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[54] CRANE OPERATING RADIUS INDICATOR 6 Claims, 3 Drawing Figs.

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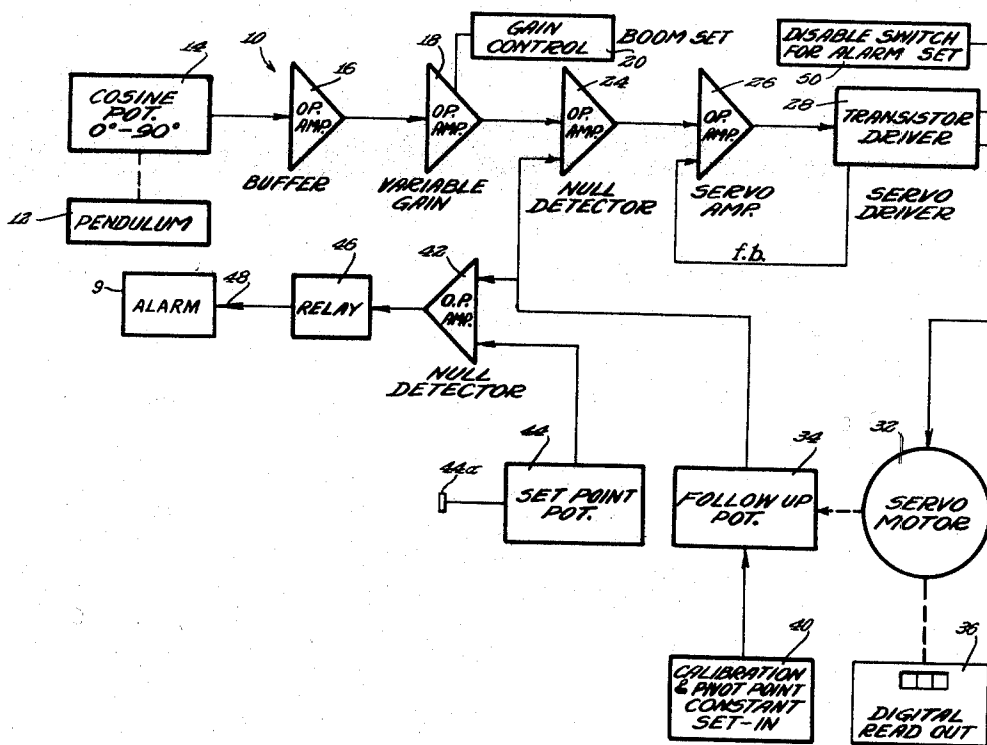
[50] Field of Search 235/186,
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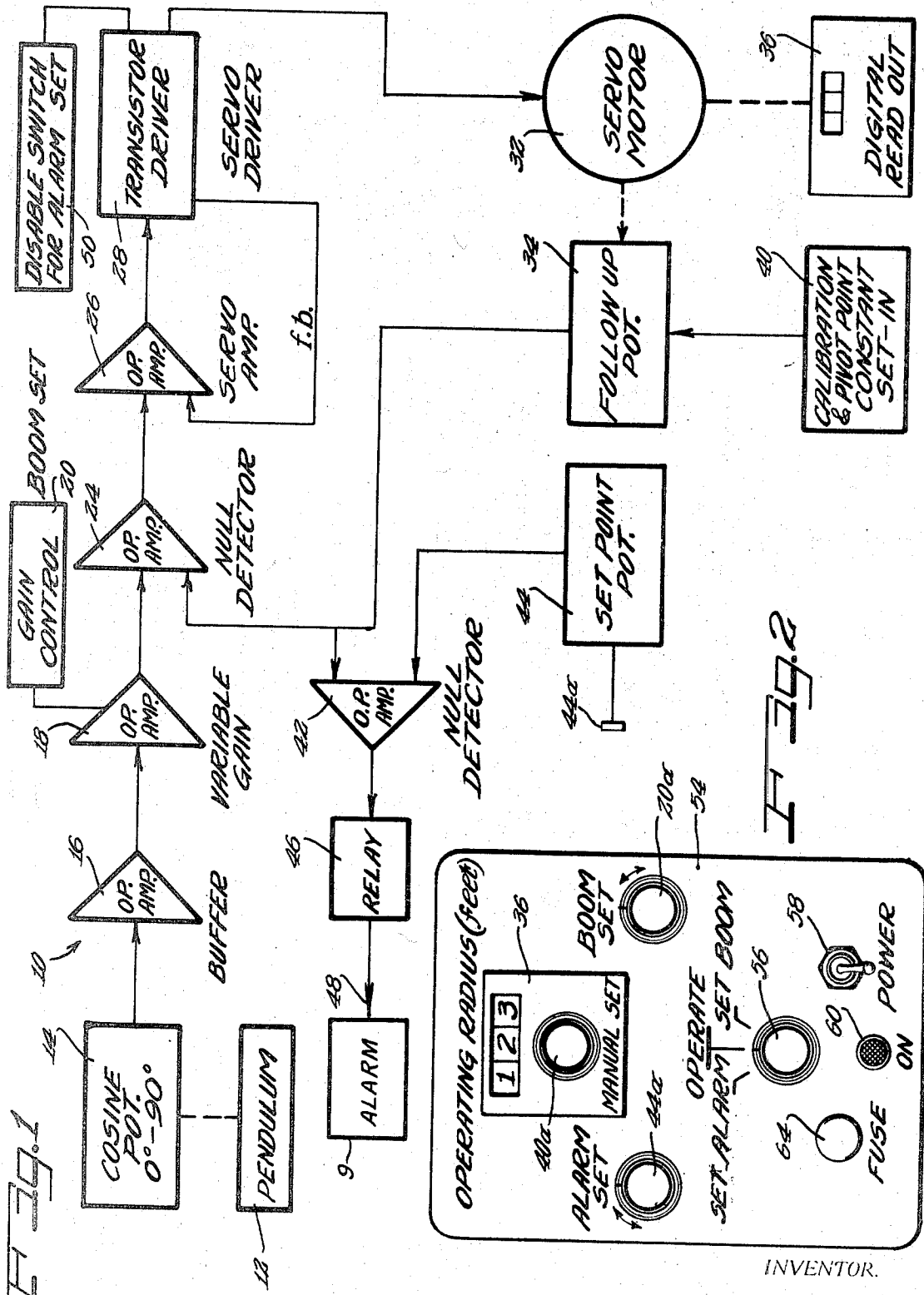
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ABSTRACT: A crane operating radius indicator including a transducer responsive to the position of the boom of the crane, and a circuit responsive to the transducer signal to produce an output which is an analogue of the radius of the boom. A servoamplifier and servomotor are controlled by the radius analogue signal, and a digital readout counter driven by the servomotor indicates the radius of the boom. The analogue of the radius of the boom may also directly drive a panel meter. The invention also includes digital and panel meter outputs for other transduced signals and the method of indicating such sensings.





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CRANE OPERATING RADIUS INDICATOR

BACKGROUND OF THE INVENTION

This invention pertains to an instrument to indicate the operating radius of a construction crane, and more particularly to a solid state servo motor control system to indicate the operating radius of a crane based on boom and boom angle.

PRIOR ART

It is known to use a transducer associated with a construction crane or boom to indicate the angle of the crane. Such a device is disclosed in U.S. Pat. application Ser. No. 626,563, filed Mar. 28, 1967, and entitled "Load Warning Device."

It is also known to use servo motors responsive to input signals to drive potentiometers and output devices to specific positions.

SUMMARY

It is a principle object of the present invention to provide a solid state instrument to indicate the operating radius of a boom.

It is a further object of the invention to provide a method and apparatus for indicating the operating radius of a boom utilizing a novel servo control system.

It is still a further object of the present invention to provide a crane operating radius indicator responsive to any angle of the boom of the crane.

Yet another object of the present invention is to provide a crane operating radius indicator having an alarm circuit.

Still another object of the present invention is to provide a crane operating radius indicator which includes a selectable alarm signal based on the radius of the boom.

Another object of the present invention resides in the inclusion of a fixed radius between the center of rotation and the boom hinge point.

Still other and further objects and features will at once become apparent to those skilled in the art from a consideration of the attached drawings and specification wherein an embodiment of the invention is shown by way of illustration only.

ON THE DRAWINGS

FIG. 1 is a block diagram of a crane operating radius indicating system in accordance with the present invention;

FIG. 2 is an operator's control panel for the system of FIG. 1; and

FIG. 3 is a block diagram of a modified crane radius indicator.

DETAILED DESCRIPTION OF THE INVENTION

In accordance with the principles of the present invention I have provided a crane operating radius indicator generally indicated by the numeral 10, FIG. 1. The system 10 is responsive to a pendulum 12 which is identical with the transducer as disclosed in the copending U.S. Pat. application entitled "Warning Device." The pendulum 12 provides a signal to a cosine potentiometer 14. The output from the cosine potentiometer 14 is a signal equivalent to the cosine of the boom angle between 0 to 90° with respect to the ground and is provided to an input operational amplifier 16 of the integrated circuit type. The amplifier 16 is used to buffer the cosine signal provided by the pendulum 12.

The output from the amplifier 16 is taken by a variable gain operational amplifier 18 having a gain control input 20 which is set for and is proportional to boom length. The output of the variable gain amplifier 18 is taken by one input of a position detector operational amplifier 24.

The output of the amplifier 24 is taken by an operational amplifier servodriver 26 which in turn supplies a signal to a transistor servodriver 28 whose signal controls a servomotor 32. The servomotor 32 drives a followup potentiometer 34 whose output is a second input to the amplifier 24 which acts as a position detector.

The amplifier 24 is a differential detector with gain. The two inputs to the amplifier 24 comprise the analogue of the radius of the boom from the variable gain amplifier 18 and the feed back signal from the followup potentiometer 34. The amplifier 24 thus operates as a DC null seeking stage to determine the position of the crane null. The servomotor 32 drives a digital readout counter or meter 36 until a null or balanced condition is reached at which point the counter 36 will indicate the radius represented by the analogue signal from the variable gain amplifier 18 which is in turn responsive to the signal from the pendulum 12.

The followup potentiometer 34 has a second input from a pivot point constant set-in 40 which provides a constant dial displacement from zero which is equivalent to the desired distance in feet. The constant set-in 40 is necessary as the system of FIG. 1 measures from the boom pivot point. The rating charts in general use, measure the radius of the boom from the cab pivot. This requires the difference of 3 or 4 feet between the cab and boom pivot be added to the indicating device to be accurate.

The followup potentiometer 34 provides a feedback signal to the amplifier 24 and the same signals to an alarm circuit consisting of an amplifier 42 which is used as a differential detector. The second input to the amplifier 42 is provided by an alarm set point potentiometer 44. The alarm set point potentiometer 44 is controlled by a knob 44a on the operator's control panel. The amplifier 42 supplies a signal to a relay 46 whose output 48 is used to actuate an alarm 9 when the followup potentiometer 34 and the digital readout counter 36 pass a desired set-in value. The transistor driver 28 is provided with a disable switch 50 for alarm setting.

The digital readout counter 36 is mounted on a panel 54 which is positioned in the vicinity of the operator's controls inside the crane cab (not shown).

The panel 54 includes a boom set gain control knob 20a. The alarm set point potentiometer knob 44a and a manual set knob 40a for the calibration and pivot point constant set-in. Also on the panel 54 is an operating switch 56 having detent positions for Set Alarm, Operate and Set Boom. The panel 54 has an on-off switch 58, a lamp 62 indicates when power is being supplied to the system through the switch 58 and a fuse 64.

In operation, the crane operating radius indicator is to move the control knob 56 to the Set Boom position. This applies a 0° or $\cos. = 1$ signal to the input of buffer 16 instead of the transducer signal. The servomotor 32 still runs and the boom set potentiometer knob 20a is adjusted until the digital readout counter 36 reads the actual boom length.

In the second step the control knob 56 is moved to the Set Alarm position. This actuates the circuit of block 50 to disable the servodriver 28. The knob 40a sets-in the desired constant radius on the followup potentiometer 34. The dial 44a is then turned until the alarm is actuated through the relay 46. The knob 56 is then moved to the central "Operate" position to reenergize the driver 28. The servomotor 32 then drives to the actual radius and indicates this on the digital readout counter 36. The control knob 56 is then set to the Central operate position for operation of the crane.

The counter 36 provides a digital readout which indicates operating radius in one embodiment constructed in accordance with the principles of the invention from 0 to 500 feet in 1 foot increments. The control knob 56 provides a means whereby the set-in values are read directly from the counter 36 thereby providing a self-calibrating feature. In addition, an internal adjustment is provided for setting in the horizontal to vertical pivot value which is a constant for any particular crane and is added to the operating radius.

Summarizing, the position of the boom of the crane is sensed by the pendulum 12. The pendulum 12 drives a cosine function type of potentiometer 14 and in turn drives the buffer amplifier 16. The amplifier 16 is followed by a variable gain amplifier 18 which multiplies the cosine signal input by its gain, gain being the analogue of boom length, and produces an output which is an analogue of the radius of the boom.

The analogue of the radius of the boom signal from the amplifier 18 is one input to the differential detector 24. The other input is provided by the servo operated followup potentiometer 34. The differential detector 24 operates as a DC null seeking stage and in turn feeds a signal to the amplifier 26 and the transistor driver 28. The servomotor 32 is responsive to the transistor driver 28 and drives the followup potentiometer 34 and the digital readout counter 36 until a null or balanced condition is reached at which point the counter 36 will indicate the radius represented by the analogue signal.

The crane operating radius indicating method includes sensing the position of the boom of the crane with the transducer 12, providing a signal responsive to the position sensing which is an analogue of the radius of the boom for the amplifier 18, driving the servomotor 32 responsive to the analogue signal, and indicating the radius of the boom on the digital readout counter 36.

A modified crane radius indicator drives a panel meter 70, FIG. 3. The variable gain amplifier 18 drives the meter 70. The alarm relay is provided with a disable switch 72 for the adjustment of the indicating system. The operation is similar to that of FIG. 1.

Other quantities may be sensed such as angle, weight, or the like and processed in a like manner to the radius signal to provide a visual readout on a panel meter or digital counter.

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:

1. A crane operating radius indicator comprising: transducer means responsive to the position of the boom; means to produce an output responsive to the transducer signal which is an analogue of the radius of the boom; servoamplifier means responsive to the signal provided by the means to produce an output which is the analogue of the radius; servomotor means responsive to said servoamplifier means; digital readout means driven by the servomotor to indicate the radius of the boom, wherein said means to produce an output which is the analogue of the radius of the boom includes an input operational amplifier of the integrated circuit type which is used to buffer the signal provided by said transducer means, and a

variable gain operational amplifier whose gain is set for and is proportional to the boom length.

2. A crane operating radius indicator as recited in claim 1 including a control panel having a boom set knob, and alarm set knob, and said digital readout means.

3. A crane operating radius indicator comprising: transducer means responsive to the position of the boom; means to produce an output responsive to the transducer signal which is an analogue of the radius of the boom; servoamplifier means responsive to the signal provided by the means to produce an output which is the analogue of the radius; servomotor means responsive to said servoamplifier means; digital readout means driven by the servomotor to indicate the radius of the boom, wherein said servoamplifier means includes a differential amplifier having a pair of inputs, one input to said differential amplifier being from said means to produce a signal which is an analogue of the radius of the boom and a second input being provided by a followup potentiometer driven by said servomotor means whereby said differential amplifier operates as a DC null seeking stage.

4. A crane operating radius indicator as recited in claim 3 wherein said servoamplifier means includes said differential amplifier, a servoamplifier, and a transistor servodriver.

5. A crane operating radius indicator as recited in claim 3 wherein said indicator includes means to set a pivot point constant in said followup potentiometer to provide a constant dial displacement from zero which is equivalent to the desired distance.

6. A crane operating radius indicator comprising: transducer means responsive to the position of the boom; means to produce an output responsive to the transducer signal which is an analogue of the radius of the boom; servoamplifier means responsive to the signal provided by the means to produce an output which is the analogue of the radius;

servomotor means responsive to said servoamplifier means; and digital readout means driven by the servomotor to indicate the radius of the boom, including an alarm circuit having a differential amplifier with one input provided by a followup potentiometer and a second input from an alarm set point potentiometer whereby when said followup potentiometer and said set point potentiometer pass a desired set in value an external alarm is triggered.

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