Oct. 25, 1966 H. MENDELSOHN 3,281,593

GATE FEATURING PICKUP CANCELLING CIRCUITRY

Filed June 27, 1962 3 Sheets-Sheet 1

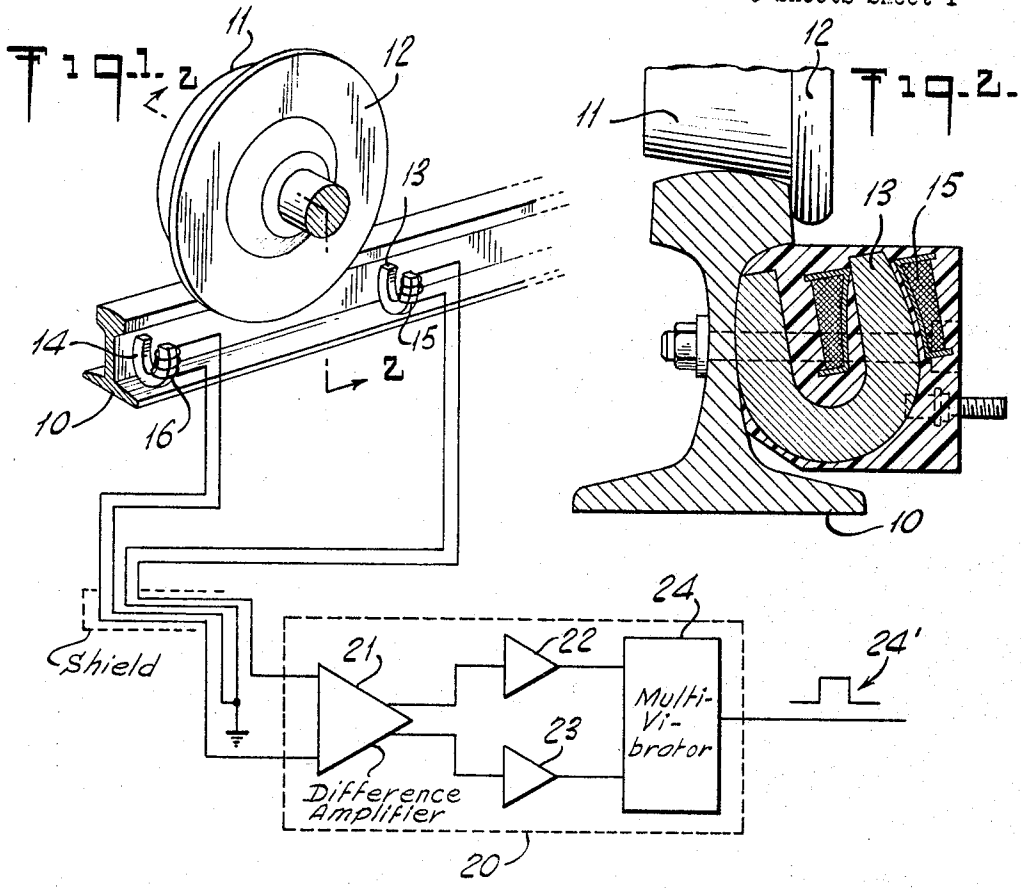


FIG. 2.

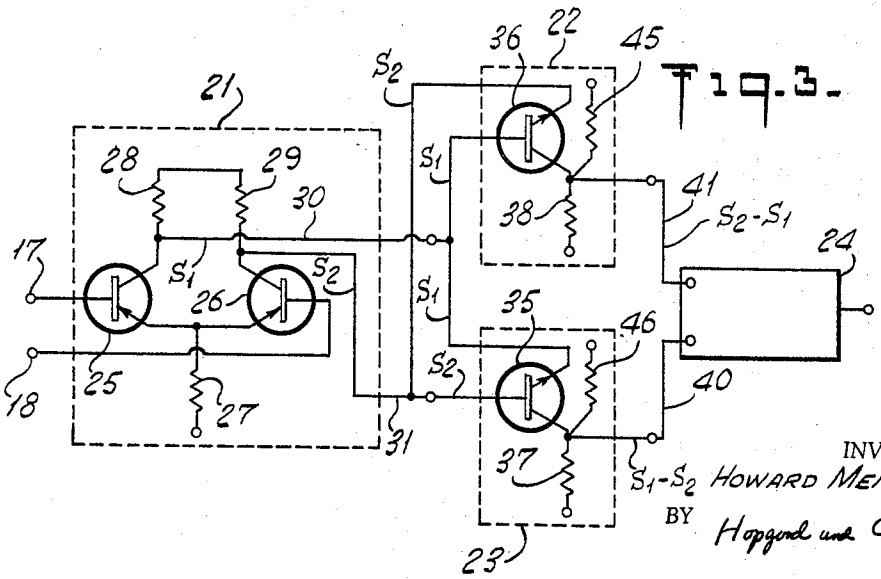


FIG. 3.

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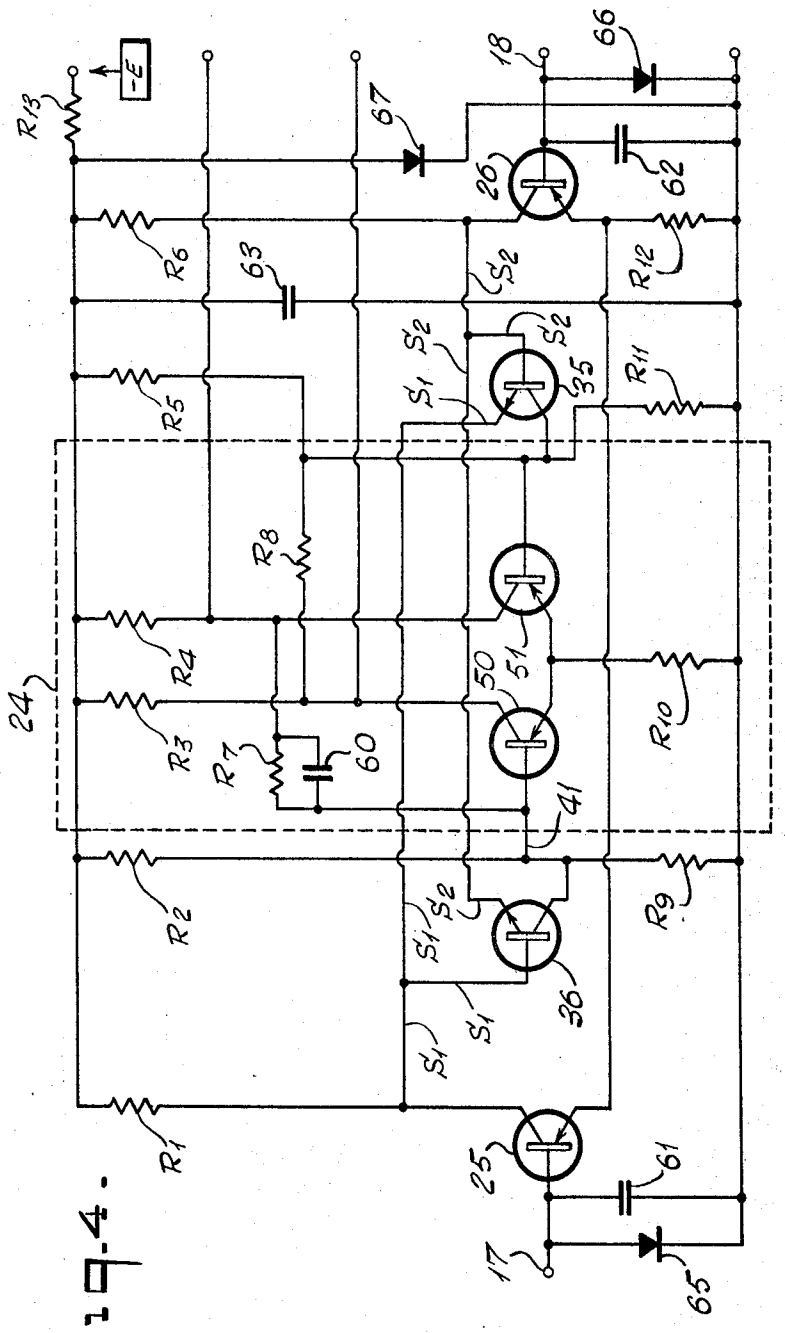


FIG. 4.

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Fig. 5.

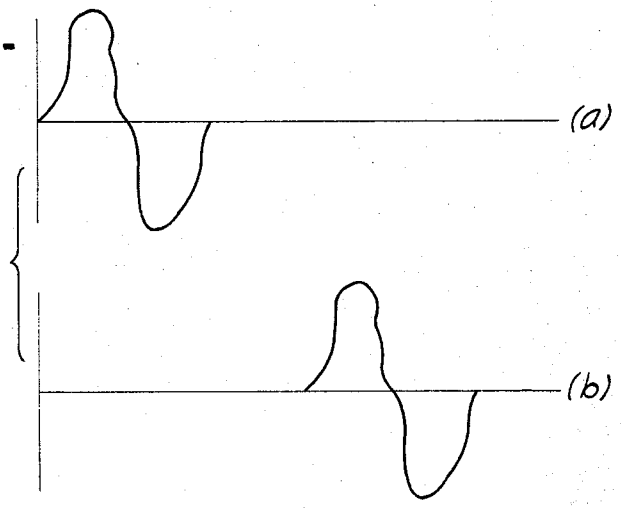


Fig. 6.

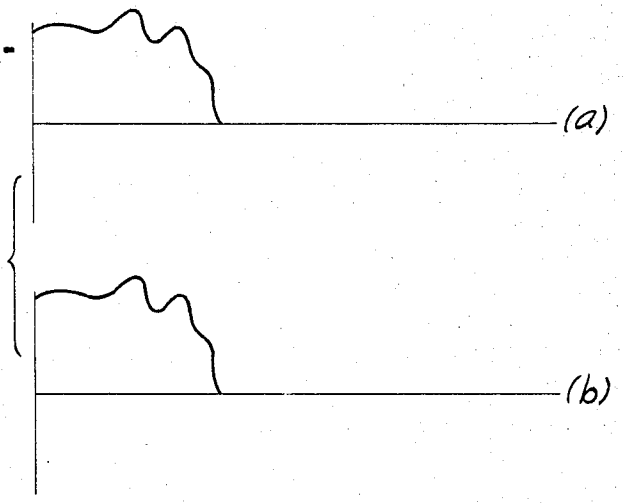
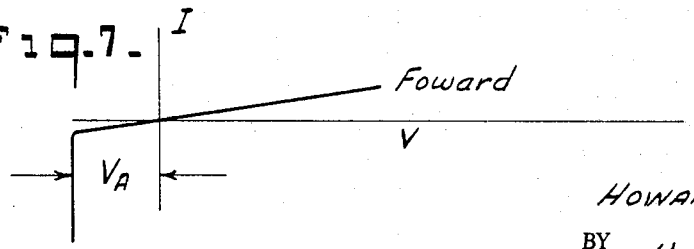


Fig. 7.



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GATE FEATURING PICKUP CANCELLING CIRCUITRY

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6 Claims. (Cl. 246—249)

This invention relates to an improved hot box detector gating signal circuit and more particularly relates to an apparatus which prevents undesired spurious signals from falsely actuating the hot box detector system.

Hot box detector systems in which my novel invention is usable are shown, for example, in Gallagher et al., U.S. Patents 2,880,309 and Re. 24,983, and in the Pelino et al. Patent 2,963,575. In such hot box detector systems, space gating is employed and a gating circuit allows a shutter to open for a predetermined duration which varies with train speed during which time imaging of the hot journal box and the background occurs. In such patents, it is recognized that a gating signal, or a gate control signal may be produced by the use of suitable wheel trips which may, for example, comprise magnetic circuits as disclosed in Gallagher Serial No. 670,220, filed July 5, 1957, now abandoned. (Space gating requires wheel trips which are spaced apart and operate independently of each other.)

It has been found, however, that spurious currents pass through the rail particularly during lightning storms and that such currents may have sufficient strength to induce similar spurious signals in the magnetic pickup means which falsely actuate the hot box detector system.

An object of this invention is to substantially suppress such spurious signals as may be induced by heavy currents in the rail and thereby prevent the hot box detector system from being falsely actuated.

A second object of this invention is to provide a simple and effective circuit to effectively eliminate the aforementioned induced spurious signals in the hot box system.

Still another object is to provide a novel symmetrical circuit having two separate magnetic wheel trip means as inputs which continuously compares the input signals and suppresses common mode signals.

A further object of this invention is to provide a means for producing a gating pulse, the width of which varies with train speed, which is substantially free from the adverse effects of spurious rail currents.

As used herein the terms "common mode signals" and "spurious signals" refer to signals existing in the rail track and simultaneously over large lengths of track. These signals are produced by the environment in general and are undesirable, and if not eliminated may adversely affect the operation of the system.

Briefly, my invention comprises a difference amplifier having two inputs which are coupled, respectively, to each of two separate, spaced magnetic wheel trip means which are positioned closely adjacent to and on the same side of the rail on which the wheel flange passes. Each magnetic means has an associated coil through which induced currents or voltages pass. The coils are energized separately and are each coupled to the above mentioned inputs. Since it is desired to produce a gating pulse having a width depending upon the time required for the wheel flange to move from the first wheel trip to the second wheel trip, a bistable multi-vibrator is provided which is coupled to the outputs of the difference amplifier. The difference amplifier has two outputs, the first of which is a voltage representing the difference between the voltages induced in the first and second magnetic means, and the second of which is a voltage representing the difference between the voltages induced in the second and first magnetic means.

In a preferred aspect of this invention, the difference amplifier comprises two transistors having a common emitter resistance. Outputs taken from the collectors of each transistor may be applied to the base and emitter of a first complementary transistor amplifier and to the emitter and base of a second complementary transistor amplifier, respectively. The outputs from the collectors of each of said transistor amplifiers represent the difference between the first and second induced pickup voltages, and the difference between the second and first induced pickup voltages. These signals are applied to the inputs of a bistable multi-vibrator which causes a pulse to be produced when the output of the first transistor amplifier is positive (when the difference of the first and second induced voltages is positive) and causes the pulse to cut off when the output of the second transistor amplifier is positive (when the difference between the second and first induced voltage is positive).

The above-mentioned and other features and objects of this invention and the manner of attaining them will become more apparent and the invention itself will be best understood by reference to the following description of an embodiment of the invention taken in conjunction with the accompanying drawing, wherein:

FIGURE 1 is a block diagram showing the arrangement of the components of this invention;

FIGURE 2 is an enlarged sectional view along 2—2 of FIGURE 1;

FIGURE 3 is a circuit diagram showing in detail the parts of the invention shown by block diagram in FIGURE 1;

FIGURE 4 is a circuit diagram similar to FIGURE 3 of a preferred embodiment of this invention;

FIGURES 5*a* and 5*b* are illustrated graphs of the signals which are induced in respective magnetic means by the passing flange;

FIGURES 6*a* and 6*b* are illustrated graphs of common mode or spurrious signals induced in respective magnetic means as a result of corresponding signals passing through the track;

FIGURE 7 is a graph of the characteristics of a Zener diode.

Referring now to the drawings, there is shown in FIGURE 1 a rail **10** over which the wheel **11** of a railroad car travels. There are provided two separate, magnetic pick-up coils **15** and **16** mounted closely adjacent to rail **10** on magnetic cores **13** and **14** respectively. The magnetic cores are supported, preferably, directly on the rail and an air gap is provided in the magnetic circuit which includes said cores through which the flange **12** of the wheel passes to change reluctance of the magnetic circuit and induce a transient electrical current in the pickup coil. Reference may be had to Gallagher et al., Serial No. 670,220 for further explantion.

The currents in such coils are induced only when the flange passes through the air gap included in the respective magnetic circuit and therefore the action of the wheel produces currents in coils **15** and **16** only at such times as it is passing through the associated air gap. Thus, each coil **15** and **16** is separate from each other and is spaced apart sufficiently to assure such independent space gating action. Other considerations may require increasing the distance between the coils **15** and **16** such as to obtain satisfactory intervals of time between the production of transients in each of coils **15** and **16** to a shutter means or like device as described in Re. 24,983.

The induced voltages are carried by leads **17** and **18** to the inputs of a gating circuit **20**. The gating circuit **20** comprises a difference amplifier **21** producing a pair of output voltages representing the difference between the first and second induced voltages (from coils **15** and **16** respectively) and the second and first induced voltages.

The pair of output voltages are applied, respectively, to driver amplifiers 22 and 23 and then to a bistable multivibrator 24 to produce an output pulse 24'. The output pulse may be referred to as a gating signal since it is used to control appropriate gating signal responsive circuits in the hot box detector to open and close the shutter as well as other functions as described.

As shown, in FIGURE 2, the differential or difference amplifier 21 comprises a pair of PNP transistors 25 and 26 having a common resistor 27 connected to each emitter. Each transmitter has resistors 28 and 29 in the collector circuits, respectively, so that output signals may be taken at the collector terminals over leads 30 and 31, respectively. The biasing arrangements are conventional and are illustrated in FIGURE 4.

The signals induced in the two magnetic means, respectively, by the passing flange are shown illustratively in FIGURES 5*a* and 5*b*, while the common mode or spurious signals induced in the two magnetic means, respectively, by corresponding signals in the track are shown illustratively in FIGURE 6.

The driver amplifiers 22 and 23 are utilized as part of the difference amplifier to produce the actual difference signals. Each driver amplifier comprises NPN transistors 35 and 36 and collector resistors 37 and 38. The signal S_1 appearing on lead 30 is applied to the emitter of transistor 35, while the signal S_2 appearing on lead 31 is applied to the base of said transistor. In reverse manner, the signal S_1 is applied to the base of transistor 36, while the signal S_2 is applied to the emitter of said transistor. The outputs from each transistor appear on leads 40 and 41 which are connected to the collector of each transistor across collector resistors 37 and 38. As indicated, the output on lead 40 is a signal representing the quantity S_1-S_2, while the output on lead 41 is a signal representing the quantity S_2-S_1.

If there are no stray or spurious currents, then it is obvious that when S_1 is produced, S_2 will be zero, and when S_2 is produced, S_1 will be zero. Therefore, the signal on lead 40 initiates the bistable multi-vibrator 24, while the signal on lead 41 cuts off thereby producing the desired gating pulse 50. When, however, there are spurious signals, it is assumed that they will induce similar signals (common mode signals) in each of leads 17 and 18, in which case the resulting outputs over leads 41 and 42, S_2-S_1 and S_1-S_2 will be zero. That is to say, it is assumed that the amplitude and phase of spurious signals will produce the same inputs at leads 17 and 18.

In operation, when there is a negative input on lead 17, transistor 25 conducts through resistor 28 and a positive voltage is set up on lead 30. In like manner, when a negative voltage appears on lead 18 a positive voltage is set up on lead 31.

When there are spurious signals or common mode signals, neither transistor 37 or 38 will be actuated for reasons now discussed.

Transistor 25 is biased so as to conduct when a negative voltage appears on lead 17 and transistor 26 is similarly biased to conduct when a negative voltage appears on lead 18. Neither transistor will conduct when positive voltages are applied and therefore only negative signals will effect the operation of the circuit. It is evident that if NPN transistors were utilized, the operation would be the same except that positive signals would be utilized.

When a negative voltage is applied across conductor 17, a positive output voltage appears over lead 30, which is identified as S_1. The signal S_1 is applied to the base of a complementary NPN transistor 36, and to the emitter of a complementary NPN transistor 35.

When a negative voltage is applied over conductor 18, a positive voltage designated as 52 appears over lead 31. The signal S_2 is applied to the base of transistor 35 and to the emitter of transistor 36. Transistors 35 and 36 will conduct until their bases are more positive than their emitters. Thus, if the quantity S_2 minus S_1 is positive, which means that S_2 is greater than S_1, then transistor 35 will conduct, while if S_1 is greater than S_2, transistor 36 will conduct. It is evident that when one transistor conducts, the other one cannot.

When S_1 minus S_2 is positive, the signal over lead 40 is applied to one of the inputs of bistable multi-vibrator 24 which causes the multi-vibrator to switch its state causing an output signal. The output S_2 minus S_1 appears only when S_2 is greater than S_1 and is applied over lead 41 to the other input of the multi-vibrator causing the output signal to stop. When, for example, there only is a negative input on lead 17, a positive signal is applied over lead 30 to the base of transistor 36, while the same positive voltage is applied to the emitter of transistor 35. In such case, transistor 36 is activated while transistor 35 remains off.

In like manner, transistor 37 is activated when there is only a negative signal on input lead 18. In such cases, amplifier 22 produces a signal when the flange passes over the first wheel trip shown as 13, and the second amplifier produces a signal when the wheel flange passes over the second wheel trip indicated as 14.

Referring now to FIGURE 4, there is shown an embodiment having the identical difference means and associated circuitry 21, 22 and 23 and further shows the bistable multi-vibrator in more detail. The bistable multivibrator is of the direct coupled variety having two PNP transistors 50 and 51 with a common emitter resistor R10. Coupling resistors R7 and R8 are connected from base to emitter respective of the two transistors. Conventional biasing resistors R3 and R4 are provided. In addition, there is provided a capacitor 60 shunted across resistor R7 in order to insure that the multi-vibrator will start in one specific position when the system is initially turned on.

A conventional power supply comprising a negative voltage (—E) connected across a resistor R13 having a shunting condenser 63 is provided. A Zener diode 67 is connected across capacitor 63 to insure constant voltage.

Condensers 61 and 62 are coupled from the bases of transistors 25 and 26 respectively to a common terminal in order to decrease the sharpness of the voltage spikes.

As a further novel feature, there are shown Zener diodes 65 and 66 connected from the input leads 17 and 18 respectively to a common terminal.

The characteristics of the Zener diodes are best shown by reference to FIGURE 7. When a positive voltage appears on lead 17, transistor 25 will not conduct and the Zener diode is arranged so as to by-pass the positive voltage to ground. However, when a negative voltage is applied, which is less than the avalanche voltage V_a in absolute magnitude, the voltage is passed directly to the base of transistor 25. However, if the voltage should exceed an absolute magnitude avalanche voltage V_a, then the Zener diode acts as a clipper and only allows a voltage of magnitude V_a to be applied to base 25. Thus, if high spurious currents should be inducted in the rail such as could be caused by lightning, protection to the transistors 25 and 26 as well as the other transistors is provided. When the voltage V_a substantially exceeds an absolute maximum the expected voltages produced by the actuation of the magnetic means by the flange of the wheel, the difference amplifier 21 truly operates as a difference amplifier and the voltage output represent true differences. However, when the expected voltage induced by the operation by the flange is set to exceed the avalanche voltage V_a then since only magnitudes of voltage of V_a are passed into the difference amplifier, the difference amplifier acts as a coincidence detector. In this operation, the Zener diode acts as a clipper.

In the preferred embodiment shown in FIGURE 4, the avalanche voltage V_a is set to be greater than the expected voltage induced by a passing flange and the Zener diode acts to protect the transistors.

I claim:

1. In a railroad car control system in which the flange of the moving car wheel is used to start and stop desired control functions as it moves between predetermined spaced locations along a length of railroad track, comprising

a first magnetic wheel trip means positioned closely adjacent to said track and responsive to said passing flange,

a second magnetic wheel trip means positioned closely adjacent to said track and responsive to said passing flange and spaced a substantial distance apart from said first wheel trip means to insure the currents induced in said first wheel trip means when said flange is at the position of said first wheel trip means do not induce a current in said second wheel trip means,

a difference amplifier having inputs coupled to each of said magnetic means and having two outputs,

the first output representing the difference between the induced signals and the second output representing the negative of said difference, said first output being connected to a bistable multi-vibrator to produce a pulse, and

said second output being coupled to said bistable multi-vibrator to cut off said multi-vibrator and said pulse.

2. In a railroad car control system in which the flange of the moving car wheel is used to start and stop desired control functions as it moves between predetermined spaced locations along a length of railroad track, comprising

a first magnetic wheel trip means positioned closely adjacent to said track and responsive to said passing flange,

a second magnetic wheel trip means positioned closely adjacent to said track and responsive to said passing flange and spaced a substantial distance apart from said first wheel trip means to insure the currents induced in said first wheel trip means when said flange is at the position of said first wheel trip means do not induce a current in said second wheel trip means,

means to suppress spurious common mode signals including means to determine the difference in magnitude between the currents produced in each of said magnetic trip means and to produce output signals

including a difference means having two inputs coupled respectively to each of said magnetic trip means,

said difference means producing two output signals, the first output signal representing the differences between the output of said first magnetic means and said second magnetic means, and said second output signal representing the difference between the output of said second magnetic means and said first magnetic means, and having first means responsive to said first signal to produce a signal when said first signal is of one polarity and having second means responsive to said second signal to produce a signal when said second signal is of the said same polarity,

and control means responsive to said first and second means to produce a control signal having duration characteristics in accordance with the polarities of said first and second signals.

3. In a railroad car control system in which the flange of the moving car wheel is used to start and stop desired control functions as it moves between predetermined spaced locations along a length of railroad track, comprising

a first magnetic wheel trip means positioned closely adjacent to said track and responsive to said passing flange,

a second magnetic wheel trip means positioned closely adjacent to said track and responsive to said passing flange and spaced a substantial distance apart from said first wheel trip means to insure the currents induced in said first wheel trip means when said

flange is at the position of said first wheel trip means do not induce a current in said second wheel trip means,

means to suppress spurious common mode signals including means to determine the difference in magnitude between the currents produced in each of said magnetic trip means and to produce output signals,

including a difference means having two inputs coupled respectively to each of said magnetic trip means,

said difference means producing two output signals, the first output signal representing the difference between the output of said first magnetic means and said second magnetic means, and said second output signal representing the difference between the output of the second magnetic means and said first magnetic means, and having first means responsive to said first signal to produce a signal when said first signal is of one polarity and having second means responsive to said second signal to produce a signal when said second signal is of said same polarity,

and control means responsive to said first and second means to produce a control signal having duration characteristics in accordance with the polarities of said first and second signals, said control means comprising a bistable multi-vibrator.

4. In a railroad car control system in which the flange of the moving car wheel is used to start and stop desired control functions as it moves between predetermined spaced locations along a length of railroad track, comprising

a first magnetic wheel trip means positioned closely adjacent to said track and responsive to said passing flange,

a second magnetic wheel trip means positioned closely adjacent to said track and responsive to said passing flange and spaced a substantial distance apart from said first wheel trip means to insure the currents induced in said first wheel trip means when said flange is at the position of said first wheel trip means do not induce a current in said second wheel trip means,

means to suppress spurious common mode signals including means to determine the difference in magnitude between the currents produced in each of said magnetic trip means and to produce output signals,

including a difference means having two inputs coupled respectively to each of said magnetic trip means and having two transistors each having collector, base and emitter terminals, a common resistor connected to a pair of one of said terminals, and a pair of output resistors across which respectively a first signal representing the input from one of said magnetic means and a second signal representing the input from the other of said magnetic means are developed,

a second pair of complementary transistors having collector, base and emitter terminals,

said first and second signals being coupled to two of said terminals of one complementary transistors and said first and second signals being coupled in alternate manner to the same two terminals of the other complementary transistors, so that one transistor will conduct when said first signal exceeds said second signal and the other transistor will conduct when said second signal exceeds said first signal.

5. In a railroad car control system in which the flange of the moving car wheel is used to start and stop desired control functions as it moves between predetermined spaced locations along a length of railroad track, comprising

a first magnetic wheel trip means positioned closely adjacent to said track and responsive to said passing flange,

a second magnetic wheel trip means positioned closely adjacent to said track and responsive to said passing flange and spaced a substantial distance apart from

said first wheel trip means to insure the currents induced in said first wheel trip means when said flange is at the position of said first wheel trip means do not induce a current in said second wheel trip means,

means to suppress spurious common mode signals including means to determine the difference in magnitude between the currents produced in each of said magnetic trip means and to produce output signals,

including a difference means having two inputs coupled respectively to each of said magnetic trip means and having two transistors each having collector, base and emitter terminals, a common resistor connected to a pair of one of said terminals, and a pair of output resistors across which respectively a first signal representing the input from one of said magnetic means and a second signal representing the input from the other of said magnetic means are developed,

a second pair of complementary transistors having collector, base and emitter terminals,

said first and second signals being coupled to two of said terminals of one complementary transistors and said first and second signals being coupled in alternate manner to the same two terminals of the other complementary transistors, so that one transistor will conduct when said first signal exceeds said second signal and the other transistor will conduct when said second signal exceeds said first signal,

and a bistable multi-vibrator having two inputs, the first input coupled to the third terminal of one complementary transistor and the second input coupled to the third terminals of said other complementary transistor.

6. In a railroad car control system in which the flange of the moving car wheel is used to start and stop desired control functions as it moves between predetermined spaced locations along a length of railroad track, having

a first magnetic wheel trip means positioned closely adjacent to said track and responsive to said passing flange, and having

a second magnetic wheel trip means positioned closely adjacent to said track and responsive to said passing flange and spaced a substantial distance apart from said first wheel trip means to insure the currents induced in said first wheel trip means when said flange is at the position of said first wheel trip means do not induce a current in said second wheel trip means, the improvement comprising

means to suppress spurious common mode signals including means to determine the difference in magnitude between the currents produced in each of said magnetic trip means and to produce output signals,

and Zener diodes each having the same avalanche voltage coupled respectively to the inputs to said suppressing means,

said avalanche voltage being predetermined and less in absolute magnitude than the expected voltage induced in said magnetic means when responsive to a passing flange, whereby time coincidence of the voltages or currents in each of said magnetic trip means may be determined.

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