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PROXIMITY ALARM
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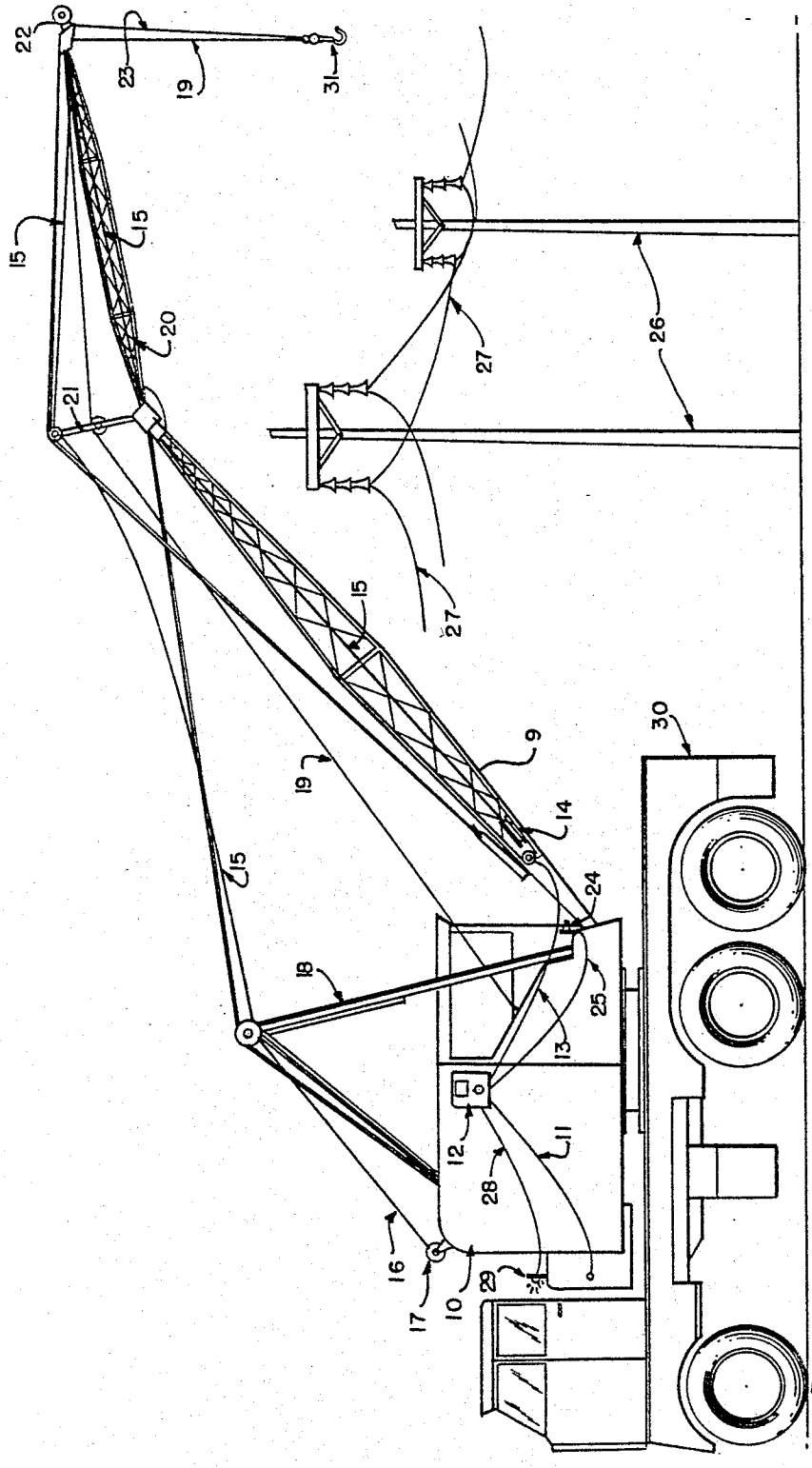


FIG. 1.

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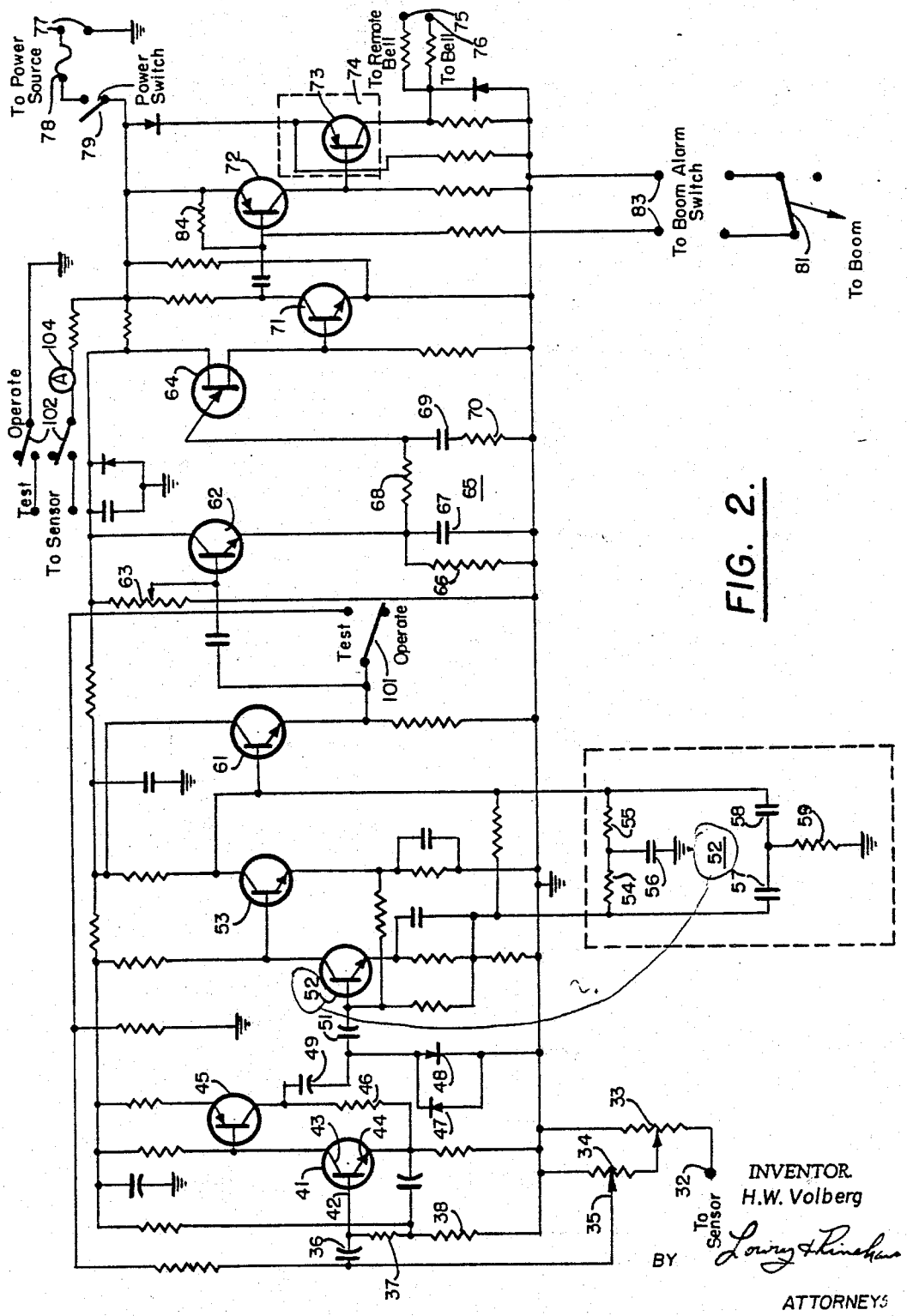


FIG. 2.

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3,168,729

PROXIMITY ALARM

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9 Claims. (Cl. 340—258)

This invention relates to proximity alarms, and, more particularly, to systems for signalling the close approach to an energized electrical transmission line.

This invention is an improvement over the Proximity Alarm of Daniel R. Winters, disclosed in the copending application Serial Number 125,732, filed July 21, 1961, now U.S. Patent No. 3,125,751, and assigned to the assignee of this application.

In the device of the above identified application, an alarm signals the approach, within a prescribed distance, to an energized electrical transmission line. The system was designed for use primarily with vehicles having projections, such as the boom of a crane or power shovel but may be used in any applications involving proximity alarms near energized high voltage lines. Often, it is necessary for such vehicles to operate closely adjacent to energized power lines, and the danger to the operator and to the electrical distribution system is great. To avoid collisions between the crane and the transmission lines, a proximity alarm is provided.

However, it has been found that such prior art alarms have disadvantages in their operation. The Winters alarm, for example, may be triggered by any source of electrical energy if the field strength at the alarm is sufficiently high. Thus, the radiations from high power radio towers, even though the vehicle is not dangerously close to the towers, and lightning in the vicinity of the alarm, are examples of radiant energy which can trigger the prior art alarms. In addition, no test circuitry is ordinarily provided with such alarm systems even though the testing for the proper operation of the system is extremely important. And seldom do the prior art alarms provide any means for distinguishing among the various types of dangers to which they may respond.

It is, therefore, an object of this invention to provide a new and improved proximity alarm.

It is another object of this invention to provide a new and improved proximity alarm which distinguishes among the types of dangers to which it responds.

It is a further object of this invention to provide a new and improved proximity alarm which distinguishes between a danger to be signalled and spurious influences.

It is still a further object of this invention to provide a new and improved proximity alarm which contains means for testing the system for proper operation.

Other advantages and objects of this invention will become more apparent as the following description proceeds, which description should be considered together with the accompanying drawings in which:

FIG. 1 is a pictorial illustration of a crane carrying the alarm of this invention; and

FIG. 2 is a schematic circuit diagram of one form of the alarm of this invention.

Referring to the drawings in detail, and more particularly to FIG. 1, the reference character **10** designates the upper house and the draw works of a mobile crane carrier **30**. Two gantries, a main gantry **18** and a jib gantry **21**, support the two portions of the boom, the main boom **9** and the jib **20** by means of cables. A load line **19** carries a hook **31** for raising and lowering objects to be moved. As shown in the drawing, the jib **20** is raised over power lines **27** which are carried by poles **26** in a normal manner. The power lines **27** and the poles

26 are but exemplary of any electrical distribution system with which the jib **20** or the main boom **9** may approach closely in operation. The alarm itself is shown at **12** mounted on the side of the upper house **10**, and is connected with the battery, or other source of direct current (not shown), for the crane by wire **11**. A two wire signal or sensor line **15** is supported between a reel **14** at the bottom of the main boom **9** and the top of the main gantry **18**, passing through the center of the main boom **9** and the jib **20**, and then out over the top portion of the jib and the main boom to the main gantry **18**. A lead-in wire **13** connects the sensor **15** with the alarm **12**. In addition, a second sensor wire **16** is connected between the main gantry **18** and a reel **17** mounted on the upper house **10**, and a third sensor wire **23** is connected between the hook **31** and the reel **22** mounted at the end of the jib boom **20**. The two auxiliary sensor wires **16** and **23** are connected to the main sensor wire **15** when they are used. A boom alarm switch **24** is connected to the alarm **12** by wire **25** and to the boom itself. An extra signal bell or light **29** is connected by wire **28** to the alarm **12** and is located close to the cab of the crane carrier **30** to indicate to the driver when the boom or jib **20** too closely approaches the power lines **27**.

It is often necessary for cranes such as the mobile unit illustrated in FIG. 1 to operate in close vicinity to energized power lines such as the lines **27**. An inadvertent contact of a projecting portion of the crane of FIG. 1 with the power line **27** can rupture the power lines causing substantial danger and discomfort to persons dependent thereupon, severely damage the mobile unit **10** and injure the operator and others in the neighborhood. Therefore, as the mobile unit **10** or any portion of it approaches energized power lines, an electrical potential is induced in the sensor wires **15**, or one of the auxiliary sensor wires **16** or **23** if they are being used and more closely approach the energized line, to apply a voltage to the alarm **12** by means of the lead-in wires **13**. When a signal voltage is induced in the sensor wires **15** by too close an approach to an energized power line, the alarm **12** causes visual or aural alarms, or both, to operate as a warning to the crane operator and driver of impending danger.

The alarm circuit itself is better shown in FIG. 2 and comprises a terminal **32** to which the lead-in wire **13** is connected. The terminal **32** is also connected to one end of a potentiometer **33**, the other end of which is grounded. The slide contact of potentiometer **32** is connected to one end of a second cascaded potentiometer **34** whose slide contact **35** is connected through a capacitor **36** and across a potential divider comprising resistors **37** and **38**, to the base electrode **42** of a transistor amplifier stage **41**. The transistor **41** further comprises an emitter electrode **44** and a collector electrode **43**. The collector electrode **43** is connected through a load resistor to one side of a source of electrical energy (not shown), and the emitter electrode **44** is connected through a resistor to ground. A second transistor **45** is connected in cascade with the first transistor **41** to produce an amplified output signal at the emitter electrode of the transistor **45**. The amplified signal is applied through a capacitor **49** to a voltage limiting network comprising reversely connected diodes **47** and **48**. The signal potential developed across the diodes **47** and **48** is applied through a capacitor **51** to the base electrode of a transistor **52** the output of which is applied to another transistor **53**. A frequency selective network **52** is connected between the emitter electrode of the transistor **52** and the collector electrode of the transistor **53**. The network **52** comprises two parallel T branches, one of which comprises serially connected resistors **54** and **55**, and the other of which comprises serially connected capacitors **57** and **58**. A capacitor **56** is connected between

the junction of the resistors 54 and 55 and ground, and a resistor 59 is connected between the junction of the capacitors 57 and 58 and ground. The output from the transistor 53 working in conjunction with the network 52 is applied to an amplifier stage 61 which feeds the signal to a transistor 62 across a potentiometer 63. The output from the transistor 62 is applied across a charging circuit 65 to a unijunction transistor 64 which together operate as a relaxation oscillator. The network 65 comprises a capacitor 67 shunted by a resistor 66 in series with the emitter electrode of the transistor 62, a capacitor 69 and a resistor 70 in series with the emitter of the unijunction transistor 64, and a resistor 68 connected between the emitter electrode of the transistor 62 and the emitter electrode of the unijunction transistor 64. The output from the unijunction transistor 64 is applied to a power amplifier comprising three transistor stages 71, 72 and 73 in cascade. The power output stage 73 may comprise a heat sink shown by the dashed lines at 74. The collector circuit of the output stage 73 is connected to a pair of output terminals 75 and 76 which are connected respectively to a remote bell and a local bell, alarm lights, or any other type of signalling alarm found to be desirable under particular circumstances. Power is supplied to the system from a source which is not shown but which may be connected to terminals 77, the power being supplied through a fuse 78 and a switch 79. In addition, a normally closed switch 81 is connected to a pair of terminals 83, which are in turn connected to ground and to the base electrode of the transistor 72. The switch 81 is mounted on the crane 11 and is opened by the boom 12 when the boom is raised to a dangerously high angle.

In operation, as the jib 20 approaches one of the high tension electric transmission lines 27, a potential is capacitively coupled to the sensor wire 15. This potential is applied to the input terminal 32, and through the two cascaded potentiometers 33 and 34 to the base electrode 42 of the transistor 41, wherein the signal is amplified and passed on to the further amplifier 45. Since the input signal as it is amplified by transistors 41 and 45 may be sufficiently strong under some circumstances to overload further stages in the system, the output from the amplifier 45 is coupled to the input of the amplifier stage 52 across a pair of reversely connected diodes 47 and 48 which act as voltage limiters. The diodes 47 and 48 may well be zener diodes which will conduct whenever the potential across them exceeds a selected value. To avoid triggering of the alarm by transient signals from other sources, the system is made frequency sensitive by the introduction of the twin-T network 52 connected to the output of the transistor 53 and the input to the transistor 61. The twin-T network 52 comprises one T having a resistive cross arm and a capacitive branch and the other T having a capacitive cross arm and a resistive branch. In effect, the network introduces positive feedback from the output of the transistor 53 back to the base electrode of the transistor 52. With the resistors 54, 55 and 59 and the capacitors 56, 57 and 58 chosen so that the time constants are suitable to feedback the desired frequency of the electricity carried by the power lines 27, the system responds more readily to that frequency than to transients such as lightning strokes or the output of high power radio transmitters in the vicinity of the crane 10. The signal of the power frequency is applied to transistor 61 and across the slide arm of the potentiometer 63 to the transistor 62 and is amplified again.

The unijunction transistor 64 operates similarly to a gas-filled electron tube. The current flowing in the emitter-collector circuit of transistor 62 charges the capacitors 67 and 69 through the resistors 68 and 70 until the potential across the capacitor 69 reaches the firing potential of the unijunction transistor 64. When the unijunction transistor 64 fires, the capacitors 67 and 69 discharge through it until the cut-off potential of the unijunction transistor 64, is reached. Conduction then ceases, and the capacitors 67 and 69 again begin charging. Of course, it becomes evident that the higher the input potential to the transistor 62, the more current will pass through that transistor, and the more rapidly the capacitors 67 and 69 will charge. Thus, the larger the input signal applied to the terminal 32, within the limits of the equipment, the faster the rate at which the relaxation oscillator comprising unijunction transistor 64 will oscillate. The circuit components are chosen so that the rate of oscillation is low, in the range of from 10 cycles per minute to about 10 cycles per second. The operator can readily distinguish between a slow intermittent operation of the alarm and a rapid one. The signal output from the relaxation oscillator is applied to transistor 71 which is a normally non-conducting amplifier stage, and then to transistor 72 which is normally conducting. Also connected to the input of the transistor 72 are the terminals 83 to which the boom alarm switch 81 is connected. If this switch is not included in the circuit, then the terminals 83 are connected together with a suitable jumper. The switch 81 is normally closed and connects the base electrode to ground through a resistor. However, when the boom 9 is raised too high, the switch 81 is opened and the connection between the base electrode and ground is broken. The transistor 72 is then biased to cutoff by the resistor 84 connecting the base electrode to the positive side of the power source. When the transistor 72 stops conducting, the transistor 73 starts conducting, energizing the alarm.

To summarize this operation of the system, as the boom 20 of a crane 10 or other such vehicle comes close to an energized power line, potentials are capacitively induced in the sensor wire 15 and are applied to the input-terminal 32. These potentials are amplified and then used to determine the rate of oscillation of a relaxation oscillator. When the oscillator conducts, the bell or other alarm sounds, and when the oscillator stops conducting, the alarm is silent. Since the oscillator is voltage sensitive, the higher the input potential, the faster the alarm sounds. In addition, a boom height alarm switch is included in one of the transistor circuits, so that when the boom 9 is raised to an elevation which becomes dangerous, the conduction of a normally conductive transistor is interrupted to cause the alarm to sound continuously. This provides a means for the operator to distinguish between the alarm sounding for an approach to a power line and the alarm sounding due to the height of the boom. So that the circuit does not trigger easily due to high power radio signals, lightning, or the like, the system is made more sensitive to the frequency of the power line transmission.

In addition to the alarm system described thus far, there is also provided test circuitry for testing the system to ensure reliable operation. For testing, switches 101 and 102 are provided. Switch 101 in the operate position is ineffective to modify the circuit as described above. However, a second position of the switch, the test circuit position shown in the drawings as the upper position, connects the input of the transistor 62 through resistors to the slide 35 of the input potentometer 34. This provides a sufficient input signal from spurious and transient conditions to cause the relaxation oscillator comprising unijunction transistor 64 to oscillate and sound the alarm. In additon, operation of the boom alarm switch 81 will cause the alarm to sound continuously. Switch 102 comprises two portions, one of which grounds one end of the sensor wire 15, and the other of which connects the other end of the sensor wire 15 through a meter 104 to one end of the power supply terminals 77. This indicates the continuity of the sensor wire 15. If the wire is broken or not properly strung in the boom, then no current will flow through the meter 104. The meter 104 will show a current flow so long as the wire 15 is intact.

The above specification has described a new and improved alarm for use on equipment which operates close to electrical power lines and which indicates a dangerous

approach to such power lines by an intermittent operation of an alarm, the closer the approach, the faster the alarm sounds. In addition, the alarm includes means for indicating a dangerous operation of the vehicle. Test means are provided to ensure reliable operation of the system. It is realized that the above description may indicate to those skilled in the art other forms which the principles of this invention may take without departing from its spirit. It is, therefore, intended that this invention be limited only by the scope of the appended claims.

What is claimed is:

1. An alarm system for indicating more than one dangerous condition in the operation of vehicles which have movable projections therefrom, an alarm, normally conductive means for energizing said alarm when the conduction thereof is interrupted, first switch means for intermittently interrupting the conduction through said normally conductive means, means for controlling the operation of said first switch means in response to a first condition comprising the reception by said system of radiated electrical oscillations of greater than a preselected amplitude, second switch means for continuously interrupting the conduction through said normally conductive means, and means for controlling the operation of said second switch means in response to a second condition comprising movements of said vehicle and its projections to indicate to the operator of said vehicle when either dangerous condition exists.

2. The alarm system defined in claim 1 wherein said first switch means is potential sensitive and operates more rapidly as the input amplitude increases.

3. The alarm system defined in claim 1 further including a discriminating means connected to said means for controlling the first switch means and comprising a stage which is most sensitive to signals at the frequency of the electrical energy carried by the power lines.

4. An alarm system to indicate to the operator of a vehicle having movable projections when the vehicle or its projections are moving into dangerous positions, said system having an alarm suitably placed to warn said operator, a normally conductive device coupled to said alarm, means under the control of said normally conductive device to energize said alarm when the conduction through the normally conductive device is interrupted, first means for interrupting the conduction through said device for an indeterminate interval, second means for interrupting the conduction through said device for a plurality of small sequential intervals, first control means for controlling the frequency of said small intervals in response to the distance from and the approach to a first position by said vehicle, and second control means for controlling the operation of said first means in response to the movement of said vehicle into a second position.

5. The system defined in claim 4 further including a discriminating means connected to said first control means and comprising a stage which is rendered more responsive to the frequency of the electrical energy transmitted by said power line than to other frequencies.

6. The system defined in claim 4 wherein said first control means comprises a relaxation oscillator including capacitors charged by an input signal, means responsive to the approach of said vehicle or its projections to within a prescribed distance from a dangerous position for generating said input signal whose amplitude varies with the distance from said dangerous position, and further including a controllable electron conductive member, the charging of said capacitors determining the conduction through said controllable electron conductive member.

7. An alarm system for warning of the approach of at least a portion of a movable object to more than one potentially dangerous condition, said system comprising means for sensing the approach of a portion of a vehicle to a potentially dangerous first condition, said sensing means generating an electrical signal whose amplitude varies inversely with the distance from said first condition, means responsive to the output from said sensing means for discriminating between the signal generated by the approach to said first condition and other signals generated in said sensor, an alarm, a normally conductive device coupled to said alarm and energizing said alarm when the conduction therethrough is interrupted, means responsive to the signal generated in said sensor and transmitted by said discriminating means for intermittently interrupting the conduction through said device, and means responsive to the approach of at least a portion of said vehicle to a second condition to interrupt the conduction through said device for an indeterminate period of time.

8. The system defined in claim 7 wherein said first condition is the approach to an energized electrical transmission line, wherein said sensor comprises an antenna in which electrical signals are generated by the variation in the field strength surrounding said transmission lines and in which the amplitude of the generated signals varies inversely with the distance of the antenna from the transmisison lines, wherein said discrimination means comprises a circuit which responds more readily to electrical signals of the frequency of the electricity carried by the transmission lines than to signals of other frequencies, and wherein said means for intermittently interrupting the conduction through the device comprises a potentially sensitive oscillator whose output varies in frequency with the potential applied to it.

9. The system defined in claim 7 wherein said second condition is an unstable posture of at least a part of said vehicle, said means responsive to said second condition comprising a switch member which is responsive to the angle of a portion of said vehicle to operate and interrupt the conduction through said device for so long as said switch member is operated.

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NEIL C. READ, *Primary Examiner.*