Feb. 23, 1971 M. W. HAMILTON 3,566,386

CRANE ANGLE INDICATING SYSTEM

Filed Feb. 6, 1968 3 Sheets-Sheet 1

Fig. 1

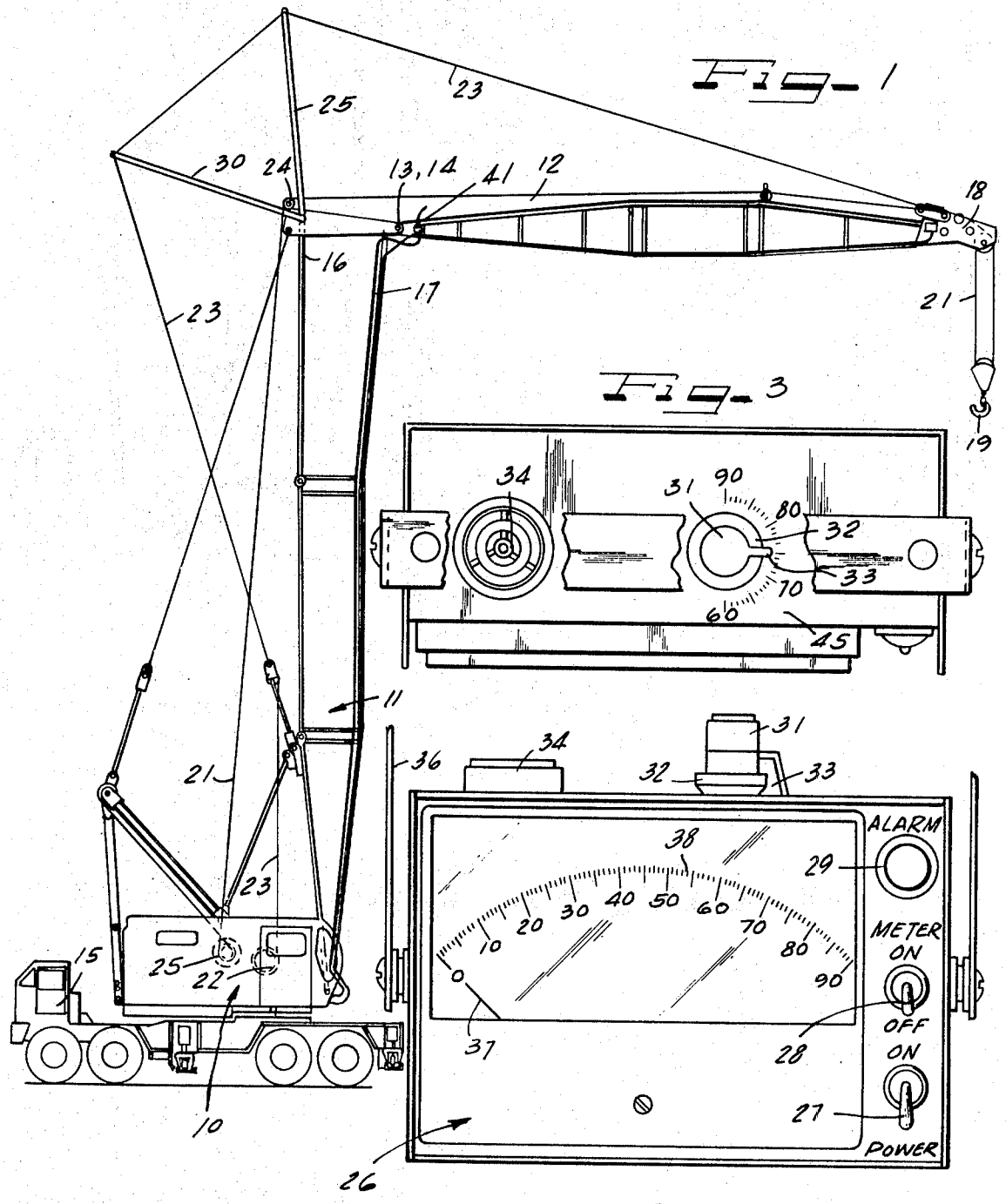


Fig. 3

Fig. 2

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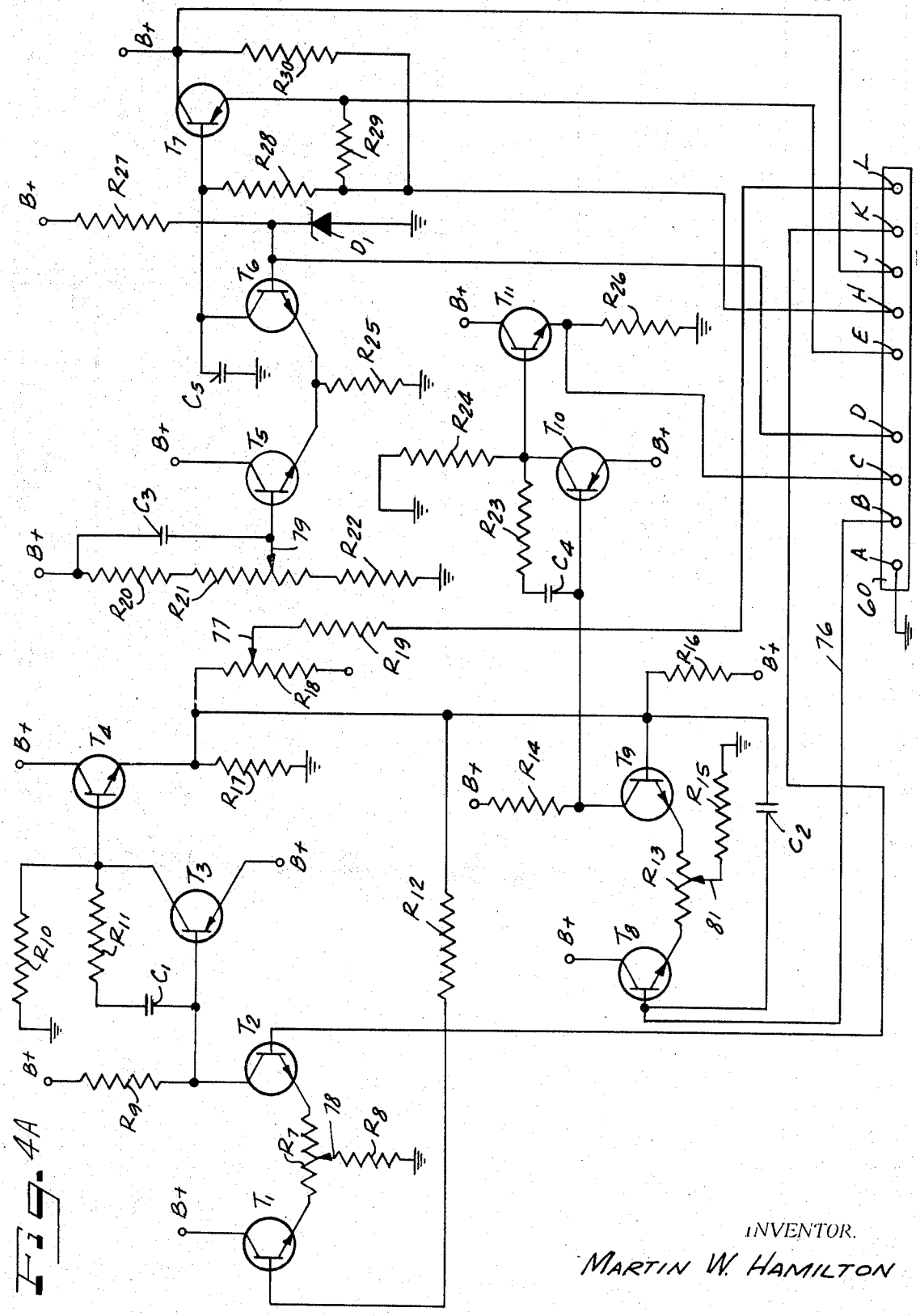


Fig. 4A

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CRANE ANGLE INDICATING SYSTEM

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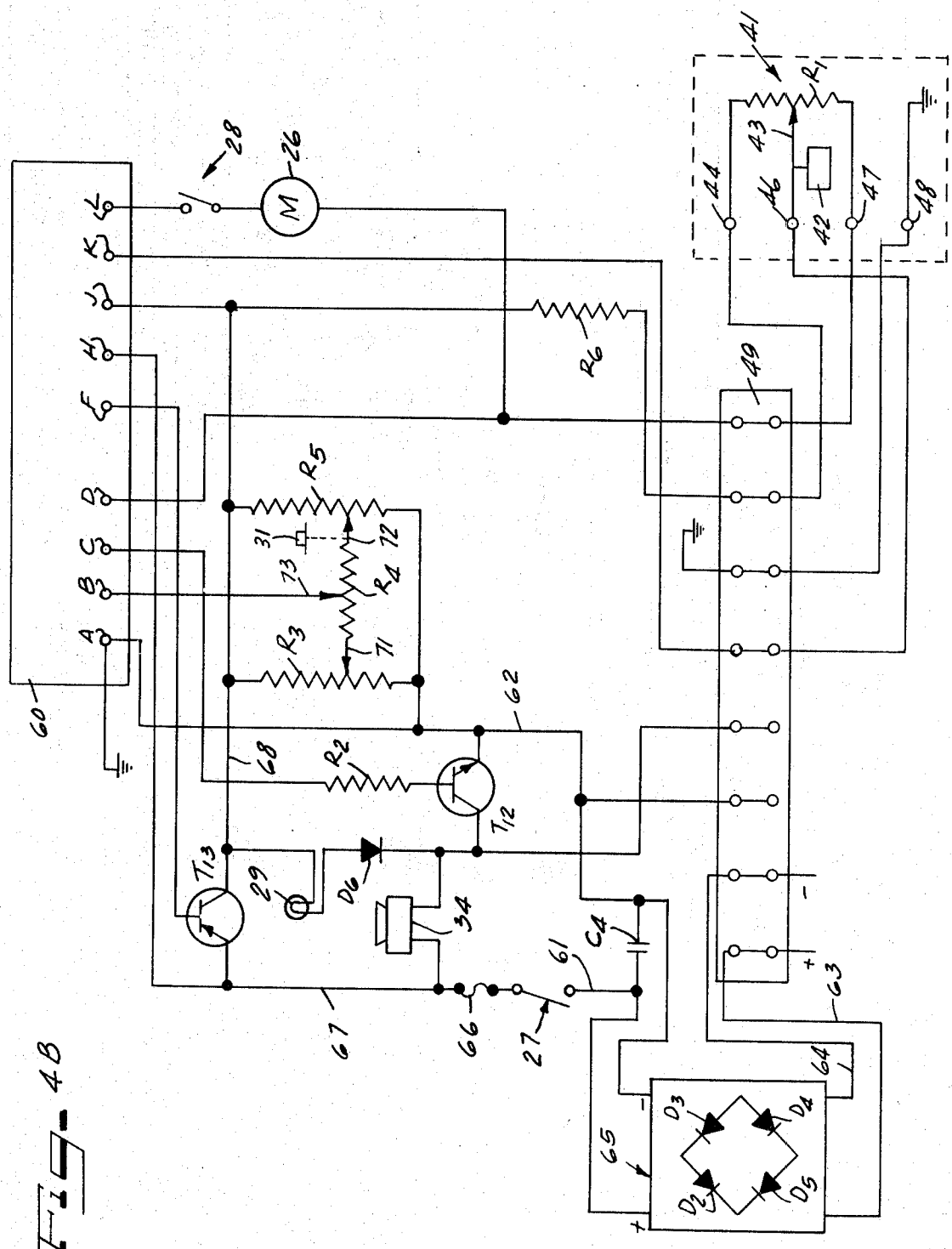


FIG. 4B

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CRANE ANGLE INDICATING SYSTEM

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Int. Cl. G08b 21/00
U.S. Cl. 340—267 9 Claims

ABSTRACT OF THE DISCLOSURE

A monitoring and alarm system for a tower crane which warns the operator of the crane if predetermined angular limits are exceeded. Tower cranes must be operated within certain limits as determined by the position of the crane boom and if such limits are exceeded, a dangerous condition exists. The present invention warns if the crane angle reaches a dangerous condition.

BACKGROUND OF THE INVENTION

Field of the invention

The invention relates to monitoring and warning devices for a tower crane so as to indicate if a dangerous condition is being approached by the crane angle.

DESCRIPTION OF THE PRIOR ART

Tower cranes have been used and it has been customary for an operator to observe charts and the angle of the boom and estimate from within the crane cab whether a dangerous condition exists.

SUMMARY OF THE INVENTION

The present invention relates to a warning and monitoring device which produces an audible and visual indication if the crane angle of a tower crane approaches or exceeds a preset limit. This allows the operator to set the warning device to the predetermined boom angle depending on load and other factors and then concentrate on moving the loads with the crane. He does not have to continuously observe the crane angle and estimate when a dangerous condition is being approached since he knows that the warning and monitoring device of this invention will automatically give him an audible and visual indication when a limiting crane angle is being approached or exceeded.

Many other advantages, features and additional objects of the present invention will become manifest to those versed in the art upon making reference to the detailed description and the accompanying sheets of drawings in which preferred structural embodiments incorporating the principles of the present invention are shown by way of illustrative example.

BRIEF DESCRIPTION OF TH DRAWINGS

FIG. 1 illustrates a tower crane in which the present invention is used;

FIG. 2 is a front view of the warning and monitoring indicator;

FIG. 3 is a top view of the indicator; and

FIGS. 4A and 4B are schematic diagrams illustrating the control and wiring portion of the warning and monitoring device.

DETAILED DESCRIPTION OF THE INVENTION

FIG. 1 illustrates a crane **10** mounted on a truck **15** and which carries a first boom portion **11** which extends upwardly from the crane cab **10**. A second boom portion **12** is pivotally attached to members **16** and **17** of the first boom portion **11** by pivot pins **13** and **14** and extends generally horizontally. An end portion **18** of the boom portion **12** carries a pulley. A cable **21** has one end

connected to the end portion **18** and passes down over a pulley which supports a hook **19**. The cable passes over a pulley **24** to a winch **25** mounted within the cab **10**. Suitable driving and control means are connected to the winch **25** to allow the hook **19** to be moved upwardly and downwardly relative to the boom portion **12**. A second winch **22** is connected to a cable **23** which passes over support members **30** and **25** to the end **18** of a boom portion **12**. Winch **22** and cable **23** control the angular position of boom portion **12** relative to the boom portion **11**. Since the boom portion **12** is pivotally attached to the portion **11** it may be pivoted upwardly and downwardly from the horizontal.

The present invention provides an audible and visible alarm to indicate to the operator of the crane when the boom portion **12** reaches a predetermined limiting angle so as to give him warning both visually and audibly so that he will be aware of the condition and correct it.

The warning and monitoring device is illustrated in FIGS. 2 and 3. FIG. 2 illustrates a meter **26** with an indicator **37** that may be read against an indicia **38** printed on the face of the meter. A power-on switch **27** supplies power to the device and the meter has a separate switch **28**. The visual alarm **29** is mounted on the face of the meter **26** and lights up to indicate to the operator when the preset angle of the boom has been exceeded. An audible warning horn **34** is also mounted on the meter **26** and audibly indicates that the angle to which the warning device has been set has been exceeded.

A warning angle setting knob **31** is mounted on the top of the meter **26** and has a pointer **33** that may be read against suitable indicia **45**. A lock **32** is rotatably mounted on meter **26** and allows the warning knob **31** and pointer **33** to be locked in any preset position. By loosening the lock **32** the pointer and knob **31** may be rotated to a different setting and locked in that position by retightening the lock **32**.

FIGS. 4A and 4B illustrate the electrical schematic of the warning and monitoring device. As shown in FIG. 4B the angle transducer **41** comprises a 90° precision potentiometer with a weighted pendulum **42** attached to it. The transducer **41** produces an output signal proportional to the angle of rotation from a horizontal reference. The pendulum may be damped to prevent excessive mechanical oscillation as for example by utilizing a permanent magnet field which causes eddy current drag in the pendulum proportional to the rate of oscillation. The transducer **41** is mounted on boom portion **12**.

The pendulum controls the position of a wiper contact **43** which engages the potentiometer R_1. Wiper contact **43** is connected to terminal **46**. One end of resistor R_1 is connected to terminal **44** and the other end is connected to terminal **47**. A grounded terminal **48** is in the transducer **41** also. Contact **44** is conneced through terminal block **49** to a resistor R_6 which has its other side connected to a terminal J on a terminal block **60**. Contact **46** is connected to terminal K of terminal block **60**. Contact **47** is connected through terminal block **49** to terminal D of terminal block **60** and to one side of meter **26**. A full wave rectifier **65** comprises diodes D_2, D_3, D_4 and D_5 and produces a rectified output on terminals **61** and **62**. Input terminals **63** and **64** are connected to a suitable direct current supply for example between 12 and 30 volts DC.

One of the leads **63** is connected to a positive terminal of the voltage supply and the other **64** is connected to the negative supply. A condenser C_4 is connected across terminals **61** and **62** to filter out noise from the generator. The rectifier **65** takes care of positive or negative ground on the machine such that terminal **61** is connected to the positive terminal and **62** to the negative terminal. A switch **27** which is the power-on switch is connected to

lead **61** and to a fuse **66**. Lead **67** is connected from fuse **66** to terminal H on terminal board **60**. Terminal A of terminal board **60** is connected to ground and to lead **62**. A horn **34** and transistor T_{12} are connected in series between leads **62** and **67**. A diode D_6 has one terminal connected to the junction point between horn **34** and transistor T_{12} and its other side connected to the warning light **29**. The other side of light **29** is connected to an electrode of a transistor T_{13}. Another electrode of transistor T_{13} is connected to lead **67**. The base of transistor T_{13} is connected to contact F on terminal board **60**. A resistor R_2 is connected to the base of transistor T_{12} and the other side of the resistor is connected to terminal C of terminal board **60**. Terminal J of terminal board **60** is connected to lead **68**. Resistors R_3 and R_5 have one side connected to lead **68**, and their other ends connected together and to the emitter of transistor T_{12}. A potentiometer R_4 has a first wiper contact **73** which is connected to terminal B on terminal board **60**. Wiper contacts **71** and **72** are electrically connected to opposite ends of resistor R_4 and engage respectively resistors R_3 and R_5. Terminal board **60** is illustrated in FIG. 4A. Terminal A is connected to ground and contact B is connected by lead **76** to the base of a transistor R_8. Contact C is connected to the emitter of a transistor T_{11}. Contact D is connected to the base of a transistor T_6. Contact F is connected to the emitter of a transistor T_7. Contact H is connected to the junction points between resistors R_{28} and R_{29} and to one side of resistor R_{30}. The other side of resistor R_{28} is connected to the base of transistor T_7. The other side of resistor R_{29} is connected to the emitter of transistor T_7, and the other side of resistor R_{30} is connected to the emitter of transistor T_7.

Contact J is connected to the emitter of transistor T_7. Contact K is connected to the base of a transistor T_2 and contact L is connected to a resistor R_{19}. The other side of resistor R_{19} is connected to a wiper contact **77** which engages a resistor R_{18}.

A resistor R_7 is connected between the emitters of transistors T_1 and T_2 and the resistor R_8 has one side connected to ground and the other side connected to a wiper contact **78** which engages resistor R_7. The collector of transistor T_1 is connected to a suitable B+ voltage. The base of transistor T_1 is connected to one side of a resistor R_{12} which has its other side connected to the base of transistor T_9 and to the emitter of a transistor T_4. The emitter of transistor T_3 is connected to B+ and the base of transistor T_3 is connected to the collector of transistor T_2. A capacitor C_1 and resistance R_{11} are connected in series between the base and collector of transistor T_3. The base of transistor T_4 is connected to the collector of transistor T_3. The base of transistor T_4 is also connected to one side of a resistor R_{10} that has its opposite side connected to ground. The collector of transistor T_4 is connected to B+ and its emitter is connected to a resistor R_{17} which has its opposite side connected to ground. The base of transistor T_9 is connected to the emitter of transistor T_4. Resistors R_{20}, R_{21} and R_{22} are connected in series between B+ and ground. A condenser C_3 is connected between B+ and the base of transistor T_5. A wiper contact **79** is connected to the base of transistor T_5 and engages the resistor R_{21}. The emitters of transistors T_5 and T_6 are connected together and to one side of a resistor R_{25} which has its other side connected to ground. The condenser C_5 is connected between ground and the collector of transistor T_6. A center diode D_1 is connected between ground and the base of transistor T_6. A resistor R_{27} is connected between the base of transistor T_6 and B+. Collector of transistor T_6 is connected to the base of transistor T_7. Transistor T_{10} has its emitter connected to B+ and base connected to the collector of transistor T_9 and to a condenser C_4. The other side of condenser C_4 is connected to a resistor R_{23} which is connected to the collector of transistor T_{10}. The collector of transistor T_{10} is also connected to resistor R_{24} which has its other side grounded. Transistor T_{11} has its collector connected to B+ voltage and its emitter connected to a resistor R_{26} which has its other side grounded. Transistor T_8 has its collector connected to B+ and its emitter connected to a potentiometer R_{13} which has its other side connected to the emitter of transistor T_9. A wiper contact **81** engages the resistor R_{13} and is connected to one side of a resistor R_{15}. The other side of resistor R_{15} is connected to ground. The base of transistor T_9 is connected to one side of resistor R_{16} which has its other side connected to a B'+ voltage. The collector of transistor T_9 is connected to B+ through a resistor R_{14}. The collector is also connected to the base of transistor T_{10}.

In operation, the crane operator unlocks the lock **32** and adjusts the knob **31** so that the pointer **33** reads against the indicia **45** to the desired limiting angle of the crane portion **12**. Switches **27** and **28** are turned on to energize the warning alarm and angle indicator. In a particular embodiment B+ voltage was 11 volts and the B'+ voltage was +6 volts. Wiper contact **72** is set by knob **31** to the desired warning angle. Transistor T_{13} is a regulator across the warning system. Transistor T_{12} drives the horn **34** and the light **29** when the set point is reached for a warning. The rectifier **65** solves the problem of positive or negative grounds and is a bridge rectifier so that the system operates properly whether particular machine and power system ground either the positive or negative side of the power supply. The condenser C_4 filters out noise from the generator and other sources. Wiper contact **73** may be adjusted to adjust the zero setting of the needle **37**. Transistors T_5, T_6 and T_7 comprise a regulator control. Wiper contact **77** allows the angle calibration to be made and the transistors T_1, T_2, T_3 and T_4 comprise an operational amplifier and receive an input from contact K and L of the terminal block **60** which is indicative of the angle of the pendulum **42**. Transistors T_8, T_9, T_{10} and T_{11} comprise a second operational amplifier which drives the alarm system. Transistors T_8 and T_9 comprise a differential amplifier and drive the alarm system. Note for example, that the emitter of transistor T_{11} is connetced to terminal C of terminal block **60** and that terminal block **60** has its contact C connected to the resistor R_2 which in turn is connected to the base of transistor T_{12} in FIG. 4B. When the differential amplifier comprising the transistors T_8 and T_9 is keyed, a bias supply is applied through contact C to the base of transistor T_{12} to turn on the horn **34** and the light **29**. The bias point for the operation of the circuit can be adjusted by moving knob **31** which controls the wiper contact **72**.

Although minor modifications might be suggested by those versed in the art, it should be understood that I wish to embody within the scope of the patent warranted hereon all such embodiments as reasonably and properly come within the scope of my contribution to the art.

I claim as my invention:

1. A warning and monitoring device for a tower crane with a movable boom which has first a boom portion that is substantially vertical and a second boom portion pivotally attached to the second boom portion comprising:

an angle transducer mounted on the second boom portion and producing an output proportional to the angle of the second boom portion relative to the horizontal and comprising a potentiometer with a wiper contact and a pendulum pivotally supported and attached to the wiper contact,

an alarm set potentiometer with a wiper contact that may be set to select a warning angle,

a flip-flop circuit comprising a first pair of transistors with one biased on and one biased off during safe operating conditions of said crane, said wiper contacts of said alarm set potentiometer connected to said normally on transistor and said wiper contact

of said angle transducer connected to said normally off transistor, and

an alarm device connected in circuit with said normally off transistor to produce a warning when the second boom portion has an angle which is beyond that set in the alarm set potentiometer.

2. A warning and monitoring device according to claim 1 comprising a set shaft connected to the wiper contact for varying the output of the alarm set circuit.

3. A warning and monitoring device according to claim 2 comprising a knob on the set shaft, and means for selectively locking the shaft.

4. A warning and monitoring device according to claim 3 comprising indicia adjacent the knob to allow the alarm set circuit to be set to a selected output.

5. A warning and monitoring device according to claim 1 wherein the alarm device produces a visual output.

6. A warning and monitoring device according to claim 5 wherein the alarm device is a light bulb.

7. A warning and monitoring device according to claim 1 wherein the alarm device produces an audible output.

8. A warning and monitoring device according to claim 7 wherein the alarm device is a horn.

9. A warning and monitoring device according to claim 1 including a meter for indicating the angle of the second boom portion.

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