

May 21, 1968

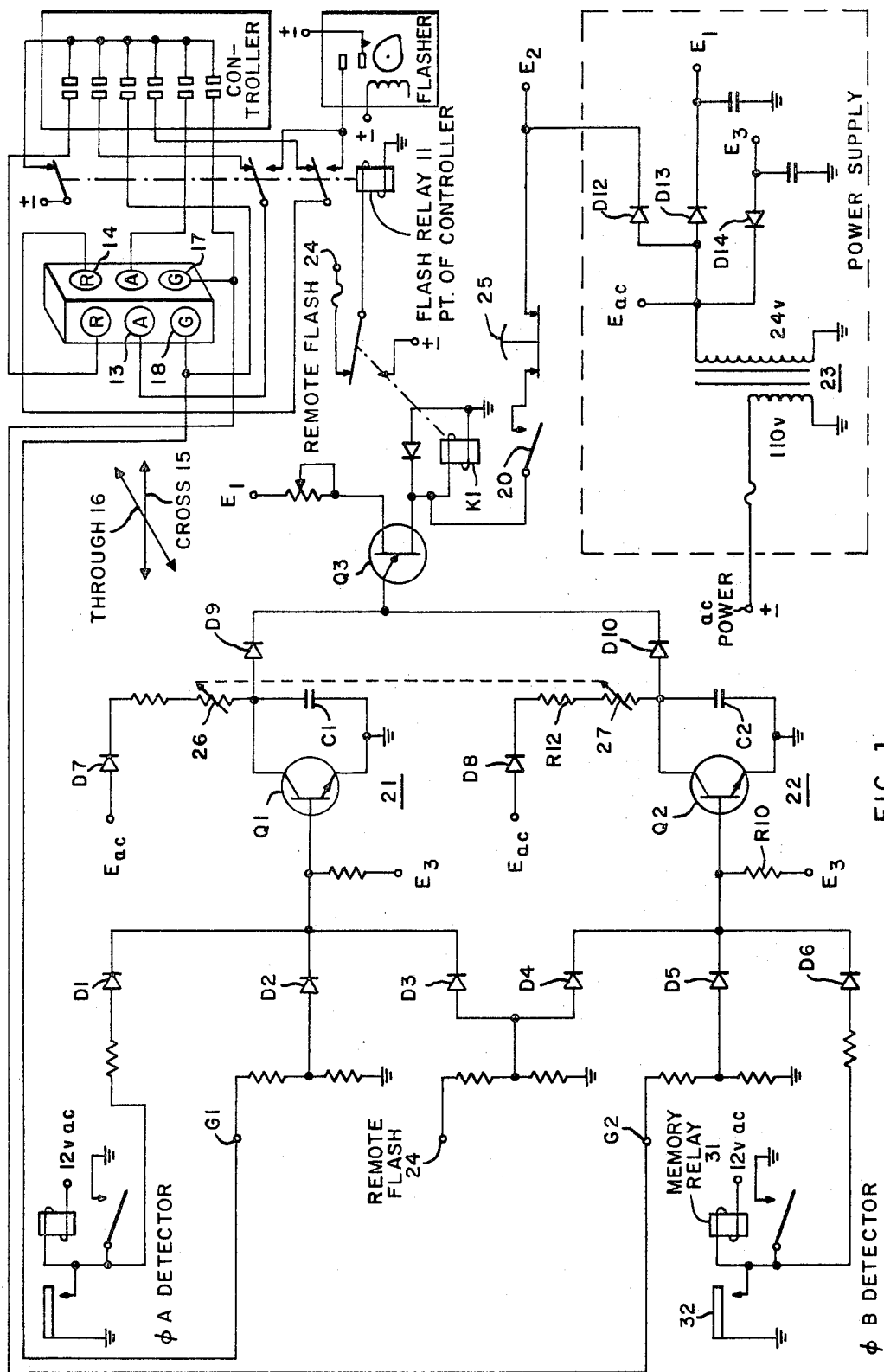
J. V. SELZER ET AL

3,384,871

SOLID STATE AUXILIARY CONTROLLERS

Filed Oct. 22, 1965

2 Sheets-Sheet 1



May 21, 1968

J. V. SELZER ET AL

3,384,871

SOLID STATE AUXILIARY CONTROLLERS

Filed Oct. 22, 1965

2 Sheets-Sheet 2

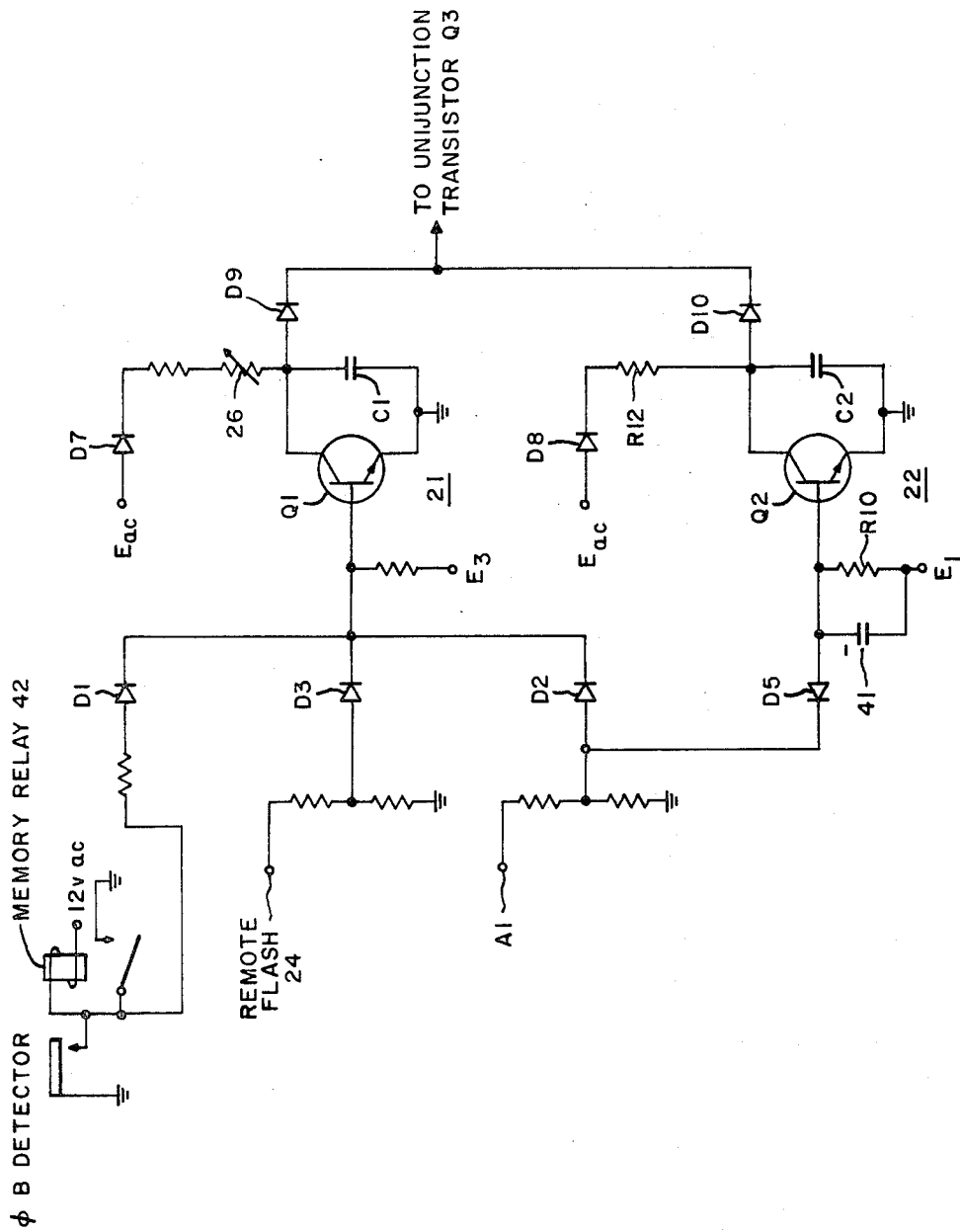


FIG. 2

1

3,384,871

SOLID STATE AUXILIARY CONTROLLERS

John V. Selzer, 410 Linden Blvd. 11203, and Philip Cane, 697 E. 22nd St. 11215, both of Brooklyn, N.Y.
Filed Oct. 22, 1965, Ser. No. 502,248
14 Claims. (Cl. 340-41)

The present invention relates in general to apparatus and techniques for responding to an abnormal condition in a system, such as a signalling system for controlling the flow of traffic across an intersection, and more particularly concerns novel semiconductor circuitry arranged to reliably respond to an abnormal condition by activating a cautioning signal so as to allow the flow of traffic across the intersection while warning operators of vehicles to exercise appropriate caution before entering the intersection.

One problem with traffic signals that control the flow of traffic across an intersection is that the controller may fail and direct traffic along one direction to go and traffic along an intersecting direction to stop for an abnormally long period of time. This type of failure frequently results in operators signaled to stop moving across the intersection in disregard of the signal while a vehicle approaching from the direction signaled to go may proceed into the intersection without realizing the failure of the signal. The dangers involved are apparent.

It is possible to prevent this unsafe condition from developing by employing a relay system that automatically signals traffic approaching the intersection from all directions to exercise caution upon detecting this condition of failure. While this system is very effective, it has a number of disadvantages. Typically at least some of the relays in the system must switch each time a traffic signal light changes color. This large number of switchings may result in deterioration in the relay elements so that when a failure does occur, the relay elements might not be in a condition to effect the desired changeover to a cautioning signal.

Accordingly, it is an important object of this invention to provide a reliable system for responding to the failure of a traffic controller which ceases to function for reasons other than power failure.

It is another object to achieve the preceding object with relatively few, but reliably operating, semiconductor devices.

It is still another object of the invention to achieve the preceding object with apparatus suitable for use both with controllers in which traffic flow along the different intersecting directions is sequenced entirely on a time basis and controllers in which the flow may also be assigned on a demand basis.

It is still another object of the invention to achieve the preceding objects with apparatus that also allows the cautioning signal source to be activated by independent means.

According to this invention, there is a source of a cautioning signal, such as a flashing yellow light. An output semiconductor device has a first or normal state which normally is ineffective for exciting the cautioning signal and a second or abnormal state which activates the cautioning signal source to produce the cautioning signal, such as the flashing of the yellow light. A first semiconductor device timing circuit responds to a first set of control signals, such as the signals directing the flow of traffic along a first direction, and a second semiconductor device timing circuit responds to a second set of signals, such as the traffic control signals directing traffic along a second direction, to provide normal signals to the output semiconductor device that maintains the latter in its first state. When either semiconductor device timing circuit

2

senses an abnormal sequence of control signals, that circuit provides a signal causing the output semiconductor device to assume the second state and activate the source of a cautioning signal.

According to another feature of the invention input coupling means may also be provided from a first phase input terminal to the first semiconductor device timing circuit and from a second phase input terminal to the second semiconductor device timing circuit to allow the apparatus to also respond to signals that might be provided by memory relay or relays in a demand controller where traffic is signaled to go only when a vehicle approaches the intersection from either of the cross streets.

Numerous other features, objects and advantages of the invention will become apparent from the following specification when read in connection with the accompanying drawing, in which:

FIG. 1 shows essentially a schematic circuit diagram of an embodiment of the invention; and

FIG. 2 shows a modification of FIG. 1 that achieves essentially the performance of the circuit of FIG. 1 with fewer components.

With reference now to the drawing and more particularly FIG. 1 thereof, there is shown a schematic circuit diagram of a preferred embodiment of the invention in which a flash relay 11 is energized when relay K1 is energized in response to an abnormal condition to flash the amber lights 13 and red lights 14 along the through street direction 16 and cross street direction 15, respectively. Typically this abnormal condition is sensed when either the power to the cross street green light 17 or to the through street green light 18 remains off for longer than a predetermined time interval determined by semiconductor device timing circuits 21 and 22. The power to the lights is provided by a conventional controller with contacts illustrated in FIG. 1 but not further described because such controllers are well known in the art.

The apparatus includes a power supply preferably arranged to convert conventional 110 volt A-C power into 24 volts across the secondary of transformer 23 and provide potentials for energizing various points. The terminals designated $\pm$ receive 110 volt A-C. The terminals designated E_{ac} are at 24 volts A-C. The terminals designated E_2 receive a half-wave rectified D-C potential provided through diode D12. The terminals designated E_1 receive a filtered positive D-C potential provided through diode D13. The terminals designated E_3 receive a filtered negative potential provided through diode D14.

Flash relay 11 may be actuated with relay K1 in its normally deenergized position by an external flash signal provided by flasher control signal source 24 when it is desired to normally flash the lights 13 and 14, for example, during early morning hours when traffic is light.

The normal condition is maintained when a green light, such as through green light 18 is energized to provide a train of half-wave rectified pulses through diode D2 that pulses NPN transistor Q1 to discharge capacitor C1 and prevent it from being charged through diode D7 and timing potentiometer 26 above a critical potential corresponding essentially to the firing potential of the emitter of output unijunction transistor Q3. This critical firing potential is sufficient to allow capacitor C1 to discharge through diode D9 and render unijunction output transistor Q3 momentarily conductive. Output transistor Q3 draws enough current through relay K1 to operate the relay. Holding contacts 20 then keep relay K1 in the operate condition until release button 25 is pressed. Thus, so long as power is fed to through green light 18, transistor Q1 conducts to prevent capacitor C1 from being charged sufficiently to render unijunction transistor Q3 conductive. Similarly capacitor C2 is charged through means including diode D8 unless transistor Q2 is rendered

conductive by an impulse transmitted through diode D5 when cross street green light 17 is supplied with voltage. Thus, if cross street light 17 remains inactive for too long an interval, capacitor C2 charges to a potential sufficient to render unijunction transistor Q3 conductive. On the other hand, if through street green light 18 remains inactive for an excessive interval, capacitor C1 charges to a potential sufficiently high to render unijunction output transistor Q3 conductive. When unijunction transistor Q3 conducts momentarily, relay K1 is energized to initiate flash relay 11 and close holding contacts 20 until such time as release button 25 is pressed.

A unijunction transistor, or double-base diode, comprises a single rectifying contact the emitter, situated approximately midway along a semiconductor bar which carries two ohmic base contacts at its ends. Appropriately biasing the bar with a potential across the base contacts establishes a negative resistance characteristic between the emitter and a base. This characteristic is between the emitter and base connected to relay K1 in the preferred embodiment.

The circuit techniques according to the present invention employing pulses derived from the ordinary power line have a number of advantages. Power consumption is relatively low. Relatively low power semiconductor devices may be employed. Yet, positive desired switching occurs in circuitry that is relatively insensitive to noise. And the power supply circuitry is relatively simple and inexpensive.

The rate at which capacitors C1 and C2 charge may be controlled by the values of ganged potentiometers 26 and 27 so that the limit period may be established well in excess of the normal green duration for either cross or through traffic. The charging time constant is preferably much greater than the discharge time constant of the path through a conducting transistor Q1 or Q2.

The apparatus also includes a remote flash inhibiting channel for preventing the timing circuits 21 and 22 from indicating a failure when the controlled flash condition has been selected by flash signal source 24. Source 24 provides signals through diodes D3 and D4 to periodically render transistors Q1 and Q2, respectively conductive so that capacitors C1 and C2 remain essentially in the discharged state and K1 cannot be energized.

Still another feature of the invention resides in having the apparatus adaptable for a vehicle actuated controller in which through street lights 16 remain green until a vehicle is ready to enter the intersection from a cross street. by connecting the phase B detector line to the detector device in the traffic signal controller, which may be a memory relay 31 that remains deenergized until the vehicle actuates switch contacts 32, a 12 volt A-C signal may pass through relay 31 through means including diode D6 to inhibit the charging of capacitor C2 by periodically rendering transistor Q2 conductive. At the same time, transistor Q1 is rendered periodically conductive by the green signal transmitted through diode D2 to keep capacitor C1 from charging appreciably. A phase A detector line is also provided for transmitting a similar signal through diode D1 should it be desired to maintain the cross street direction in the normally green condition. When switch 32 is closed, relay 31 is energized to effectively connect the 12 volt A-C ground and prevent transistor Q2 from being rendered conductive. Consequently, capacitor C2 may be charged should the cross street light 17 not return to the green condition for too long a period.

Referring to FIG. 2, there is shown a schematic circuit diagram of alternate circuitry according to the invention in which the number of monitored signals are reduced. Since the circuitry to the right of diodes D9 and D10 is identical to that in FIG. 1, FIG. 2 shows only the modified circuit portions to the left of the latter two diodes. Corresponding elements in FIGS. 1 and 2 are identified by the same reference symbol. Having described

the circuit arrangement of FIG. 1, FIG. 2 is best described by explaining what changes have been made in the circuit of FIG. 1 to produce the circuit of FIG. 2.

The ganged potentiometer resistance 27 has been eliminated so that timing adjustment is controlled entirely by adjusting potentiometer 26. The line leading from the ϕ B detector through diode D6 is eliminated and no signal from the G2 terminal need be delivered through diode D5 to the base of transistor Q2. Instead a capacitor 41 is connected across resistor R10 from the base of transistor Q2 to a source of positive direct potential such as E1. Diode D5 is connected poled as shown between the base of transistor Q2 and the anode of diode D2 which junction then receives a signal representative of the selection of amber for one of the directions. The ϕ B detector signal is coupled through diode D1 to the base of transistor Q1.

Operation is as follows. Capacitor C1 again charges through timing potentiometer 26 at a rate determined by the adjustment of the latter. When the controller designates by signal A1 that a corresponding amber light be ignited, diode D2 provides a rectified signal that renders normally nonconductive transistor Q1 conductive to discharge capacitor C1.

Transistor Q2 performs the function of sensing failure whereby the controller continuously provides a control signal A1 for continuous selection of an amber light. This fault is recognized when diode D5 provides a rectified signal across capacitor 41 to render transistor Q2, now normally conductive in the circuit of FIG. 2 nonconductive so that capacitor C2 can charge to a potential sufficient to render unijunction transistor Q3 conductive.

The time constant of resistor R12 and capacitor C2 is chosen to be sufficiently large so that the potential on capacitor C2 cannot rise to a value sufficient to render diode D10 conductive for the normal duration of an amber signal.

The circuitry of FIG. 2 is also suitable for use with semi traffic actuated equipment. With such equipment the controller may stay in the green one (C1) position indefinitely. The memory relay 42 in the controller equipment then couples a 12 volt A-C signal representative of the ϕ B detector state through diode D1 to render transistor Q1 conductive and keep capacitor C1 discharged. If a vehicle approaching from the cross street calls for a green two (G2) signal to turn the cross street green light green, relay 42 is energized to close the associated contacts and place the ϕ B line essentially at ground potential to establish a negative potential on transistor Q1 rendering that transistor nonconductive. If the cross street green light remains green for too long, capacitor C1 charges to a sufficiently high potential to render unijunction transistor Q3 conductive.

As in the circuit of FIG. 1, conducting unijunction transistor Q3 pulls in relay K1. Relay K1 locks through its own holding contacts 20 and the release push button 25. Other contacts of relay K1 also operate the flash relay 11 that is responsible for turning the signal lights into a flashing condition.

In a manner similar to that described above in connection with the circuit of FIG. 1, the externally designated flash signal coupled through diode D3 disables the protection device when operating from a remote flash circuit. The flash signal causes transistor Q1 to conduct on the occurrence of each flash to discharge capacitor C1 during intervals sufficiently closely spaced to prevent a potential to develop across that capacitor sufficient to render diode D9 conductive.

While the specific embodiments described employ specific logic as examples, it is within the principles of the invention to employ different logic. Numerous other modifications of, uses of and departures from the specific embodiment described herein will be apparent to those skilled in the art without departing from the inventive concepts. Consequently, the invention is to be construed

5

as limited solely by the spirit and scope of the appended claims.

What is claimed is:

1. Traffic control apparatus responsive to signal control failure for producing a cautioning control signal comprising:

a source of a cautioning signal,
a source of a first set of control signals directing traffic along a first direction and a second set of control signals directing traffic along a second direction that intersects with said first direction,

an output semiconductor device coupled to said cautioning signal source and capable of assuming a first state and a second state which second state activates said cautioning signal source,

first and second semiconductor timing circuits coupled to said source of control signals and responsive to normal operation of said first set of control signals and said second set of control signals for continuously providing said output semiconductor device with a disabling signal that normally maintains said output semiconductor device in said first state when both said first set of control signals and said second set of control signals occur in normal sequence, said first and second timing circuits being responsive to the abnormal occurrence of said first set of control signals and said second set of control signals respectively by providing an enabling signal to said output semiconductor device to change the latter device to said second state and thereby activate said source of a cautioning signal.

2. Traffic control apparatus in accordance with claim 1 and further comprising:

power supply means including means for rectifying A-C energy of power line frequency for providing rectified impulses, and

means for applying said rectified impulses to said timing circuits and said output semiconductor device.

3. Traffic control apparatus in accordance with claim 2 wherein said first and second timing circuits include first and second timing semiconductor devices respectively, the occurrence of current flow in each of said devices being only contemporaneously with the occurrence of respective ones of said rectified impulses.

4. Traffic control apparatus in accordance with claim 3 wherein said output semiconductor device comprises a unijunction transistor and said first and second semiconductor timing circuits comprise first and second timing capacitors respectively, and further comprising:

means for charging said first and second capacitors, first and second timing resistances connected to said first and second timing capacitors respectively,

means including said first and second timing resistances respectively for charging said first and second capacitors with respective ones of said impulses,

means including said first and second timing semiconductor devices for respectively providing first and second respective discharge paths for said first and second capacitors, and

means including said output semiconductor device for providing another discharge path for said first and second capacitors when the potential on said capacitors exceeds a predetermined value to only then render said output device conductive and in said second state.

5. Traffic control apparatus in accordance with claim 4 wherein said first set of control signals include a first directing signal and said second set of control signals include a second directing signal,

means for deriving a first directing set of said rectified impulses from said first directing signal,

means for deriving a second directing set of said rectified impulses from said second directing signal,

means for coupling said first directing set to said first timing semiconductor device to normally maintain

6

the potential on said first timing capacitor less than said predetermined value,

means for coupling said second directing set to said second timing semiconductor device to normally maintain the potential on said second timing capacitor less than said predetermined value,

whereby the absence of either of said first and second sets for a time interval greater than a predetermined period related to first and second charge time constants related to the product of each of said timing capacitors and each of said timing resistances results in said predetermined value being exceeded and said output semiconductor device rendered conductive.

6. Traffic control apparatus in accordance with claim 5 and further comprising:

a cautioning signal selection terminal,
switching means responsive to said output semiconductor device being in said first state for coupling said cautioning signal selection terminal to said source of a cautioning signal whereby the presence of a cautioning signal selection signal on said cautioning signal selection terminal activates said cautioning signal source, and

timing circuit inhibiting means responsive to the presence of said cautioning signal selection signal on said cautioning signal selection terminal for coupling ones of said rectified impulses to both said first and second timing semiconductor devices to then maintain the potential on said first and second timing capacitors less than said predetermined value.

7. Traffic control apparatus in accordance with claim 6 and further comprising at least a first phase input terminal, and

means for coupling said first phase input terminal to one of said timing circuit semiconductor devices to selectively provide ones of said rectified impulses to said one timing circuit semiconductor device.

8. Traffic control apparatus in accordance with claim 7 and further comprising a second phase input terminal, and

means for coupling said second phase input terminal to the other of said timing circuit semiconductor devices to selectively provide ones of said rectified impulses to said other timing circuit semiconductor device.

9. Traffic control apparatus in accordance with claim 2 wherein said first and second timing circuits include first and second timing semiconductor devices respectively,

means for establishing said first semiconductor device normally conducting,

means for establishing said second semiconductor device normally conducting, and

means responsive to selected ones of said rectified impulses for selectively rendering said first semiconductor device conducting and said second semiconductor device nonconducting,

the occurrence of current flow in said first semiconductor device and the absence of current flow in said second semiconductor device being only contemporaneously with the occurrence of respective ones of said rectified impulses.

10. Traffic control apparatus in accordance with claim 9 wherein said output semiconductor device comprises a unijunction transistor and said first and second timing circuits comprise first and second timing capacitors respectively, and further comprising:

means for charging said first and second capacitors, first and second timing resistances connected to said first and second timing capacitors respectively,

means including said first and second timing resistances respectively for charging said first and second capacitors with respective ones of said impulses,

means including said first and second timing semiconductor devices for respectively providing first and second respective discharge paths for said first and second capacitors, and

means including said output semiconductor device for providing another discharge path for said first and second capacitors when the potential on said capacitors exceeds a predetermined value to only then render said output device conductive and in said second state.

11. Traffic control apparatus in accordance with claim 10 wherein said first set of control signals include a first directing signal and said second set of control signals include a second directing signal,
- means for deriving a first directing set of said rectified impulses from said first directing signal,
- means for deriving a second directing set of said rectified impulses from said second directing signal,
- means for coupling said first directing set to said first timing semiconductor device to normally maintain the potential on said first timing capacitor less than said predetermined value,
- means for coupling said second directing set to said second timing semiconductor device to normally maintain the potential on said second timing capacitor less than said predetermined value except when the duration of said second directing signal exceeds a predetermined duration,
- whereby the absence of said first set for a time interval greater than a predetermined first period related to a first charge time constant related to the product of said first timing capacitor and said first timing resistance and the presence of said second set for a time interval greater than a predetermined second period related to a second charge time constant related to the product of said second timing capacitor and said second timing resistance results in said predetermined value being exceeded and said output semiconductor device rendered conductive.

12. Traffic control apparatus in accordance with claim 11 and further comprising:

a cautioning signal selection terminal, switching means responsive to said output semiconductor device being in said first state for coupling said cautioning signal selection terminal to said source of a cautioning signal whereby the presence of a cautioning signal selection signal on said cautioning signal selection terminal activates said cautioning signal source, and

timing circuit inhibiting means responsive to the presence of said cautioning signal selection signal on said cautioning signal selection terminal for coupling ones of said rectified impulses to said first timing semiconductor device to then maintain the potential on said first timing capacitor less than said predetermined value.

13. Traffic control apparatus in accordance with claim 12 and further comprising at least a first phase input terminal, and

means for coupling said first phase input terminal to said first timing circuit semiconductor device to selectively provide ones of said rectified impulses to said first timing semiconductor device.

14. Traffic control apparatus in accordance with claim 13 wherein said first phase input terminal bears a signal for rectification to provide said rectified impulses only when said first directing signal occurs signalling traffic in a preferred direction to go and the latter signal for rectification is absent upon demand for occurrence of a demand for a signal that signals traffic in said preferred direction to stop.

No references cited.

35 THOMAS B. HABECKER, *Primary Examiner.*