

Dec. 22, 1970

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3,550,121

ANNUNCIATOR SYSTEM

Filed June 26, 1967

4 Sheets-Sheet 1

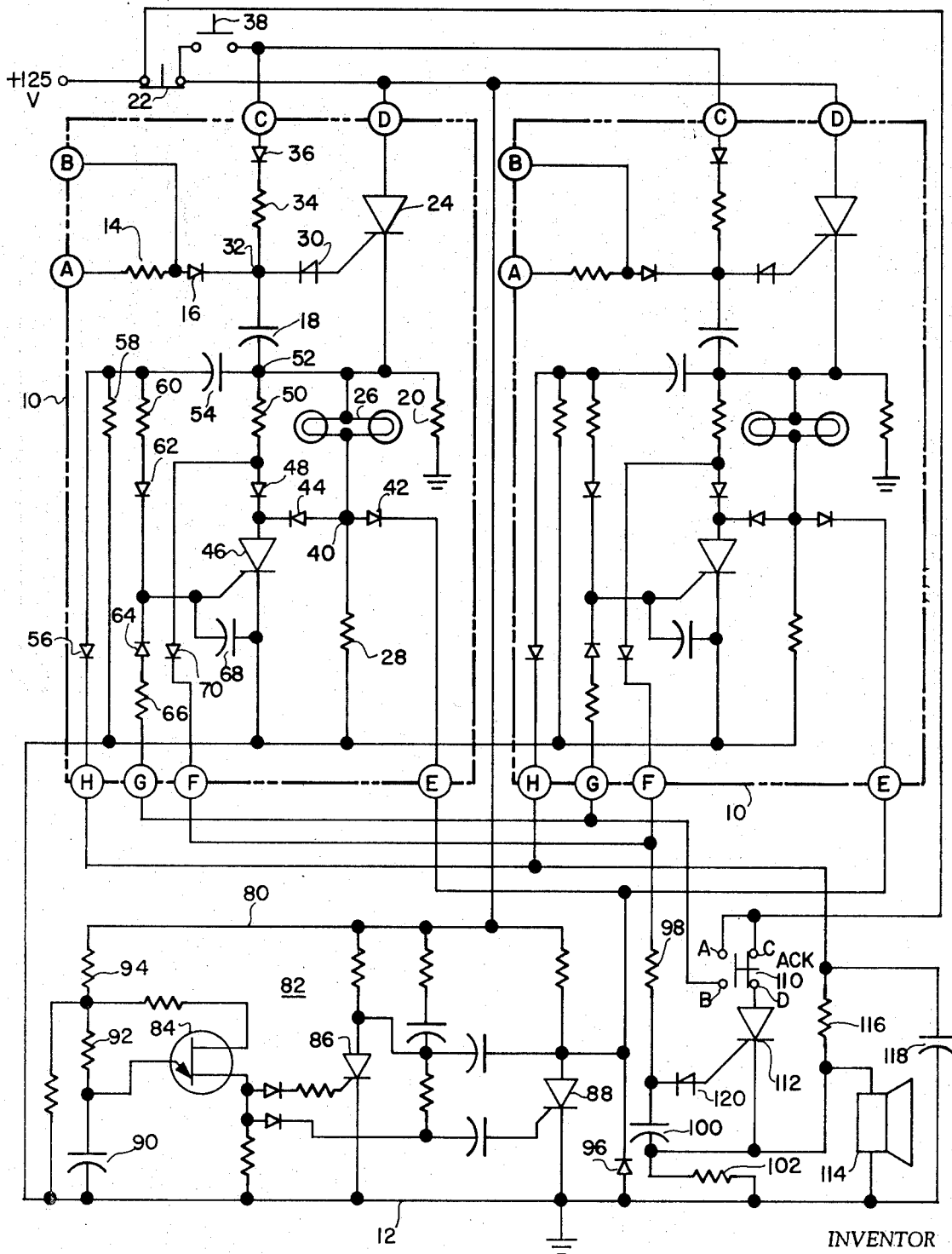


FIG. 1

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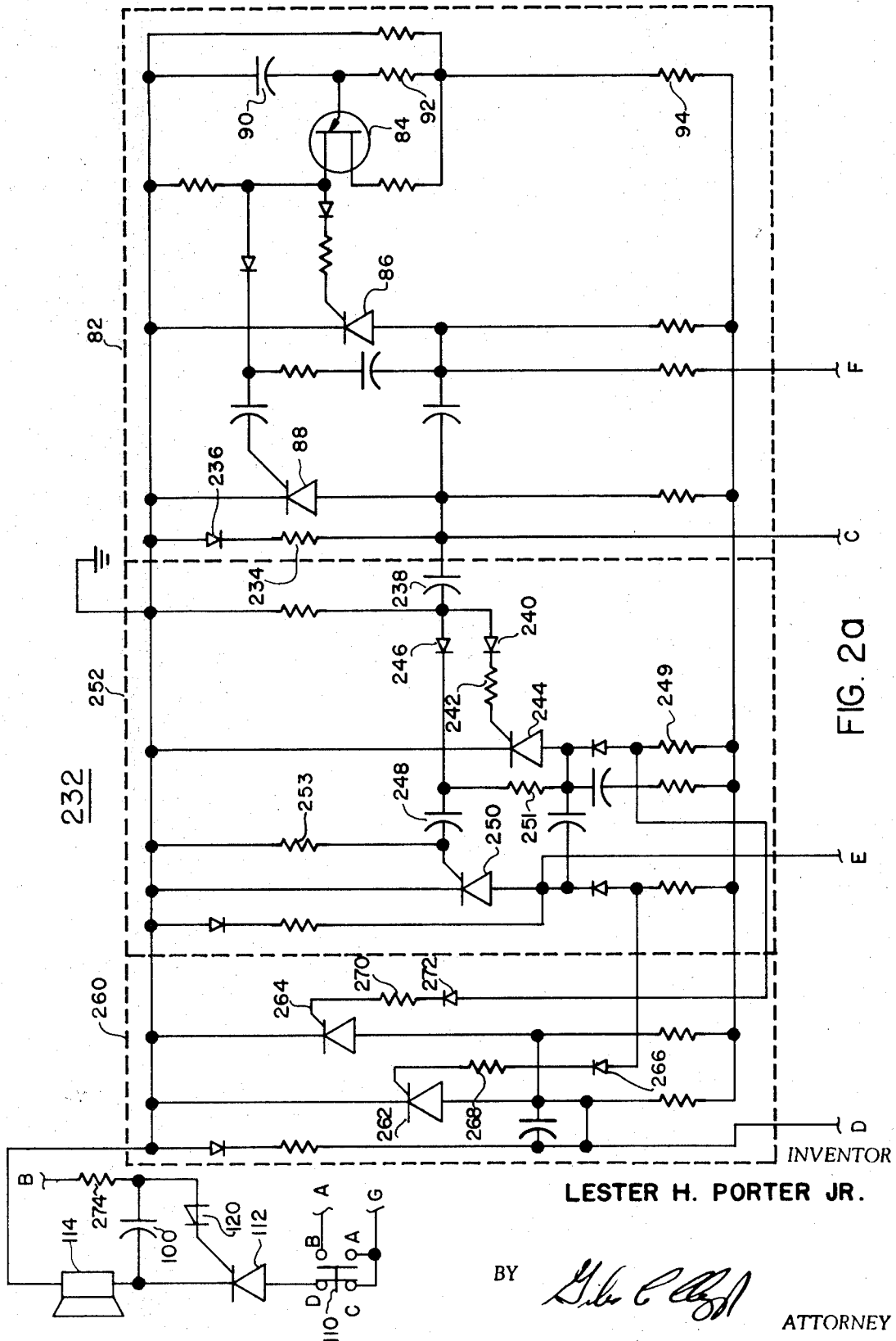
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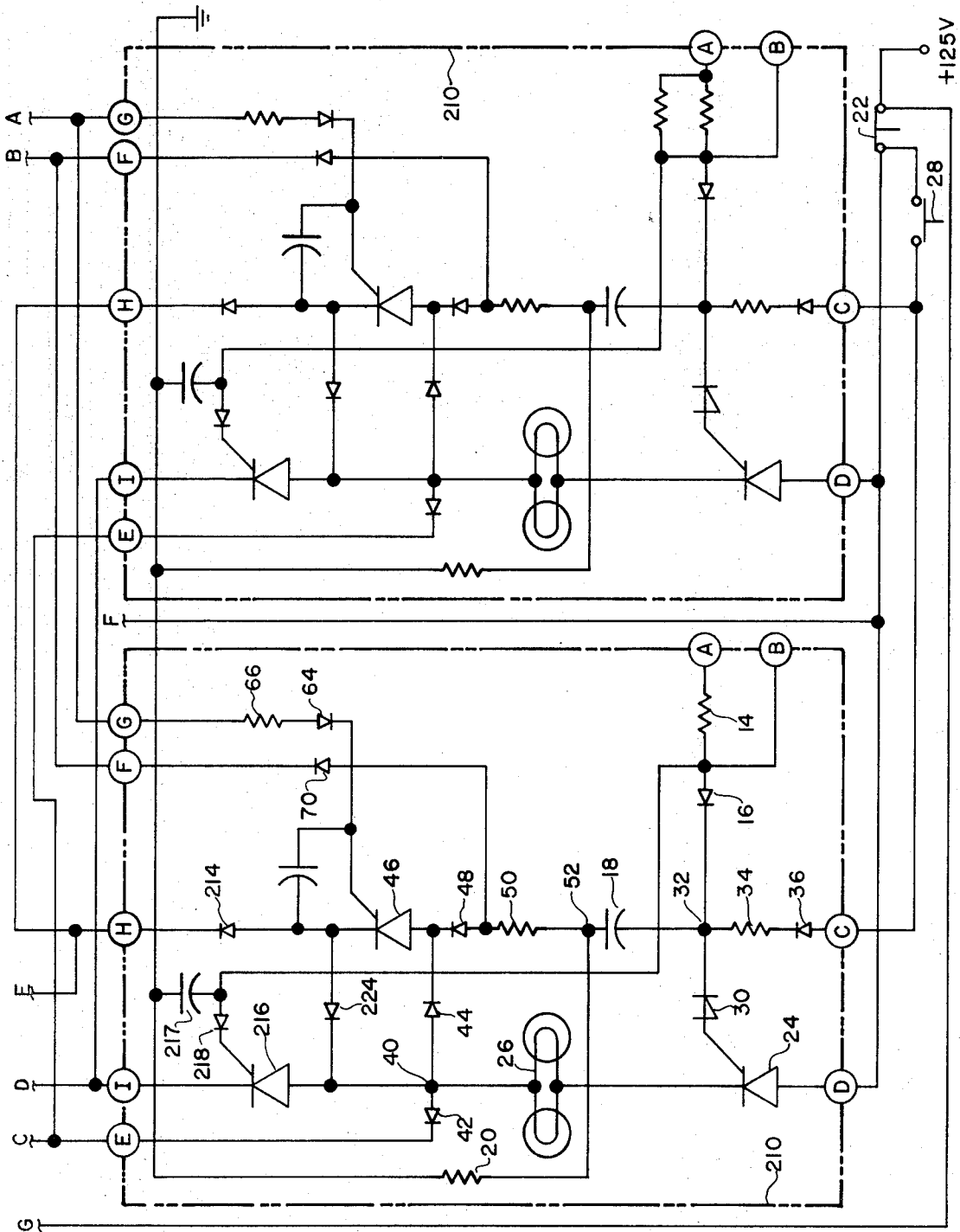


FIG. 2b

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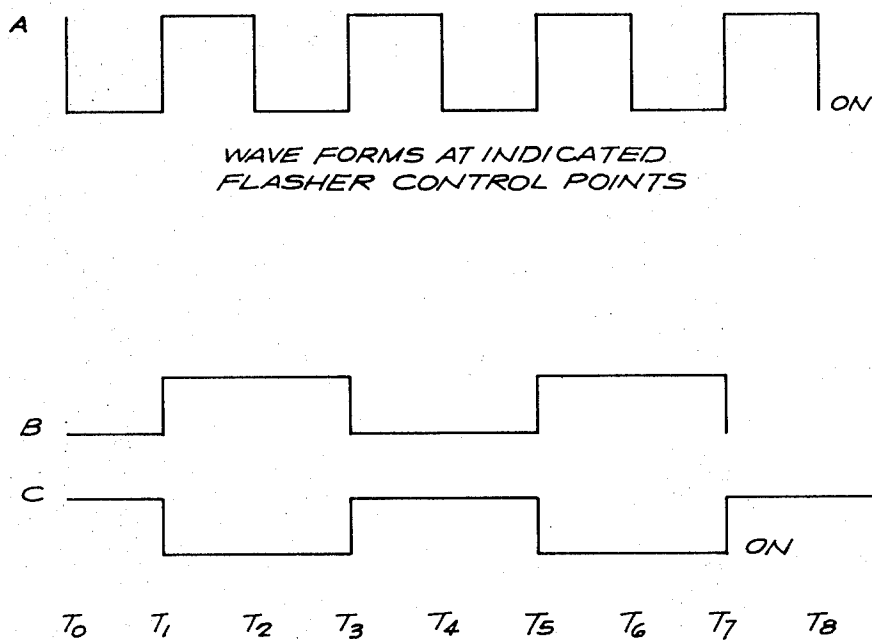


FIG. 3

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ANNUNCIATOR SYSTEM

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U.S. Cl. 340—415

8 Claims

ABSTRACT OF THE DISCLOSURE

There is disclosed in the specification and drawings an annunciator system in which the lamp modules associated with variables being monitored include a silicon controlled rectifier which is switched to the low impedance state responsive to the associated variable becoming abnormal. The control rectifier, a lamp, and a flasher circuit are connected in series with a source of supply voltage. When the silicon controlled rectifier is turned on responsive to the charge on a capacitor indicating that the variable has become abnormal, the lamp will be periodically energized causing the lamp to flash on and off. There is also provided an acknowledge switch and second silicon controlled rectifier, the second silicon controlled rectifier being connected in parallel with the flasher circuit. When the acknowledge switch is operated, the second silicon controlled rectifier will be switched to its low impedance state such that ground will be continuously applied to the lamps causing the lamps to be energized steadily. In accordance with one embodiment of the invention there may also be provided an additional flasher circuit connected in parallel with the first flasher circuit and necessary control circuitry such that when the variable first becomes abnormal the lamp will flash at one rate and if the variable returns to normal after operation of the acknowledge switch the lamp will flash at a different rate. In another embodiment of the invention a first-out mode of operation is provided in which only the lamp module associated with the first variable in the series to become abnormal will flash and lamps associated with variables which thereafter become abnormal will produce a steady indication. Upon operation of the acknowledge switch, all lamps associated with variables which are abnormal at that time will produce a steady indication. The next variable which becomes abnormal will be indicated as a first-out by flashing of the lamp associated with the variable. Variables which become abnormal subsequently will be indicated by a steadily lit light.

The processes and equipment used in operation such as utility plants, chemical processing plants, pump stations, and the like, are often monitored and controlled from a central control console which would usually be from most of the equipment or stations being monitored. The central control console commonly employs an annunciator system which is connected to selected stations for monitoring the operations of the process or equipment. In the event of a malfunction or abnormal condition of any of the monitored stations a visual and audible signal device is energized for advising the operator of the presence of the malfunction. Depending upon the complexity of the system being monitored and other factors, a wide variety of such visual and audible indications may be needed in the annunciator system. For example, a first-out system may be appropriated, wherein the first station to indicate an abnormal condition produces one indication while subsequent malfunctions produce a different indication. Also, in some systems it may be desirable to produce still a different indication if a variable which was previously abnormal should return to normal.

It is also common to provide acknowledge switches in

such systems in order that at least one of the indications provided by the annunciator will change when the acknowledge switch is operated in order that the operator can determine if at least certain variables became abnormal subsequent to the operation of the acknowledge switch. The present invention provides an annunciator system which fulfills many of these needs but which is not complex and can be operated in systems wherein the voltage used is substantially higher than normal.

Many objects and advantages of the invention will become apparent to those skilled in the art as a detailed description of the preferred embodiments of the invention unfold in conjunction with the drawings wherein:

FIG. 1 of the drawings is a schematic diagram showing the specific example of the invention especially adapted for first-out operation;

FIGS. 2a and 2b are schematic diagrams illustrating a second specific example of the invention especially adapted for ring-back type operation; and

FIG. 3 is a group of curves showing the relationship of signals produced by the circuitry of FIGS. 2a and 2b.

In accordance with the embodiment of the invention shown in FIG. 1, there is provided a plurality of lamp modules 10 is associated with each of the variables to be monitored. In FIG. 1 of the drawings there is shown only two of the lamp modules 10 for purposes of illustrating the interconnections between the lamp modules and the control circuitry 12. It will be appreciated that any desired number of lamp modules can be provided. The components associated with each lamp module 10 are within areas bounded by dashed lines with the remaining components being a portion of the control module 12.

The annunciator in accordance with the specific embodiment of the invention disclosed herein is especially adapted for operation from a primary power source of 125 volts D.C. and for use with a system in which the field contact voltage is also 125 volts D.C. In order to provide maximum flexibility, lamp modules are adapted such that they may be used with either normally open or normally closed field contacts. If the normally open contact is to be utilized, it would be connected between 125 volts D.C. and terminal A. If the field contact to be used is of the normally closed type, terminal A is connected to +125 volts D.C. and the negative side of the power supply is connected through the field contact switch to terminal B. Terminal A is connected through resistor 14 to the anode of a diode 16, the cathode of the diode 16 being connected to the over terminal of capacitor 18 at juncture 32. The under terminal of capacitor 18 is connected through resistor 20 to ground.

It can be seen that if a normally open field contact is connected between terminal A and +125 volts, on closure of the field contact current will flow through the series circuit described above to charge capacitor 18. If, on the other hand, a normally closed field contact is utilized terminal B will be connected to ground through the normally closed contact and terminal A will be connected directly to +125 volts. The juncture between resistor 14 and diode 16 will therefore be connected to ground and the capacitor will not become charged as long as the field contact remains closed. Upon opening of the field contact, current will flow to charge the capacitor 18.

The +125 volts is also connected through a reset switch 22 to terminal D of each of the lamp modules 10. Terminal D of the lamp module 10 is connected to the anode of a silicon controlled rectifier 24, the cathode of silicon controlled rectifier 24 being connected through indicating lamp 26 and resistor 28 to ground. The gate electrode of the silicon controlled rectifier is connected through break-over diode 30 to the juncture 32 between the cathode of diode 16 and capacitor 18. The juncture 32 is also

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connected through resistor 34 to the cathode of diode 36, the anode of diode 36 being connected to terminal C. Terminal C is connected to the +125 volts D.C. supply voltage through test switch 38 and the reset switch 22, the reset switch being positioned between the test switch and the supply voltage.

The juncture 40 between the lamps 26 and the resistor 28 is connected to the anode of diode 42, the cathode of diode 42 being connected to terminal E. The juncture 40 is also connected to the anode of a diode 44 whose cathode is connected to the anode of a silicon controlled rectifier 46. The cathode of the silicon controlled rectifier 46 is connected to ground. The anode of the silicon controlled rectifier 46 is connected to the cathode of a diode 48 whose anode is connected through resistor 50 to the underterminal of capacitor 18. The juncture 52 between capacitor 18 and resistor 50 is connected through capacitor 54 to the anode of a diode 56 whose anode is connected to terminal H. The anode of diode 56 is connected through resistor 58 to ground. Similarly, the anode of diode 56 is connected through resistor 60 to the anode of diode 62. The cathode of diode 62 is connected to the cathode of a diode 64, the anode of diode 64 being connected through resistor 66 to terminal G. The cathode of diode 62 is also connected to the gate electrode of the silicon controlled rectifier 46 and through capacitor 68 to ground. The anode of diode 48 is connected to the anode of diode 70, the cathode of diode 70 being connected to terminal F. The above described elements constitute a lamp module 10, each of which are suitably identical.

The control module 12 includes the reset switch 22. As described previously, one terminal of the reset switch 22 is connected to a supply voltage, suitably 125 volts D.C. The other terminal of the reset switch is connected to bus 80. The bus 80 supplies power to a flasher unit denoted generally by the reference character 82 and which comprises a unijunction transistor 84 and two silicon controlled rectifiers 86 and 88. The flasher circuit 82 is a conventional bistable silicon controlled rectifier switch circuit driven by a unijunction transistor oscillator and, accordingly, a detailed description of its components and the mode of operation will not be given. The output from the flasher circuit is taken from the anode of silicon controlled rectifier 88 and will be pulsating voltage with the frequency depending upon the time constant established by capacitor 90 and the charging resistors 92 and 94. The output of the flasher circuit 82 is taken from the anode of silicon controlled rectifier 88. The anode of silicon controlled rectifier 88 is connected to the anode of diode 96 whose cathode is connected to ground.

The anode of silicon controlled rectifier 88 is commonly connected to terminal E of each of the lamp modules 10. Terminal F of each of the lamp modules 10 is connected through resistor 98, capacitor 100 and resistor 102 to ground. There is also provided an acknowledge switch 110 having four terminals A, B, C, and D. The switch 110 is biased such that the connection between terminals A and B is normally open and terminals C and D are normally shorted together by the acknowledge switch. Terminal A of the acknowledge switch 110 is connected to the source of supply voltage. Terminal B of the acknowledge switch is commonly connected to terminal G of each of the lamp modules 10. Terminal C is shorted to terminal A of the acknowledge switch and terminal D of the acknowledge switch is connected to the anode of a silicon controlled rectifier 112.

The cathode of silicon controlled rectifier 112 is connected to the juncture between capacitor 100 and resistor 102 and through horn 114 to ground. Horn 114 will be energized whenever the silicon controlled rectifier 112 is switched from its normally high impedance state to a low impedance state. The cathode of silicon controlled rectifier 112 is also connected through resistor 116 and capacitor 118 to ground. The juncture between

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resistor 116 and capacitor 118 is commonly connected to terminal H of each of the lamp modules.

When the first variable of a series becomes abnormal, the associated field contact will be operated, causing the current to flow through resistor 14, diode 16, capacitor 18, and resistor 20 to charge the capacitor 18. At such time as the capacitor 18 is charged to the breakover voltage of the switching diode 30, the diode 30 will switch from its normally high impedance state to its low impedance state, permitting discharge of the capacitor 18 into the gate electrode of the silicon controlled rectifier 24. Upon this occurrence the silicon controlled rectifier 24 will switch from its normal high impedance state to its low impedance state, permitting current to flow from terminal D through lamps 26 and resistor 28 to ground.

It will be appreciated that the present system is especially adapted for use where the supply voltage available is substantially higher than that which could be used with transistor circuitry without reducing the voltage level as the silicon controlled rectifiers can be operated and successfully switch voltage levels much higher than those at which transistors can operate. The provision of the capacitor 18 is extremely important. If the capacitor 18 and the breakover diode 30 were not provided and the resistor 14 was connected directly to the gate electrode of the silicon controlled rectifier 24, the silicon controlled rectifier 24 would turn on when current was caused to flow through resistor 14 into the gate electrode. Assuming that the supply voltage is for example, 125 volts, substantial power would be dissipated in the resistor 14 when gate current flows, producing a substantial amount of heat in the lamp module. By contradistinction, in the circuitry of the present invention, substantial amount of gate current flows when the capacitor 18 discharges through breakover diode 18 into the gate electrode, but the current flowing through the resistor 14 to charge the capacitor 18 is very small, minimizing the power dissipation. Also, the current flowing through the conductors leading from the field contact to the annunciator station is reduced substantially, making it practicable to use conductors of much smaller size than would otherwise be required. The current flowing through the field contacts is also reduced, minimizing the possibility of the contacts both becoming burned. Accordingly, it can be seen that provision of the capacitor 18 and the breakover diode 30 in combination with the silicon controlled rectifier 24 provides many advantages.

The juncture 40 is connected through diode 42 to terminal E. Terminal E is connected to the output of the flasher circuit and, accordingly, the potential appearing at terminal E will vary between B+ and ground potential at the frequency of the flasher circuit 82. When point E is connected to ground, the resistor 28 will be shunted and a greater amount of current will flow through the silicon controlled rectifier 24, causing the lamp 26 to grow brighter. When the point E is at supply voltage potential, the diode 42 will be back biased and current will only flow through resistor 28, causing the lamps 26 to be energized at a much lower level.

The potential appearing at juncture point 62 will be substantially the same as the supply voltage potential when the silicon controlled rectifier 24 is conductive. Accordingly, capacitor 100 of the control circuit will be charged through a path comprising resistor 50, diode 70, through F of the lamp module, resistor 98, capacitor 100 and resistor 102. At such time as the capacitor 100 is charged to the breakover voltage of the diode 120 which is connected between the over terminal of capacitor 100 and the gate electrode of silicon controlled rectifier 112, diode 120 will switch to a low impedance state, permitting discharge of the capacitor 100 through the gate electrode of silicon controlled rectifier 112, causing the silicon controlled rectifier to switch from its normally high impedance state to its low impedance

state. The anode of silicon controlled rectifier 112 is connected through terminal C and D of the acknowledge switch 110 to the supply voltage and, accordingly, the potential developed across resistor 102 will approximately be the supply voltage potential. This potential is connected across the horn 114, causing the horn to sound.

At the time the silicon controlled rectifier 24 switches from its normally high impedance state to its low impedance state, the potential at juncture point 52 will become much more positive. This change in potential is differentiated by capacitor 54. The capacitor 54 is connected through diode 56 and capacitor 118 to ground and through resistor 60 to the gate electrode of silicon controlled rectifier 46. Capacitor 118 is, however, much larger than capacitor 54 and, accordingly, effectively provides a short circuit to ground from capacitor 54 and gate current will not be applied to silicon controlled rectifier 46. It will be noted that the differentiated pulse produced by capacitor 54 is produced prior to the time that silicon controlled rectifier 112 switches to its low impedance state. Once the silicon controlled rectifier switches to its low impedance state, the potential developed across resistor 102 is applied through resistor 116 to charge capacitor 118.

It can be seen from the foregoing that when the first variable of the series becomes abnormal, the lamp module associated with the variable will provide a flashing light indication and the horn 114 will sound continuously.

When additional variables become abnormal, silicon controlled rectifier 24 of the lamp module associated with the variable will be switched to its low impedance state due to charging of capacitor 18 as described above. However, since capacitor 118 is charged, the positive going pulse produced when juncture point 52 becomes positive is applied through resistor 60 and diode 62 to the gate electrode of silicon controlled rectifier 46, causing silicon controlled rectifier 46 to switch to its low impedance state. Juncture point 40 thereafter will be connected to ground through diode 44 and silicon controlled rectifier 46, causing the lamp 26 of variables which become abnormal subsequent to the first of the series to be energized steadily. It can thus be seen that when any one of the variables becomes abnormal, the associated lamp module will provide an indication expressed by the energization of its lamp. However, only the lamp module associated with the variable which first becomes abnormal will produce a flashing indication.

When the acknowledge switch 110 is operated, terminal C will no longer be connected to terminal D. The supply voltage potential will be removed from the anode of silicon controlled rectifier 112 and the flow of current through the device will cease momentarily. Upon this occurrence, the silicon controlled rectifier 112 will return to its high impedance state. Also, when the acknowledge switch 110 is operated, terminal A will be shorted to terminal B, causing a positive signal to be applied to the gate of silicon controlled rectifier 46 through terminal G, resistor 66 and diode 64. Accordingly, silicon controlled rectifier 46 of the lamp module associated with the first variable to become abnormal will be switched from the normally high impedance state to the low impedance state, causing the indication displayed by the lamp module to change from a flashing indication to a steady indication.

Since the SCR 46 of all lamp modules associated with the abnormal variables will now be conducting, when the acknowledge switch 110 is released and returns to its initial position as shown in FIG. 1, there will not be a potential available to charge the capacitor to cause turn-on of the silicon controlled rectifier 112 when supply voltage is again applied to its anode. The capacitor 118 will discharge through resistor 116 and resistor 102 and the horn 114 will become deenergized. All of the lamp modules associated with variables which were abnormal prior to acknowledgement therefor provide the indication of a steady energization of their lamp and the horn will be

silenced. The next variable to become abnormal will provide a first-out indication and produce energization of the horn.

The system is reset by operation of the reset switch 22. When the reset switch 22 is operated, the supply voltage is no longer applied to the anode of silicon controlled rectifier 24 of any of the lamp modules and, accordingly, the silicon controlled rectifier 24 will return to its high impedance state. If the variable associated with the particular lamp module has returned to normal, potential will not be available for charging of the associated capacitor 18 and the lamp will remain off. It will be noted that with the particular connection as shown, the silicon controlled rectifier 112 will continue to conduct if the reset button is operated prior to the time that the acknowledge switch is operated. If the acknowledge switch is not operated the horn will continue to operate and capacitor 118 will remain charged even though the reset switch is operated. So long as the capacitor 118 is charged, the first-out indication of the flashing lamps will not be provided as another variable becomes abnormal subsequently. However, if terminals A and C of the acknowledge switch are connected to the supply voltage through the reset switch, all elements of the system will be deenergized when the reset switch is operated.

The circuit of FIG. 1 can be readily modified for operation in a sequence where the lamps of all abnormal points will flash and the audible alarm will be energized before acknowledgement with steady lamps and a silenced audible alarm after acknowledgement. This is accomplished by preventing the pulse produced when capacitor 54 differentiates the change of potential at juncture point 52 being applied to the gate of silicon controlled rectifier 46. This could suitably be accomplished by breaking the connection between capacitor 54 and juncture 52. If such a sequence is desired, it would not be necessary to provide capacitor 54 or 118, diodes 56 and 62 and resistors 58, 60 and 116. If such a change is made, the silicon controlled rectifier 46 will only be switched to its low impedance state responsive to operation of the acknowledge switch and, accordingly, all lamp modules which are associated with variables which become abnormal prior to actuation of the acknowledge switch will provide a flashing indication.

It will also be noted that the flashing indication can be obtained if resistor 28 is eliminated. Rather than flashing between dim and bright, the lamps will flash between energized and deenergized if resistor 28 is removed. It will be noted that if resistor 28 is removed, the resistor 20 provides a source of holding current for the silicon controlled rectifier 24 to prevent the silicon controlled rectifier 24 returning to its high impedance state when the anode of silicon controlled rectifier 88 of the flasher circuit rises to supply potential.

It will be noted that the indication provided by the annunciator described with reference to FIG. 1 is of the latching variety in which the indication provided in the event a variable becomes abnormal does not change if the variable subsequently returns to its normal state. Another common type of annunciator is those of the non-latching type in which indication will only persist during the time that the variable is abnormal, and if the variable returns to its normal condition the lamp module associated with the variable will also return to its normal state. Frequently, it is desirable that a ring-back type of operation be provided in which if subsequent to becoming abnormal the variable should return to its normal state, the indication provided by the lamp module associated with the variable will change to indicate that the variable has become normal and is not a present source of concern, but the operator will yet be made aware that a malfunction of some type had occurred.

The preferred embodiment of the invention providing ring-back operation is shown in FIGS. 2a and 2b of the drawings, the control circuitry being illustrated in FIG.

2a of the drawings and the lamp modules in FIG. 2b, except that the reset switch and the test switch which are a portion of the control circuitry are included in FIG. 2b.

The lamp modules 210 to be described with respect to the second preferred embodiment of the invention are quite similar to the lamp modules 10 shown in FIG. 1 of the drawings. Accordingly, the same reference characters have been applied to the same components whenever practical. It can be seen that the differences between the lamp module 210 and the lamp module 10 is that capacitor 55, resistors 58 and 60 and diodes 56 and 62 have been eliminated. In addition, the cathode of silicon controlled rectifier 46 is connected to the anode of the diode 214, whose cathode is connected to terminal H. Also, resistor 28 of lamp module 10 has been eliminated and instead juncture point 40 is connected to the anode of the silicon controlled rectifier 216 whose cathode is connected to terminal I. The gate electrode of silicon controlled rectifier 216 is connected to the cathode of a diode 218. The cathode of silicon controlled rectifier 46 is connected to the anode of a diode 224 whose cathode is connected to the anode of silicon controlled rectifier 216.

The reset switch 22 and test switch 28, which are a part of the control circuitry, are shown also in FIG. 2b of the drawings and it can be seen that the connections between the test and reset switches and the lamp modules are the same as described with reference to FIG. 1. The remainder of the control circuitry as shown in FIG. 2a, is substantially different however. The control module, designated generally by the reference character 232 includes a flasher unit 82 identical in form to that described with reference to FIG. 1 of the drawings. The output of flasher unit 82 is taken from the anode of silicon controlled rectifier 88 and applied through line C to terminal E of each of the control modules, also described with reference to FIG. 1. The output of the flasher unit 82 is also connected through resistor 234 and diode 236 to ground. As mentioned earlier, the potential at the anode silicon controlled rectifier 88 will periodically vary between ground and the supply voltage potential at the frequency of the oscillator defined by the unijunction transistor 84.

Each time that the silicon controlled rectifier 88 is turned off, the anode will become more positive. This change in potential is differentiated by the capacitor 238 and applied through diode 240 and resistor 242 to the gate of silicon controlled rectifier 244. The pulse produced when capacitor 238 differentiates the change of voltage is also applied through diode 246 and capacitor 248 to the gate electrode of silicon controlled rectifier 250. The capacitor 248 is charged through a path comprising resistor 249, 251 and 253 when silicon controlled rectifier 244 is off, preventing the pulse being applied to the gate electrode of silicon controlled rectifier 250. Accordingly, silicon controlled rectifier 244 will turn on and silicon controlled rectifier 250 will remain off. When silicon controlled rectifier 244 turns on capacitor 248 will discharge. The next time an output pulse is received from the capacitor 238, the capacitor 248 will not be charged. The positive going pulse will only be applied to the gate of silicon controlled rectifier 250, causing silicon controlled rectifier 250 to turn on and resulting in silicon controlled rectifier 244 returning to its normal high impedance state. The output of the second flasher unit designated generally by the reference character 242, is taken from the anode of silicon controlled rectifier 250 and is applied through line E to terminal H of each of the lamp module 210. It will be noted that the flasher unit 232 operated at one-half the frequency as the flasher unit 82 since it is necessary to obtain two output pulses from the flasher 82 to produce one output pulse from flasher 232.

The third flasher unit designated generally by the reference character 260 comprises two silicon controlled recti-

fiers 262 and 264. The gate signal for silicon controlled rectifier 262 is derived from the anode of silicon controlled rectifier 250 of flasher unit 232 through diode 266 and resistor 268. Similarly, the gate electrode of silicon controlled rectifier 264 is connected through resistor 270 and diode 272 to the anode of silicon controlled rectifier 244. Silicon controlled rectifier 264 will therefore be biased on each time silicon controlled rectifier 244 is biased off and similarly silicon controlled rectifier 262 will be biased on each time that silicon controlled rectifier 250 is biased off. The flasher unit 260 will therefore operate at the same frequency as the flasher unit 252. The output of the flasher unit 260 is taken from the anode of silicon controlled rectifier 262 and is applied through line D to terminal I of each of the lamp modules 210.

The acknowledge switch 110 is connected as described with reference to the embodiment of FIG. 1. Thus, both the terminals A and C of switch 110 are connected through line D to the source of supply voltage. Terminal D of the acknowledge switch is connected to the anode of silicon controlled rectifier 112 whose cathode is connected through horn 114 to ground. Terminal B of the acknowledge switch is connected through line A to terminal G of each of the lamp modules. Operation of the acknowledge switch will therefore be effective to interrupt the anode cathode circuit of silicon controlled rectifier 112 and apply a gating signal to the gate of silicon controlled rectifier 46, as described with reference to FIG. 1. The gate of silicon controlled rectifier 112 is connected through switch diode 120, resistor 274 and line B to terminal F of each of the lamp modules 210. The juncture between resistor 274 and switching diode 120 is connected through capacitor 100 to the cathode of silicon controlled rectifier 112, as described previously.

The operation of the circuitry shown in FIGS. 2a and 2b will now be described in detail. Upon one of the field contacts being operated responsive to the associated variable becoming abnormal, the supply voltage will be applied through terminal A, resistor 14, and diode 16 to charge capacitor 18 through a path including resistor 20. When capacitor 18 is charged to the breakover voltage of the switching diode 30, the switching diode 30 will switch to its low impedance state, permitting discharge of the capacitor 18 through the gate electrode of the silicon controlled rectifier 24, causing the silicon controlled rectifier to switch from its normally high impedance state to a low impedance state. When the silicon controlled rectifier 24 switches on, a path for holding current is provided through lamps 26 to ground. Ground is provided for the lamps 26 through three separate paths. One of the paths is through diode 42 to terminal E which is connected through line C to the anode of silicon controlled rectifier 88 of flasher circuit 82. The second path to ground for the lamps 26 is through silicon controlled rectifier 216 which is connected by its cathode to terminal I and then through line D to the anode of silicon controlled rectifier 262 of flasher unit 260. The third return path for lamps 26 is through diode 44, silicon controlled rectifier 46, diode 214 which is connected to terminal H and through line E to the anode of silicon controlled rectifier 250 of flasher unit 252. It can therefore be seen that the lamp 26 will be energized at either the flashing rate of the flasher unit 82 or the rate of one of the flasher units 232 and 260, or constantly depending upon connections within the control circuitry.

Silicon controlled rectifier 46 will initially be off and, accordingly, positive potential will be applied from the juncture between diode 48 and resistor 50 through diode 70 and terminal F through line B to the gate electrode of silicon controlled rectifier 112. Silicon controlled rectifier 112 will accordingly switch from its high impedance state to its low impedance state, permitting current to flow through horn 144 and produce an audible indication that one of the variables has become abnormal.

At the time the field contact closes, current will also flow through resistor 14 to charge capacitor 217 which is connected between resistor 14 and ground. When the charge on capacitor 217 becomes sufficiently high, gate current will be applied to the gate electrode of silicon controlled rectifier 216 through diode 218, causing silicon controlled rectifier 216 to switch from its normal high impedance state to its low impedance state. It will be noted that silicon controlled rectifier 216 cannot be switched to its low impedance state until subsequent to the time silicon controlled rectifier 24 switches to its low impedance state as anode voltage is applied to silicon controlled rectifier 216 from the cathode of silicon controlled rectifier 24.

When silicon controlled rectifier 216 switches to its low impedance state, current flows through terminal I and line D to ground through silicon controlled rectifier 262 of flasher 260 whenever silicon controlled rectifier 262 is in the low impedance state. It will be noted that capacitor 217 will be charged only when supply voltage potential is applied to the cathode of silicon controlled rectifier 216 and will discharge, applying gate current to silicon controlled rectifier 216 such that it will turn on each time that silicon controlled rectifier 262 is in its low impedance state. It will therefore be seen that when the variable first becomes abnormal that ground will be provided to the lamps 26 through both the flasher unit 82 and the flasher unit 260.

Turning now to FIG. 3 of the drawings, there is shown curves A, B and C which illustrate wave forms appearing at the outputs of the flasher units 82, 232 and 260, respectively. With reference to the curves, it can be seen that when the variable first becomes energized, the lamps would be lit from time T-0 to time T-3. The lamps will be deenergized from time T-3 to time T-4. The lamps will then be energized from time T-4 to time T-7. This cycle would be repeated with the lamps flashing on and off at the frequency of the flasher unit 260 but with duty cycle such that the lamps will be on three times as long as they will be off. If the lamp is only energized by flasher 82, the lamps will flash on and off at a frequency of flasher unit 82. If the lamp 26 is energized through all three flasher units, the lamps will be on steadily and the flashing indication will not be provided.

As additional ones of the variables being monitored become abnormal, the lamp module associated with the respective variable will produce flashing indication and the horn will continue to sound. It will be noted that a first out indication is not provided. When the acknowledge switch 110 is operated, the flow of current through the anode cathode circuit of silicon controlled rectifier 112 will be interrupted, causing the silicon controlled rectifier to return to its normal high impedance state. Also, when the acknowledge switch 110 is actuated, a short is provided between terminals A and B thereof, applying a gating signal through line A to terminal G and thence through resistor 66 and diode 64 to the gate electrode of silicon controlled rectifier 46, causing silicon controlled rectifier 46 to switch from its normal high impedance state to its low impedance state. The silicon controlled rectifier 46 will, of course, remain in its low impedance state so long as holding current flows, through its anode cathode circuit. It will be noted that when silicon controlled rectifier 46 switches to the low impedance state, gating current will no longer be applied to silicon controlled rectifier 112 and, accordingly, silicon controlled rectifier 112 which control operation of the horn 114 will not be gated to the low impedance state when the acknowledge button is released, providing that silicon controlled rectifier 46 remains in its low impedance state until the potential is removed from juncture point 32, indicating that the variable has again become normal.

As described previously, the cathode of silicon controlled rectifier 216 is connected to ground through silicon controlled rectifier 262 of flasher circuit 260.

Reference to curves B and C of FIG. 4 shows that one of the silicon controlled rectifiers 250 and 262 will always be connected to ground. Silicon controlled rectifier 46 will be maintained in its low impedance state, preventing the horn circuit being energized and causing the lamp 26 to be steadily energized, since it is connected to ground through both a circuit comprising line E and silicon controlled rectifier 250 and a circuit comprising diode 224, silicon controlled rectifier 216, line I and silicon controlled rectifier 262. It will be noted that after acknowledgement, the lamps will be receiving ground through all three of the flasher units, and that the primary source for ground would be through rectifier 44 and silicon controlled rectifier 46.

If a variable associated with one of the lamp modules becomes normal subsequent to the operation of the acknowledgement switch 110, potential will no longer be applied from resistor 14 to juncture point 32 or to the gate electrode of silicon controlled rectifier 216. Silicon controlled rectifier 46 will return to its normal high impedance state when silicon controlled rectifier 216 next turns on. Also, since the gate current will no longer be applied to silicon controlled rectifier 216, silicon controlled rectifier 216 will return to its high impedance state during the next cycle of flasher unit 260. Ground will be provided for the lamps 26 only through flasher unit A and the lamp will flash at the frequency of the flasher unit 82.

To reset the system and remove indications from all lamp modules associated with variables which are not abnormal, the reset switch 22 is operated. When this occurs, the anode cathode circuit of silicon controlled rectifier 24 will be interrupted. Potential will no longer be applied from resistor 14 to the various components of the various lamp modules and all of the active elements in the system will momentarily be cut off. Upon release of the reset switch, only the flasher units 82, 232 and 260 will be operative.

It can therefore be seen that four indications are provided by the second embodiment of the annunciator system of the present invention. The first indication is that in which lamp 26 will not be energized, indicating that the variable is normal. The second indication is that of a lamp which flashes slowly, indicating that the variable has become abnormal. The third indication is that provided when the lamp is energized steadily, indicating the variable is abnormal but that the presence of the abnormal condition has been acknowledged. The fourth indication is that provided when the lamps flash at a more rapid rate, indicating that the variable has become normal and that the existence of the abnormality of the variable was acknowledged.

Having thus described the invention in its best embodiment and mode of operation, that which is desired to be claimed by Letters Patent is:

1. An annunciator system for indicating the conduction state of each of an interrelated group of monitoring means each having conducting and nonconducting states, including:

- an indicator means comprising a single lamp circuit for each of said monitoring means and forming a primary circuit therewith, each of said lamp circuits providing a flashing visual indication of a change in the state of conduction of its associated monitoring means;
- a power supply connected in common to said primary circuits for continuously supplying potential to each of said circuits;
- a first switching means connected in each of said primary circuits between said indicator means and its associated monitoring means for energizing said indicator means in response to a change in the state of conduction of the associated monitoring means, said first switching means having a high impedance level to a current flowing therethrough in a first

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direction in the absence of a control signal applied to said switching means and having a low impedance level to said current flowing therethrough following a momentary application of said control signal thereto, said low impedance level continuing so long as said current continues to flow uninterruptedly therethrough but reverting to said high impedance level following momentary interruption of such current by manually operable reset means connected in common with said primary circuits;

- a charging network connected in each of said circuits between said first switching means and monitoring means for producing and applying said control signal to said first switching means in response to a change in the state of conduction of the associated monitoring means, said charging network being substantially insensitive to stray voltages thereby preventing inadvertent operation of said indicator means; and
- a continuously energized flasher network connected in common to all of said primary circuits for enabling said lamp circuits to provide said flashing indication.

2. The annunciator of claim 1 wherein said charging network includes a capacitor connected for charging in response to a change in the state of conduction of the associated monitoring means and said first switching means includes a bistable switching means for discharging said capacitor into said first switching means to control said impedance levels thereof.

3. The annunciator of claim 1, and in addition:

- a secondary circuit connected in common with said primary circuits between a manually operable acknowledgement means and ground including a second switching means and an audible alarm means, said secondary switching means being responsive to a change to a low impedance level of said first switching means for directing current through said secondary circuit for activating said audible alarm means, said current flow through said secondary circuit being interrupted by operation of said acknowledgement means for deactivating said audible alarm means.

4. An annunciator system for indicating the conduction state of each of an interrelated group of monitoring means each having conducting and nonconducting states and adapted for a first-out mode of operation wherein an indicator means associated with the first of said group of monitoring means to change its state of conduction provides a flashing visual indication of such first change and the indicator means associated with any other monitoring means changing its state of conduction subsequent to said first change provides a steady visual indication, including:

- an indicator means for each of said monitoring means and forming a primary circuit therewith, each indicator means providing a visual indication of a change in the state of conduction of its associated monitoring means;

- a power supply connected in common to said primary circuits for continuously supply potential to each of said circuits;

- a first switching means connected in each of said primary circuits between said indicator means and its associated monitoring means for energizing said indicator means in response to a change in the state of conduction of the associated monitoring means, said first switching means having a high impedance level to a current flowing therethrough in a first direction in the absence of a control signal applied to said switching means and having a low impedance level to said current flowing therethrough following a momentary application of said control signal thereto, said low impedance level continuing so long as said current continues to flow uninterruptedly therethrough but reverting to said high impedance level following momentary interruption of such current by

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manually operable reset means connected in common with said primary circuits; and

- a charging network connected in each of said circuits between said first switching means and said monitoring means for producing and applying said control signal to said first switching means in response to a change in the state of conduction of the associated monitoring means, said charging network being substantially insensitive to stray voltages thereby preventing inadvertent operation of said indicator means; first and second current paths connected in parallel between each of said indicator means and ground, said first current path including a flasher network connected in common to all of said indicator means for enabling the indicator means to provide said flashing visual indication,

- said second current path including a second switching means for each of said indicator means for enabling the indicator means to provide said steady visual indication; and

- a selection network for each of said primary circuits responsive to a change in potential between said first switching means and said indicator means for directing current flowing from said indicator means to said first current path in response to said first change and for directing current flowing from said indicator means to said second current path in a response to a change in conduction of another of said monitoring means occurring subsequent to said first change, for providing said first out mode of operation.

5. The annunciator of claim 4 further adapted for an acknowledge mode of operation wherein said selection network is provided with means for manually changing said flashing visual indication to a steady visual indication thereby enabling said annunciator system to indicate a first change in conduction of another monitoring means occurring subsequent to said manual change, including:

- manually operable acknowledge means connected in common to said primary circuits for applying a first acknowledge control signal to said second switching means in said second current path that is then operating in response to a said first change in conduction for directing the current flowing through said first current path to said second current path thereby causing the associated indicator means to provide a steady visual indication; and

- a third current path between said acknowledge means and ground which includes a third switching means in series with an impedance so that an interruption of a current flowing through said third path by said acknowledge means enables said first current path to receive a current in response to a first change in conduction of another monitoring means occurring subsequent to the operation of said acknowledge means.

6. The annunciator of claim 5, and in addition, an audible alarm means responsive to said third switching means when said third switching means responds to a first change in impedance level of said first switching means, said audible alarm means being rendered inoperative by operation of said acknowledge means.

7. An annunciator system for indicating the conduction state of each of an interrelated group of monitoring means each having conducting and nonconducting states and adapted for a ring-back mode of operation wherein an indicator means associated with each of said monitoring means provides a flashing visual indication at a first rate in response to a change in the state of conduction of its associated monitoring means and provides a steady visual indication if said monitoring means remains in said changed state following manual operation of an acknowledgement means and provides a flashing visual indication at a second rate if said monitoring means has reverted to its first state of conduction, including:

- an indicator means for each of said monitoring means and forming a primary circuit therewith, each in-

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indicator means providing a visual indication of a change in the state of conduction of its associated monitoring means;

a power supply connected in common to said primary circuits for continuously supplying potential to each of said circuits; 5

a first switching means connected in each of said primary circuits between said indicator means and its associated monitoring means for energizing said indicator means in response to a change in the state of conduction of the associated monitoring means, 10

said first switching means having a high impedance level to a current flowing therethrough in a first direction in the absence of a control signal applied to said switching means and having a low impedance level to said current flowing therethrough following a momentary application of said control signal thereto, 15

said low impedance level continuing so long as said current continues to flow uninterruptedly there-through but reverting to said high impedance level following momentary interruption of such current by manually operable reset means connected in common with said primary circuits; and 20

a charging network connected in each of said circuits between said first switching means and said monitoring means for producing and applying said control signal to said first switching means in response to a change in the state of conduction of the associated monitoring means, said charging network being substantially insensitive to stray voltages thereby preventing inadvertent operation of said indicator means; 25

first, second, and third current paths connected in parallel between each of said indicating means and ground, 30

said first current path including a first flasher network operating at a first frequency, 35

said second current path including a second flasher network operating at a second frequency that is one-half the frequency of said first network and a second switching means, 40

said third current path including a third flasher network operating at a third frequency that is the same as said second frequency and a third switching means, 45

said second switching means being responsive to a change in said impedance level of said first switching means thereby permitting current to flow from said indicating means through said second current path to said second flasher means and through said first current path to said first flasher means in response to a change in said impedance level of said first switch- 50

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ing means thereby establishing said first rate of flashing visual indication by said indicator means, said first rate comprising the superimposition of said first and second frequencies;

a manually operable acknowledgement means connected in common between said power supply and all of said third switching means for causing said third current path to conduct current from said indicating means to said third flasher network concurrently with conduction of current through said first and second current paths thereby superimposing said first, second, and third flashing frequencies thereby establishing said steady visual indication by said indicating means if the conduction state of said monitoring means is still in its changed state at the time said acknowledgement means is operated; and

said second and third switching means being responsive to a change in conduction caused by said monitoring means reverting to its first state of conduction following manual operation of said acknowledgement means thereby permitting current to flow from said indicating means through said first current path to said first flasher network thereby establishing said second rate of flashing visual indication by said indicator means which comprises only said first frequency.

8. The annunciator system of claim 7 and in addition: a fourth current path connected between said manually operable acknowledgement means and ground including a fourth switching means and an audible alarm means, said fourth switching means being responsive to a change in the conduction level of said monitoring means for permitting current to flow through said fourth current path thereby activating said audible alarm means, said current flow through said fourth current path being interrupted by operation of said acknowledgement means for deactivating said audible alarm means.

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