supplied with the crane.

As a matter of fact, in certain instances it is incumbent on crane manufacturers that do not provide any form of boom angle indicator, to apply a fixed, permanent plate reading to this effect. Apropos of this, any investigation in the field of use of cranes herein concerned will develop the fact that foremen or supervisors, when there is any question of object weight versus angularity of boom, will resort to a measuring tape to determine the horizontal distance between the point of swivel of the crane cab and the pick-up cable when lowered to the surface on which the crane is positioned. Following determining this distance and guessing at the boom angle, should there be no boom angle gauge, reference is had to a chart and the weight of an object before any attempt is made to move it.

From the above, it will be appreciated that boom type cranes should, for safety sake, if nothing else, be equipped with a boom angle gauge and means for directing the operator's attention to the near approach of safe maximum boom angularity.

The present invention has for its primary object the provision of a direct view dial indicator for operator determination of the boom angle of a crane or similar load or object moving machine.

Another and important object of the invention lies in the provision of means by which a crane operator may, by reason of a chart and boom angle indicator, set the maximum weight and angle to lift and move a given object and will be apprised of any near approach to this maximum by visual or audible means.

A further and most important object of the invention lies in provision of a visual and audible signaling mechanism that can be manually set to operate within the charted maximum boom angle limits whereby to warn the operator that he is approaching or has reached the safe operative usefulness in boom angle and weight.

FIG. 1 is a small, side elevation of a crane and boom showing the general location of the boom angle indicator with respect to the operator's cab;

FIG. 2 is a front elevational view of the indicator as mounted on a boom, being taken as suggested in FIG. 1;

FIG. 3 is a front view of a cab mounted dial that, when set for maximum boom angle, will signal approach to such an angle;

FIG. 4 is a top view of the boom angle indicator and is taken substantially as suggested by the line 4--4 of FIG. 2, part of the cover being broken away to locate certain of the operative parts;

FIG. 5 is a front elevational view of the indicator, part of the front panel being broken away to further disclose certain of the operative parts thereof;

FIG. 6 is a vertical sectional view and is taken substantially on the line 6--6 of FIG. 5;

FIG. 7 is an enlarged, lengthwise vertical sectional view, taken substantially as suggested by the line 7--7 of FIG. 4, the central portion of the unit being eliminated;

FIG. 8 is an enlarged view of the support for the disk shown in FIG. 7, parts being broken away to show anchorage of the cable to the tubes;

FIG. 9 is a view of the contact bar affixed to a cover plate, being taken as suggested by the line 9--9 of FIG. 7;

FIG. 10 is a wiring diagram suggesting the electrical circuits for the warning device; and

FIG. 11 is a view taken substantially as indicated by the line 11--11 of FIG. 7.

Referring more particularly to the drawings, the reference numeral 10 is employed to indicate a boom rigged crane of the general type to which the invention may be applied. Such cranes may include some form of transport chassis as suggested at 11. Mounted to rotate about the vertical axis of this chassis is a cab 12 which, of course, includes a motor cable winch and operator's quarters. At one end of the cab, the boom 13 is attached and is movable from a substantially horizontal plane in the direction.
of the frame to a substantially vertical position. Suitable cables, attached to the boom, are operable through the winch arrangement and by operator control of the motor to raise or lower the boom as desired. Of course, an operator may swing the entire cab and the boom through a range of movement not in the present invention is primarily concerned with the operator's proper knowledge and vision of the angular position of the boom at all times.

To this end, attention is now particularly directed to the provision of a boom unit 14 and a warning flag 42. The boom 13, near its pivot, connection 17 with the cab, mounts a bracket 18 into which one end of a tube 19 projects, being rigidly secured thereto. It is to be kept in mind that as the boom is raised or lowered this tube will in effect turn.

The tube 19 projects lengthwise through the upper portion of the unit 14 and, in fact, extends slightly beyond the unit end remote from the bracket 18. The unit 14 may be box-like and, as shown, includes front and rear panels 20, 21, top and bottom panels 22 and 23, respectively, and end panels 24 and 25. The tube 19 mounts to the unit through end panels 24 and 25 and the central portion of this end panel contains suitable anti-friction means, such as the sleeves 26, and by reason of which the unit may freely swing about the tube.

Centrally of the top portion of the unit is a small enclosure 27 which is suspended from the top panel 22 of the unit. The tube 19 (see FIG. 3) isvided and mounts a bevel gear 28 therein. A short shaft 29 is carried by the front panel 20 and mounts a bevel gear 30 that meshes with the bevel gear 28. The other end of the shaft 29 projects through the front panel 20 and mounts an indicator 31 which is intended to swing through an approximately 180° arc and pass over a graduated scale attached to or impressed on the outer surface of the front panel 20. Although the ratio of gears 29 and 30 is approximately two to one, this is optional and merely intended to accord with the spacing of the graduations on the front panel 20.

At one side of the base wall 32 of the enclosure 27 there is located a depending well 33. The well receives a piston 34 that is joined at its upper end to a connecting rod 35. This structure is of the nature of a dashpot as indicated, the purpose of which is to provide dampening to prevent tending and create a steady movement of the indicator 31 in either direction, regardless of any possible irregularity of movement of the boom 13. Joined at one end to the rod 35 is a link 36, the other end of which is attached to a collar 37 secured to the shaft 19. Since the unit 14 is suspended by and capable of free movement with the tubular enclosure 40 it is free to swing about this tube and will in effect act as a plumb with respect to the boom. That is, due to the location of the tube 19, gravity will cause the unit 14 to at all times be perpendicular to the ground, regardless of any ground unevenness on which the crane may be positioned. The basic purpose of this, of course, is to compute the boom angle on the basis of its relationship to the earth's surface with respect to gravity rather than the boom angle with respect to the crane on which it is mounted.

The warning device 16, shown in FIG. 3, is mounted in the cabinet directly in front of the crane operator and consists of a small box-like unit having a pointer 38 that may be joined to one end of a flexible cable 39, or this pointer may be carried by a suitable shaft extending into the unit which, in turn, mounts a bevel gear. Another bevel gear meshes through the aforementioned gear and is joined to one end of the flexible cable 39. Although the bevel gears of this device are not shown, they may take the form and arrangement of the gears 28 and 30 described above. The cable 39 extends from the device 16 into and through the full length of the tube 19. As may be observed in several of the figures, the unit 14 has small, box-like end enclosures 40 and 41. The tube 19 projects through the enclosure 40 and into the enclosure 41.

That portion of the structure within the enclosure 41 relates to the coordinating of the warning device with respect to the boom angle. This end of the flexible mount and secures a disk 43. On this disk are separate electrical contact bars 44 and 45, arranged in a common arc about the center of the disk. A suitable lead 46 includes a lamp 47 in series therewith and terminates at one post 48 of a battery or other source of current 49. The enclosure 41 may be attached to the end panel 24 of the unit 14 by screws 51 and serves to conceal the disk 43. Attached to or formed integral with the inner face of this enclosure is an elongated contact bar 52, disposed in an arc on center with the arc for bars 44 and 45. As may be seen from the diagram of FIG. 10, bar 52 has 53 directly connected to the other post 54 of the battery 49. This particular structure makes possible the rotation of disk 43 with respect to tube 19 by means of the pointer 38 whereby to move the bars 44 and 45 in a circular path closer to or farther away from the tube 19 (see FIG. 4) projects through the enclosure 41.

Attention is now directed to the other end of the unit 14. Here, as shown in FIG. 7, the enclosure 49 is attached to the unit end panel 25 by further screws 51. Within this enclosure is located means by which an operator will be apprised, by two warning media, of the approach of the boom toward near vertical position. Attached to the outer face of the end panel 25, or a plate 56 secured thereto, is an elongated contact bar 57 that is disposed in an arc, the center for which is that of tube 19. Within this enclosure is a disk 58 that is secured, by a set screw 59, to the tube 19. On the inner face of this disk is a pair of contact bars. These bars are identical with the bars 44 and 45 of disk 43 and are generally indicated at 61. It will be noted that, although disk 58 may be rotated with respect to tube 19 to properly relate bars 61 to bar 57, this disk, when so rotated, is secured by the set screw, and in operation of the invention, this relationship of these contact bars never changes. This is because of the fact that no adjustment for warning of the approach of the boom toward a vertical position is required.

The following description of operation of the invention will illustrate this. In the exception that the fact that disk 43 rotates counter-clockwise and disk 58 clockwise with respect to the unit 14, the diagram of FIG. 10 is intended to suggest the electrical connections for either or both sets of warning media.

To illustrate the usefulness of the invention, it may be assumed that the boom 13 occupies the position shown in FIG. 1 and that it is to be lowered a determined number of degrees to lift a load of known weight. The problem here, although charts are provided for this purpose, is to prevent extending the boom towards its horizontal plane beyond the weight capability of the body of the crane to lift such a load. Although the chart suggests the maximum boom angle for a given load, it often occurs that an operator may move the boom to and beyond the specified maximum angle and difficulty may be encountered in an attempt to lift a given load, such as by overloading the entire crane. To avoid any such possibility, the crane operator, knowing the chart indicated maximum angle for the boom, sets the pointer 38 to a position approximately 10° less than the chart indicates for maximum boom angle with load. Movement of this pointer away from the indicated 43 projects through the contact bars 44 and 45 in a circular path (see arrow
A—FIG. 10) closer to the elongated contact bar 52. At this point, the distance between bar 44 and bar 52 directly represents the distance the boom may travel from its present position to a position approximately 10° short of the maximum boom angle.

As the boom moves downward, tube 19 is caused to rotate to the same extent that the boom angle changes. Since the unit is suspended as a pendulum, it will, by reason of the bearings 26, remain perpendicular and thus there is relative rotation as between tube and unit. As has been stated, although the disk 39 may be rotated by the pointer 38 or its equivalent, the fit between the cable and tube is such that the cable and disk will rotate with the tube. Thus, the space between bars 44 and 52 lessens until they make contact. By referring to FIG. 10 it will be seen that such contact closes a circuit and causes the lamp 47 to light. Since this lamp is directly in the operator's line of vision of the boom, he is made immediately aware of the fact that the boom can only be safely further lowered not over ten more degrees. Continued downward movement of the boom brings bar 44 into contact with bar 52 and this completes a circuit 62 to operate the bell or buzzer 63. Due to the length of bar 52, it may be in contact with both bars 44 and 45 and in consequence the operator is apprised that the boom is not only in the danger zone but has reached its maximum safety angle. It may be assumed, for purposes of illustration, that a load has been engaged with the boom cable and that the boom must be raised to a nearly vertical position, possibly at one side of the crane. In any event, the point that is to unload, the operator must raise the boom to a nearly vertical point and caution must be exercised not to exceed a boom position that would allow it to tip backward out of control. For convenience, the graduations on the warning device are substantially as shown and read from zero to ninety degrees. The ninety degree mark represents full vertical position of the boom, whereas the zero mark indicates full horizontal boom position.

The operator, upon picking up a load, raises and probably swings the boom into the unloading area. As the vertical angle of the boom increases, the tube 19 rotates in a clockwise direction, thus carrying with it disk 43, resulting in the diagram of FIG. 10. It may be assumed that disk 58 is identical with disk 43 and therefore is rotated as suggested by the arrow B. This will bring one of the bars 61 into contact with the fixed bar 57 to complete an electrical circuit. This circuit, however, is the same as that for bar 44 and, consequently, will cause lamp 63 to light. As the boom continues movement toward a vertical position, further rotation of disk 58 will bring the second bar 61 into contact with the fixed bar 57. This, of course, closes the circuit for energizing the bell or buzzer 63, the circuit for which is as suggested for bar 45. Here again, the operator is first warned by a light of the boom's approach to a dangerous angle and immediately thereafter warned again by a bell that the maximum safe angle of the boom has been reached.

Thus, an operator of a crane, although depending upon guides or charts for boom operation, is enabled, by means of the present invention, to see for himself the exact boom angle and be warned when the boom approaches and reaches its safe angle for any given load. It will be understood that the ratios indicated as between boom and unit 14 and the setting pointer of the warning device 16 may be varied as required and that no attempt is made to precisely locate the unit and device except as to proximity and ease of viewing and manipulation of the pointer by a crane operator. These and other variations are considered as being within the spirit and scope of the invention insofar as they are within the meaning of the attached claims.
ing a boom angle indicator, a laterally extending tubular rod secured to said boom, an indicator unit, said rod projecting lengthwise through said unit adjacent the top thereof and suspending said unit for pendulum-like movement with respect to said boom, a pointer mounted adjacent one face of said unit and moveable over graduated markings on said face, drive means connecting said pointer with said rod, a switch element secured to that end of said unit remote from said boom, a manually operable dial available to a crane operator, a flexible cable joined at one end to said dial and projecting through and beyond the end of said tubular rod and terminating adjacent said switch element, a switch-arm joined to the other end of said cable, said switch element being adapted to rotate when the angularity of said boom changes whereby to contact said switch arm and complete an electrically energized warning device.

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