

- [54] CONTROL OF MULTIPLE HIGHWAY CROSSINGS
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- [51] Int. Cl. B611 29/32
- [58] Field of Search 246/125-130

[57] ABSTRACT

The apparatus controls operation of highway warning devices at a plurality of crossings in accordance with the approach of a railroad vehicle and includes a computer for calculating a uniform warning time for each crossing in response to signals received from the crossings. There is means responsive to computer control at each crossing for imposing on the rails a read and check signal at different times in accordance with a selected computer sequence. Receiver means is responsive to the received signal associated with the read and check signals from each crossing and has an output feeding the computer for providing digital intelligence signals with respect to the difference between the received signals. Means at the computer compares the intelligence signals with anticipated responses relative to the associated crossing and other relevant crossings and provides output signals in accordance with the comparison, while means responsive to the comparison means activates the warning device at each crossing a uniform time before the approach of the vehicle.

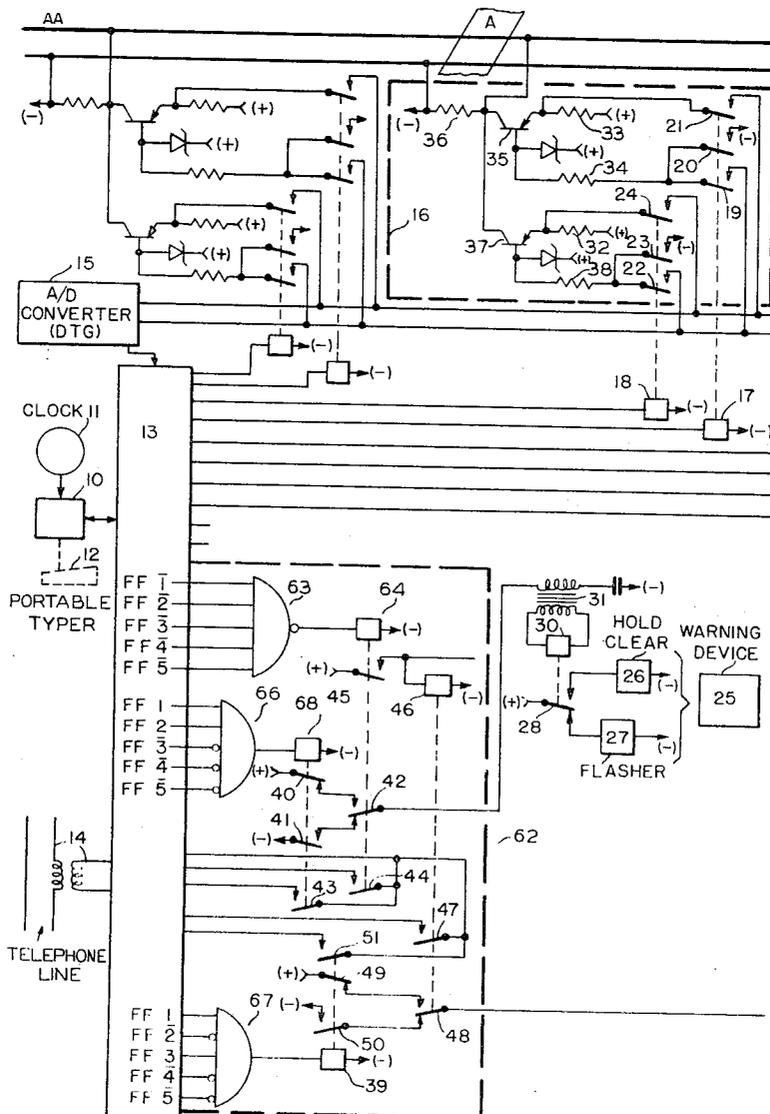
[56] References Cited

UNITED STATES PATENTS

3,390,256	6/1968	Clanton et al.	246/125 X
3,422,262	1/1969	Brockman	246/130 R

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7 Claims, 3 Drawing Figures



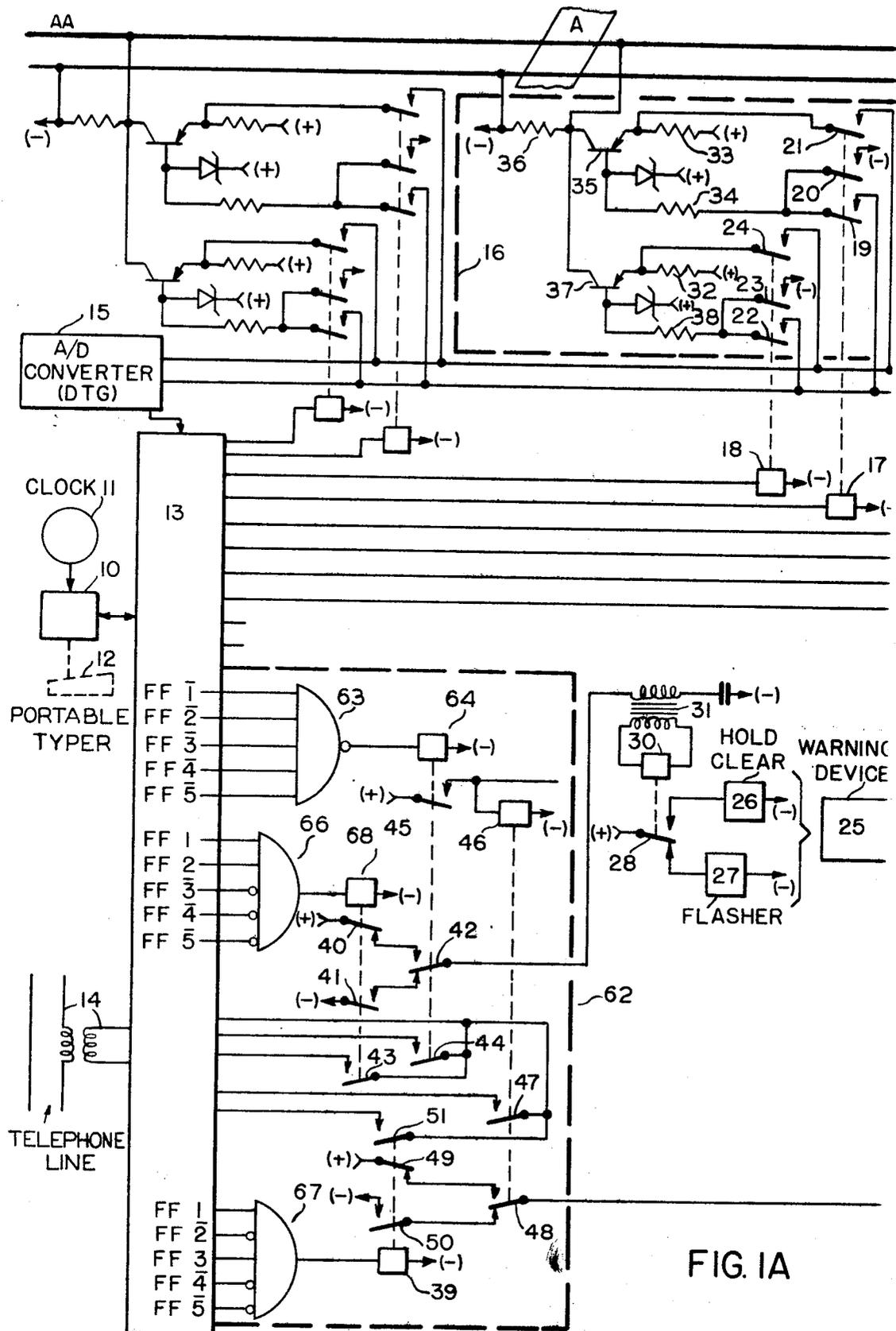


FIG. 1A

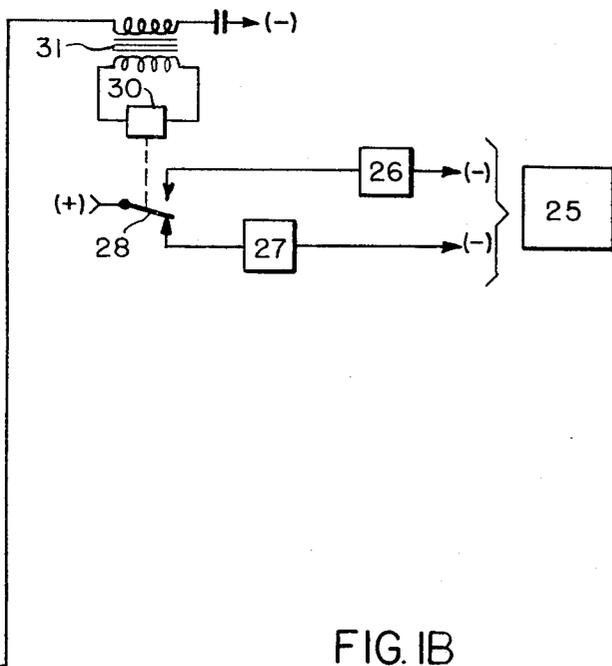
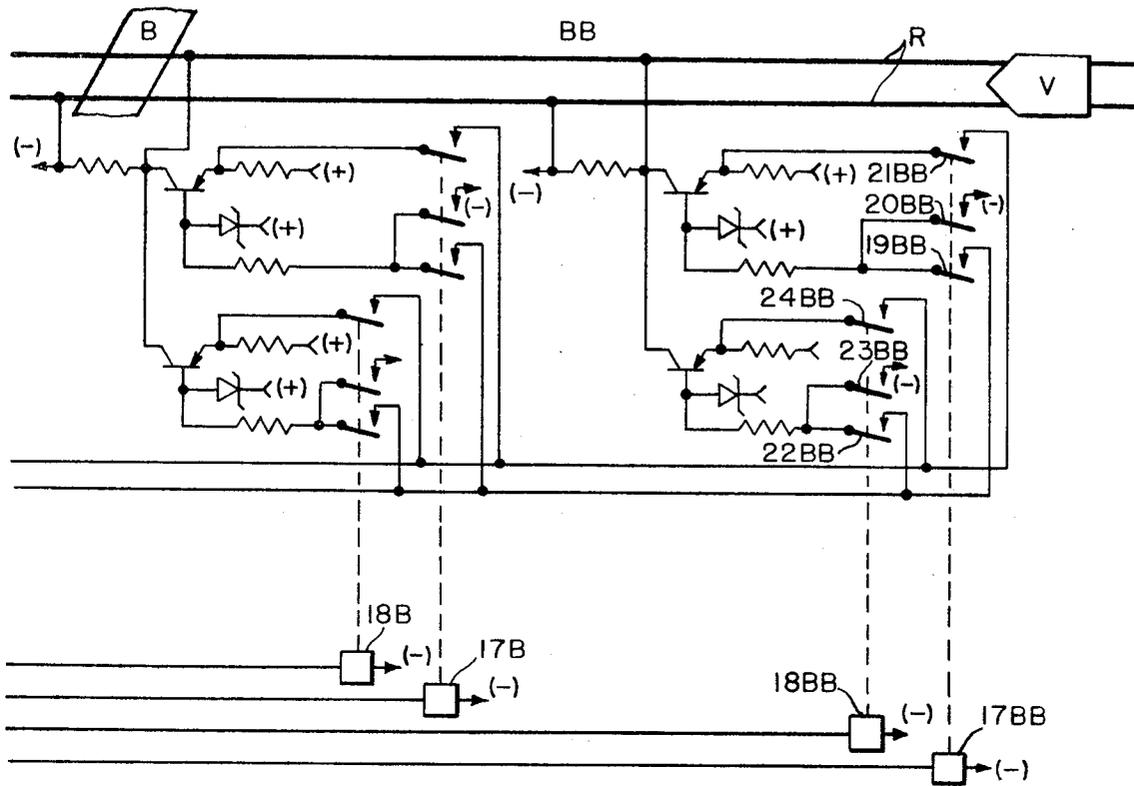


FIG. 1B

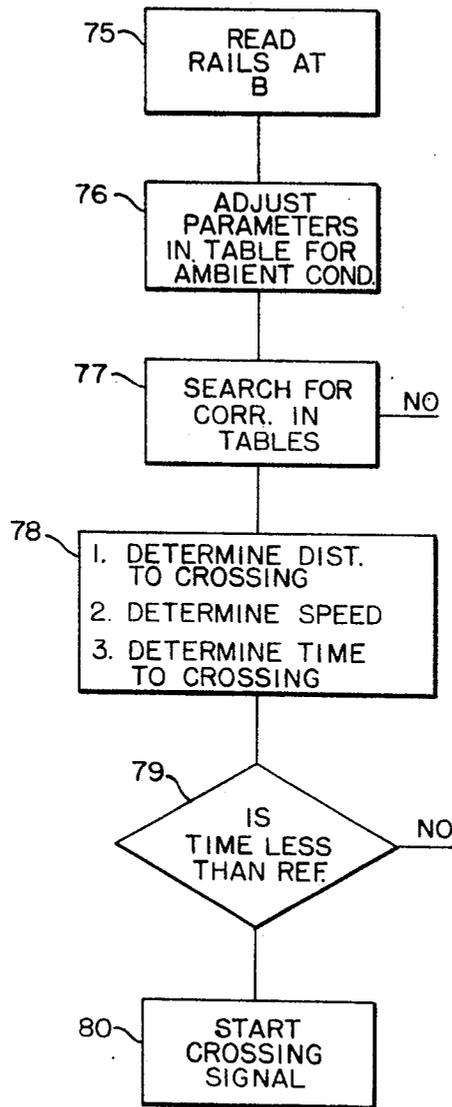


FIG. 2

CONTROL OF MULTIPLE HIGHWAY CROSSINGS

BACKGROUND OF INVENTION

This invention relates to the control of highway warning devices and in particular to a system for controlling a plurality of warning devices at crossings which are relatively close to one another.

In order to control multiple highway crossings on a single length of track, it is usually necessary to employ a separate train detection system for each crossing with its consequent cost or sacrifice efficiency by utilizing one warning detection system for more than one crossing. In the former case, if a large number of crossings are located within a certain area the cost becomes prohibitive; and in view of the safety provided in the latter, not enough protection is provided and warning time may be increased to the extent that motorists disregard the warning which many times is the cause of crossing accidents.

It would be particularly advantageous to control a number of closely spaced crossings with one device serving each location on a shared basis. In this way, a certain efficiency is achieved which would not otherwise be available to an independently operating crossing system.

It is therefore an object of the present invention to provide a system which obviates one or more of the disadvantages of the described prior arrangements.

It is another object of the present invention to control a plurality of highway crossings from a single location.

SUMMARY OF INVENTION

There has been provided apparatus controlling the operation of highway warning devices at a plurality of crossings in accordance with the approach of a railroad vehicle. The system comprises a computer for calculating a uniform warning time for each crossing in accordance with signals received from the crossings and means responsive to the computer for each crossing for imposing on the rails a read and check signal at different times in accordance with a selected computer sequence. Receiver means is responsive to signals associated with the read and check signals from each crossing and have an output feeding the computer for providing digital intelligence signals thereto in accordance with difference between the received signals. Means at the computer compares intelligence signals with anticipated responses relative to the associated crossing and other relevant crossings for providing output signals in accordance with the comparison, while means is responsive to the comparison means output for activating the warning devices at each crossing a uniform time before the approach of the vehicle.

For a better understanding of the present invention, together with other and further objects thereof, reference is directed to the following description taken in connection with the accompanying drawing, while its scope will be pointed out in the appended claims.

DESCRIPTION OF THE DRAWINGS

FIGS. 1A and 1B, when placed side by side, illustrate a preferred embodiment of a control system for multiple highway crossings according to the present invention; and,

FIG. 2 is a flow chart illustrating the mode of operation of the apparatus according to FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

This system may generally be described as a warning system for highway crossings utilizing a computer to control the activation of the warning devices at the crossing in accordance with the approach of a railroad vehicle at a uniform time before the vehicle reaches the crossing regardless of the speed of the railroad vehicle.

FIGS. 1A and 1B show a set of railroad tracks R and a railroad vehicle V travelling thereon approaching successive highway crossings A and B. It should be noted that the crossings may be quite numerous but two are shown merely to simplify the drawing and to convey the general concept of the present disclosure. Further it should be noted that the crossings may be on different tracks for example where three or four railroad lines cross the same highway in a relatively close stretch of roadway. At any rate, the system concept would be the same regardless of the layout for multiple highway crossings up to the capacity of the computer used in connection with this invention.

The computer 10 used in connection with the present invention may be one of the newer mini computers which are finding successful application in limited or specialized areas of application. A clock 11 provides the basic timing for the system and a portable typewriter 12 may be utilized to provide input-output information thereto in connection with maintenance or programming of the system. The computer 10 operates to communicate with various crossings through an interface 13 which couples each of the crossings A and B and other relevant portions of the system to the computer or central processing unit 10. An alarm device shown schematically as the primary and secondary of a transformer 14 is coupled to the interface for communication with a telephone line which may be coupled to dispatcher at a centralized traffic control location. An analog to digital converter 15 couples signals from each of the highway crossings to the interface 13 and subsequently to the computer 10.

The computer 10 can be of the type described more in detail in my prior U. S. Pat. No. 3,601,602, resulting from an application filed July 24, 1969. This patent shows how the computer can be programmed to determine distance and speed. A similar system is used according to the present invention except that the present system is simplified in that it is not necessary to identify the vehicles. A table of track circuit potentials, calibrated for shunts at measured distances in approach of each crossing is substituted for the table of track sections in the patent; and the computer searches for correspondence between a reading across the track rails and the calibrated readings in the tables to determine distance of a vehicle in approach of the crossing. The computer determines speed from distance travelled during measured time intervals.

Each of the crossing locations A and B and other approach locations labeled AA and BB include a coupling device 16 which includes apparatus for imposing read and check signals on the rails R at different times in accordance with the selected computer sequence. The computer program or sequence activates periodically the respective read and check relays 17 and 18 which are associated with the particular crossing. These relays operate respective contacts 19 through 21 and 22 through 24 which in turn impose discrete signals on the

rails R which provide basis for computing the uniform warning time and other functions which shall be described further in the discussion.

Since the apparatus included in the coupling device 16 are generally the same for each crossing and other selected locations, the corresponding elements thereof are the same as all other locations. However, when necessary a reference letter may be applied to a device to indicate the location being discussed. Each crossing may include a warning device 25 which is controlled by a hold clear relay 26 and flasher relay 27. The hold clear relay 26 is normally energized and provides an input to the warning device 25 which may be a crossing gate arm which is held up as long as the relay 26 is energized. The relay 27 similarly is normally deenergized for controlling flashing lights and the like associated with the warning device 25. It should be noted that any type of device which could effectively apprise an approaching motorist of the condition of the tracks in approach of the crossing would be sufficient and as required possibly only a bell or flashing light would be necessary to provide this necessary signal. The relay 26 is held energized through front contact 28 of relay 30, which is a safety relay that is held energized by pulsing a transformer 31, which pulsing is provided by the interface 13 at selected intervals, perhaps every 100 milliseconds.

When the system is initially set up with no trains present, energy is fed to each track through fixed resistors 32 and 33 which respectively represent 2 and .5 ohms. A read relay 17, when energized by the signal from the interface 13, closes contacts 19 through 21 in a coupler 16. Closure of contact 20 provides negative energy through a biasing resistor 34 to the base of transistor 35 bypassing the bias of zener diode D and causing the transistor to conduct thereby feeding a potential from resistor 33 across the track rails and the input resistor 36 in multiple. This resistor provides a potential across the rails R in proportion to the bias of the 0.5 ohm resistor 33. The potential across the track rails is read from the upper rail through the transistor 35 and closed contact 21 to an input line to converter 15 and completed from converter 15 through contacts 19 and 20 to a lower rail. This analog signal is converted by the analog to digital converter 15 to a signal which is coupled to the central processing unit 10 through the interface 13. The relay 17 is then deenergized and checking relay 18 is energized which couples energy to the rails R through fixed resistor 32 through transistor 37 which is conductive through closed contact 23 and biasing resistor 38. The signal is again fed across the track rails and the input resistor 36 in multiple and the inter-rail potential is measured when closed contact 24 feeds the input of converter 15.

If a vehicle V is present on the rails in the vicinity of crossing A, the track rail circuit associated with crossing A effectively has been modified by the value of the combined series resistance of the track rails and the vehicle shunt in parallel with the resistor 36.

When there are no vehicles present within detectable range of the coupling 16, each location is successively tested such that relays 17 and 18 are energized successively and a reading is taken of the potential across input resistor 36. This potential is an indication of the track conditions. It is assumed that since the crossings are relatively closely spaced, weather conditions which greatly affect the parameters of track circuits would

generally vary the effective resistance of the tracks uniformly so that each time a particular location is checked it should generally show similar characteristics to other locations checked. If, for example, it is raining, the track resistance decreases sharply which might indicate the present of a vehicle, however, since a number of locations are checked in a sequential order as determined by the central processing unit program, generally the track resistance values will vary similarly. A great discrepancy from one location to another would indicate the probable malfunction of a detector unit 16 or defective rail the detection of which have heretofore been difficult to ascertain. Certain margins of tolerance are programmed into the central processing unit 10 to permit adjustment of the response of the central unit 10 in accordance with variations in track parameters which in general change uniformly under similar ambient conditions.

The advantage of this system over independently operating systems is that the multiplicity of crossing locations detected and controlled by the central unit 10 enhances the effectiveness of the safety checking by redundancy of the measurements taken.

When no vehicles are present in the system, this sequential checking of each location proceeds at a specified rate one after the other. However, the drawing shows start sections AA and BB which are located in advance of the crossings A and B respectively. When a vehicle is detected in approach of a start section, for example, BB a signal is transmitted from the location BB through the digital converter 15 and interface 13 to the central processing unit 10. This is then cause for an output from the central processing unit 10 to increase the scanning time for those sections immediately effected by the approach of the vehicle V. For example, if a vehicle is travelling from right to left, the read signal provided by the closure of contacts 19BB-21BB provides a first signal to the converter 15 indicating the approach of a vehicle. The check contacts 22BB-24BB verify the read signal and this is communicated to central unit 10 which increases the scan time for relays 17BB-18BB and 17B-18B. Such calculations as the rate of approach of the vehicle V are provided by the central unit 10 and cause acceleration of the checking and reading rate of relays 17A and 18A as required by the program.

The reason why resistors 32 and 33 were chosen to be different is that each time read and check signals are taken a certain proportionate difference should be detected between the two potentials across the input resistor 36. If this proportionate difference is not detected, a malfunction is indicated and pulsing of the appropriate relay for that crossing is terminated by the computer through the interface 13 and checking device 32 which drops the relay 31 and in turn activates the warning 25 through appropriate contacts of relays 26 and 27. It should be noted, however, that if a massive failure occurs, that is, if the clock 11 malfunctions such that the timing of the system is drastically affected, then the alarm circuit 14 would be activated to indicate a catastrophic failure requiring immediate supervision by the maintenance dispatcher involved.

As previously noted, the system may be set up for various configurations of multiple highway crossings and generally the uniform warning time may be provided in the computer program by calibrating the track circuit, as by imposing test shunts every hundred feet

in approach of each crossing or start area upon the initial installation. When the vehicle V is initially detected, the rate of checking is increased and the standard test shunts which are incorporated into the computer program are compared against the actual values of track resistance which are provided in accordance with the potential values across resistor 36. The comparison of the actual change in the track resistance with the standard variations of the track resistance from the calibration procedure provides a means to calculate the distance that the vehicle appears in approach of the crossing and the rate of change of the actual track resistance gives an indication of the speed of the vehicle which may be utilized to activate the warning device 25 a uniform time before vehicle actually reaches the crossing. The complexity of the system is greatly reduced because the overlap between closely spaced crossings are not effective to hinder calculation of the uniform warning time. Measurements of the data for calculating the warning time are made sequentially, one location at a time, and signals provided from the coupling unit 16 are synchronized with that portion of the program associated with the section being tested.

The above described mode of operation is summarized by the flow chart of FIG. 2. This chart shows the mode of operation in response to periodically sensing potential across the track rails R at a typical highway crossing location B. The value sensed at step 75 is transferred to step 76 to adjust track parameters in a table for ambient conditions and moves to step 77 to search for a corresponding value in the table of calibrated values. If no value is found that is indicative of presence of a train, no further steps are taken relative to the input reading. If the presence of a train is indicated in step 77, the system proceeds to step 78 to (1) determine the distance to the crossing B, (2) determine the speed of the train, and (3) determine time interval until train will arrive at crossing B. The next step 79 determines whether the train determined by step 78 is less than reference warning time. Step 80 starts the corresponding signal at crossing B if there is an affirmative answer to step 79.

Other calculations such as train length may be provided by calculating the speed of the vehicle and measuring the time of approach and departure from a specific location. In addition, the location using a small computer 10 as contemplated in the present invention may be a convenient relay device for train identity information which could be fed into the computer 10 from wayside detectors now utilized in the railroad industry.

As previously described, each of the safety relays 30 maintain its respective warning device 25 deenergized as long as a periodic signal appears at the transformer 31. A checking circuit 62 is utilized to provide an output to the primary of each transformer 31 in accordance with a selected code for each crossing. The checking circuit 62 includes a first AND gate 63 which is driven by selected outputs of a register (not shown) included in the interface 13. Each 100 milliseconds five inputs must be provided to the input of gate 63, which has an inverted output for picking relay 64. In addition, the outputs of the register must change to certain other codes for energizing gates 66 and 67. Gate 66 requires a two out of five code, that is, inputs 1 and 2 must be ONES, while 3, 4 and 5 must be ZEROS. On the other hand, gate 67 requires similarly two out of

five codes. However, inputs 1 and 3 require the ONES, while 2, 4 and 5 require ZEROS for picking their respective relays 68 and 39. Contacts 40 and 41 of relay 68 are respectively opened and closed each time relay 68 is energized. Contacts 42 of relay 64 is activated similarly for providing alternate inputs to the transformer 31. Contact 43 of relay 68 provides an input to the interface 13 for assuring that the relay 68 has been energized for holding off arm 14. A similar function is provided by contact 44 or relay 64.

Each time relay 64 is energized, contact 45 closes for picking relay 46 and closing its contacts 47 and 48. Contact 47 provides an input to the computer interface 13 for assuring that the relay 46 is operating properly, while contact 48 alternates the input to the transformer 31 for section B through contacts 49 and 50 of relay 39. The relay 39 is energized by the two out of five code for gate 67 and contact 51 is checked to assure that the relay is operating properly. By this means if any of the relays or gates fail, a signal is immediately provided to the interface 13 for indicating an alarm condition through transformer 14 which may be a coded alarm indicating which particular crossing is malfunctioning. In addition, if either of the contacts 44 or 47 do not close, indication of a failure of the gate 33 or any of its associated relays 64 or 66 are indicated which means that a basic failure may have occurred in the timing of the system. Such a condition would require a general alarm.

While there has been shown what is at present considered to be the preferred embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is therefore aimed in the appended claims to cover all such changes and modifications that fall within the true spirit and scope of the invention.

What is claimed is:

1. Apparatus for controlling the operation of highway warning devices at a plurality of crossings in accordance with the approach of a railroad vehicle comprising:

- a. a computer for calculating a uniform warning time for each crossing in accordance with signals received from said crossings;
- b. means responsive to computer control at each crossing for imposing a read and check signal transmission at different times, in accordance with a selected computer sequence;
- c. receiver means responsive to receive signals associated with said read and check signals for each crossing having an output feeding the computer for providing digital intelligence signals to the computer in accordance with the difference between said received signals;
- d. comparison means at the computer for comparing intelligence signals with anticipated responses relative to the associated crossing and other relevant crossings providing output signals in accordance with said comparison; and
- e. means responsive to said comparison means output signals for activating the warning devices at each crossing a uniform time before the approach of the vehicle.

2. The control apparatus of claim 1 wherein the imposition means controlled in accordance with a computer program energized to read and check aspects at

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different times and providing an output for each read and check signal input.

3. The control apparatus of claim 2 wherein the means for imposing a read and check signal includes solid state switches energized by respective triggering signals from the computer.

4. The control apparatus of claim 1 wherein said receiver means comprises an analog to digital converter responsive to said received read and check signals for converting the output of said imposition means into digital signals indestructive of read and check signals.

5. The control apparatus of claim 1 further including: computer checking means including gates selectively activated in response to coded outputs of the computer

for providing indications when energized of a proper computer sequence.

6. The control apparatus of claim 5 wherein said gates comprise: an AND gate for the computer and for each crossing signal periodically energized with selected code inputs and a relay device held normally energized by the periodic energization of the AND gates.

7. The control apparatus of claim 6 wherein said computer includes an output register selectively coupled to said AND gates said output register stepped in sequence for providing the codes to each AND gate sequentially.

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