Nov. 22, 1966 M. KRAUS 3,287,717

STATIC ANNUNCIATOR WITH ACKNOWLEDGMENT AND RING BACK

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FIG. 3.

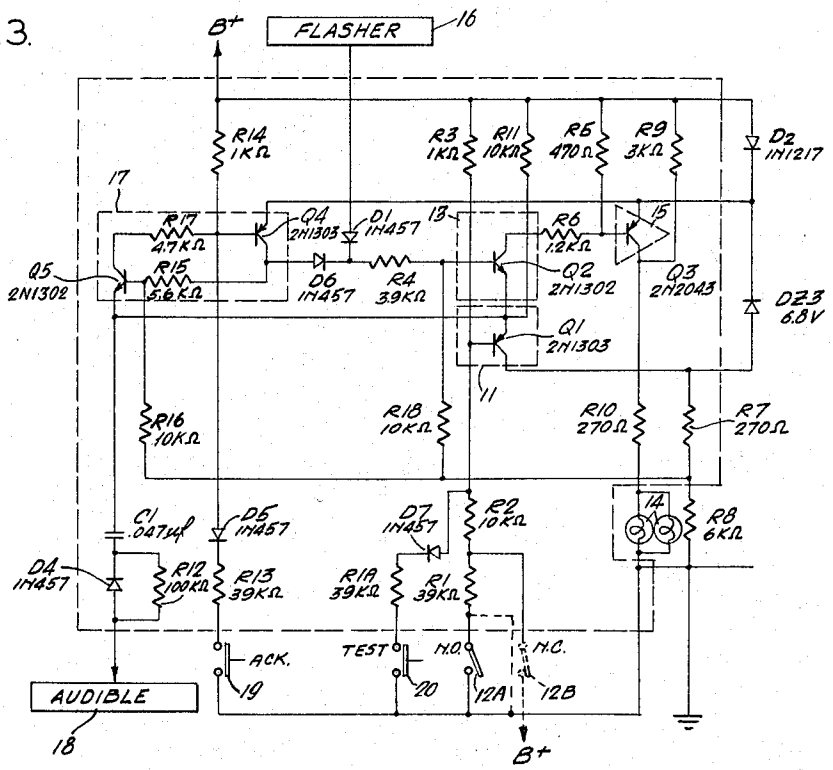
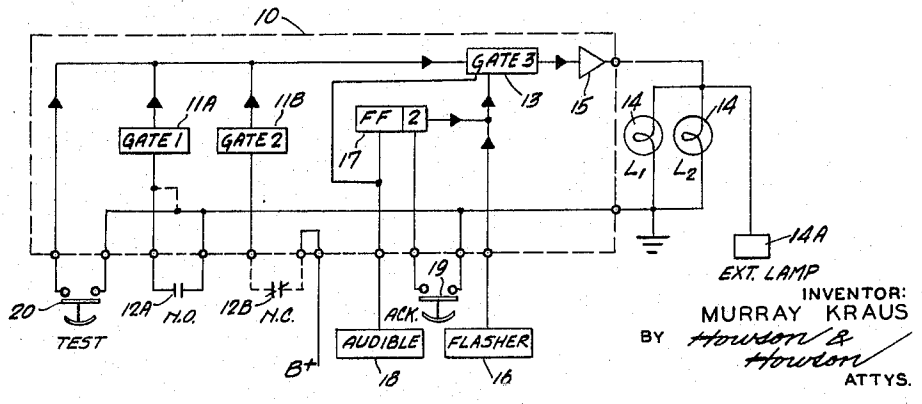


FIG. 2.

	NORMAL	ALERT	NORMAL BEFORE ACK.	ACK.	RETURN TO NORMAL	RESET	TEST
LAMP	OFF	FLASH	OFF	BRIGHT	OFF	——	FLASH
AUDIBLE	OFF	ON	ON	OFF	OFF	——	ON / OFF
N.O. CONTACT	OPEN	CLOSED	OPEN	CLOSED	OPEN	——	OPEN
N.C. CONTACT	CLOSED	OPEN	CLOSED	OPEN	CLOSED	——	CLOSED

FIG. 1.



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FIG. 6.

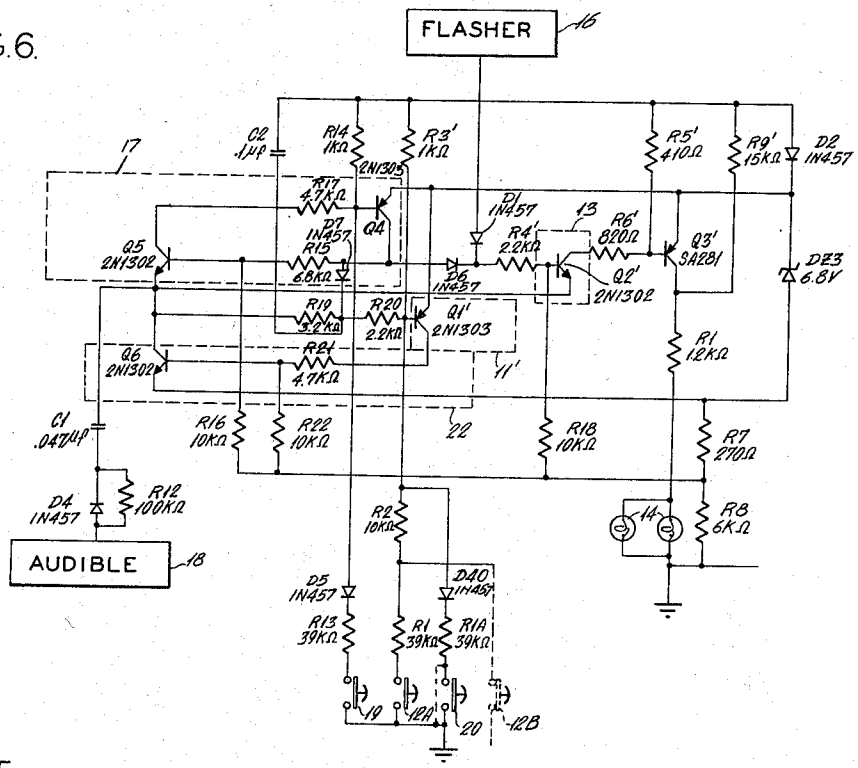
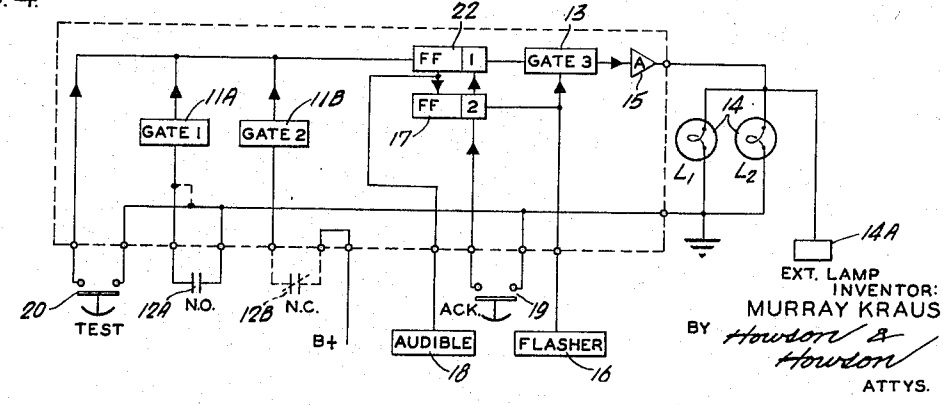


FIG. 5.

	NORMAL	ALERT	NORMAL BEFORE ACK.	ACK.	RETURN TO NORMAL	RESET	TEST
LAMP	OFF	FLASH	FLASH	BRIGHT	OFF	—	FLASH
AUDIBLE	OFF	ON	ON	OFF	OFF	—	ON / OFF
N.O. CONTACT	OPEN	CLOSED	OPEN	CLOSED	OPEN	—	OPEN
N.C. CONTACT	CLOSED	OPEN	CLOSED	OPEN	CLOSED	—	CLOSED

FIG. 4.



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FIG.8.

	NORMAL	ALERT	NORMAL BEFORE ACK.	ACK.	RETURN TO NORMAL	RESET	TEST
LAMP	OFF	FLASH	FLASH	BRIGHT	BRIGHT	OFF	FLASH
AUDIBLE	OFF	ON	ON	OFF	OFF	OFF	ON / OFF
N.O. CONTACT	OPEN	CLOSED	OPEN	CLOSED	OPEN	OPEN	OPEN
N.C. CONTACT	CLOSED	OPEN	CLOSED	OPEN	CLOSED	CLOSED	CLOSED

FIG.7.

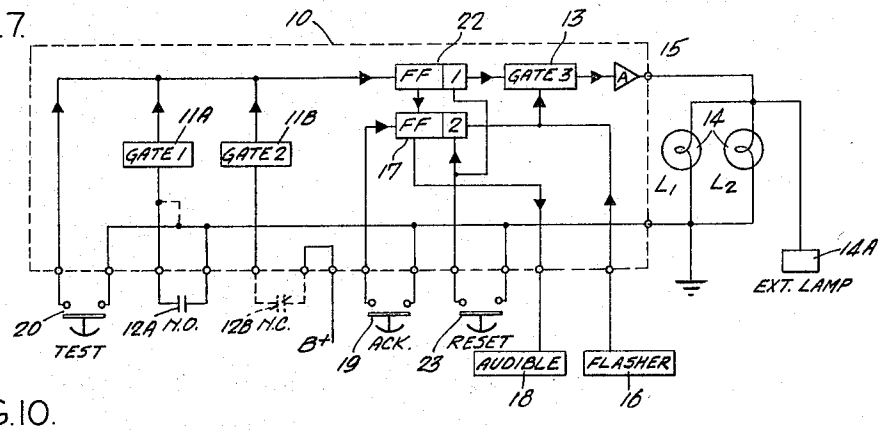
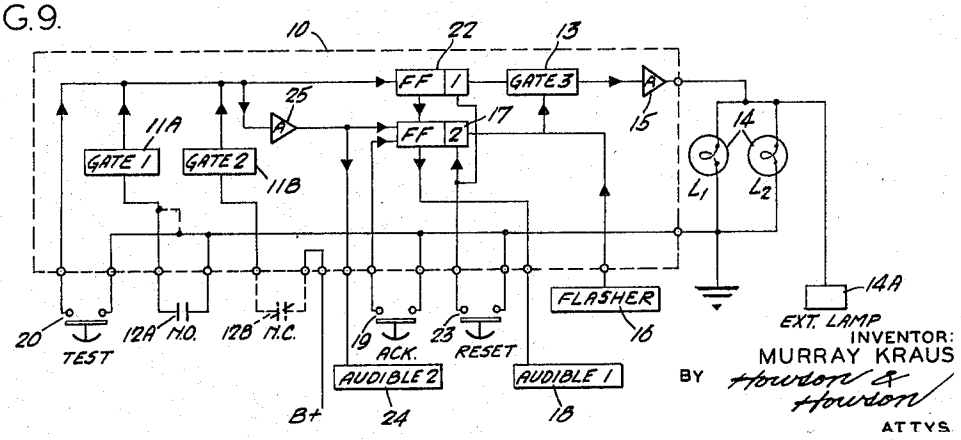


FIG.10.

	NORMAL	ALERT	NORMAL BEFORE ACK.	ACK.	RETURN TO NORMAL	RESET	TEST
LAMP	OFF	FLASH	FLASH	BRIGHT	FLASH	OFF	FLASH
AUDIBLE 1	OFF	ON	ON	OFF	OFF	OFF	ON/OFF
AUDIBLE 2	OFF	OFF	ON	OFF	ON	OFF	OFF/ON
N.O. CONTACT	OPEN	CLOSED	OPEN	CLOSED	OPEN	OPEN	OPEN
N.C. CONTACT	CLOSED	OPEN	CLOSED	OPEN	CLOSED	CLOSED	CLOSED

FIG.9.



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FIG. 14.

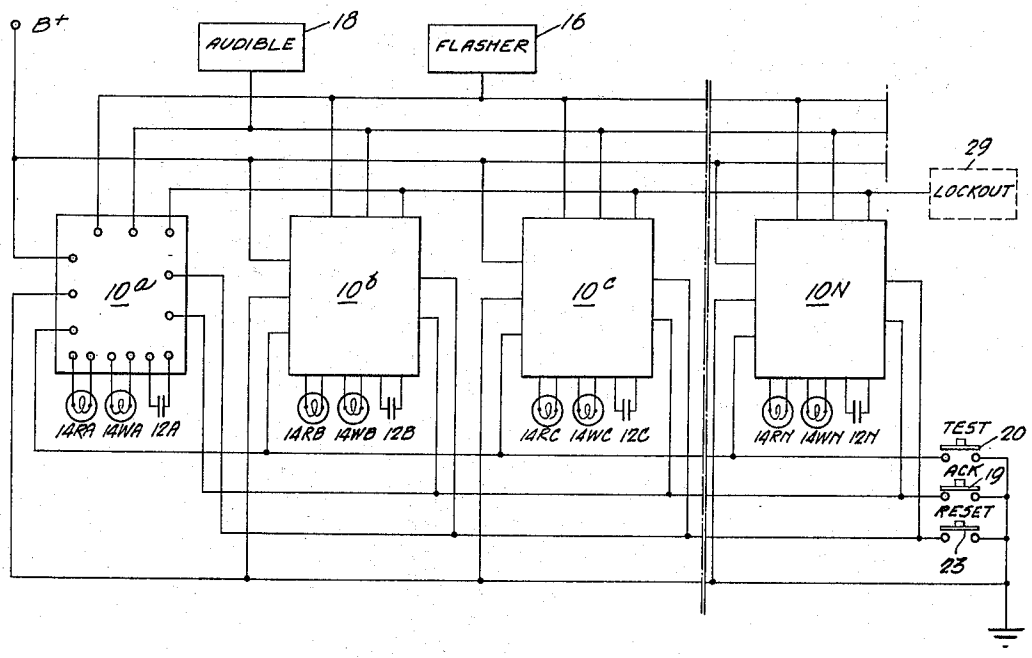
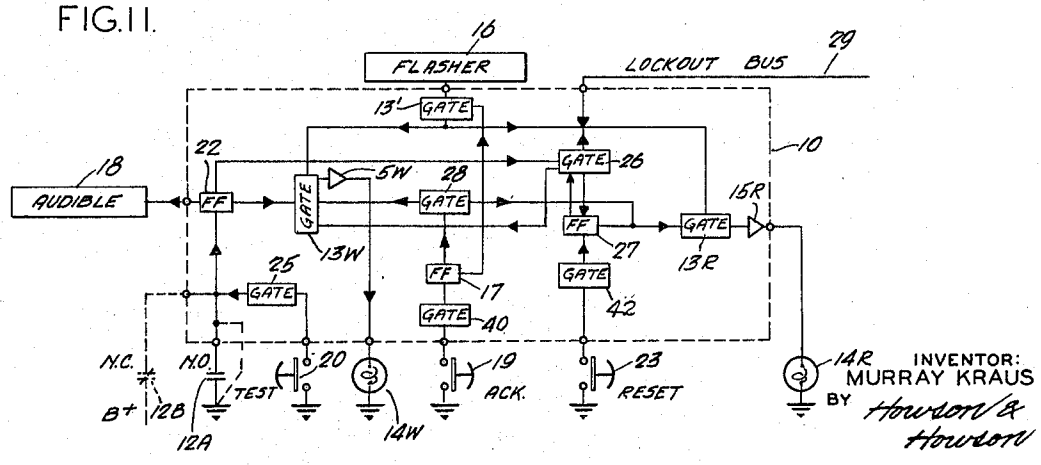


FIG. 12.

	NORMAL	ALERT	ACK.	RETURN TO NORMAL	RESET	TEST
1 ALARM LAMP	OFF	RED FLASH	RED BRIGHT	RED BRIGHT	OFF	RED FLASH
SUBSEQ. LAMP	OFF	WHITE FLASH	WHITE BRIGHT	OFF	OFF	WHITE BRIGHT
AUDIBLE	OFF	ON	OFF	OFF	OFF	OFF/ON

FIG. 11.

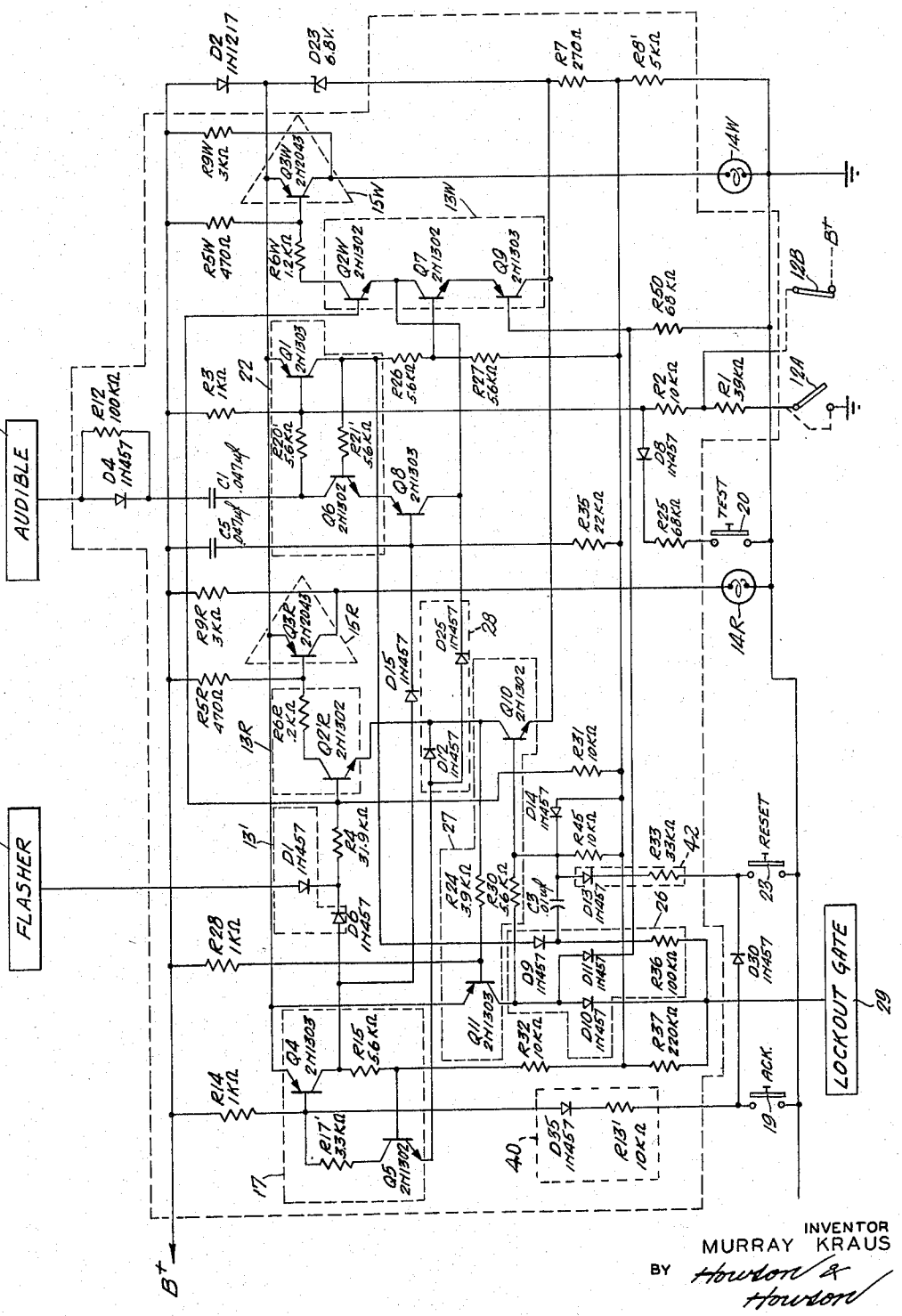


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FIG. 13.



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STATIC ANNUNCIATOR WITH ACKNOWLEDGMENT AND RING BACK

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Filed July 30, 1962, Ser. No. 213,277
13 Claims. (Cl. 340—213)

This invention relates to an annunciator system and individual points therein each of which is responsive to the condition of a sensing means in the form of switch contacts at the monitored point or location and each of which has at least one lamp to indicate the normal condition of the contacts in one state of the lamp and an alert condition of the contacts in the other state of the lamp. More specifically, the invention relates to the system and circuitry of an annunciator point of extreme simplicity lending itself to small module, transistorized construction and at the same time extremely low cost. This annunciator point is capable of a multitude of variations to accomplish different results and effects and is capable of using either normally open and normally closed contacts as the sensing means.

Annunciators have been used for years to indicate quickly the location of trouble at one or more remote locations by observation at a central monitoring point, usually a panel board with lamps identifying various locations monitored. The remote points or locations are trouble sensitive regions of the devices monitored which are provided with sensing means usually a transducer including a switch with either normally closed or normally open contacts which change state in response to the changes in the such sensed conditions as pressure, temerature, mechanical movement, etc.

Use of annunicators has been limited for the most part to installations employing expensive capital equipment, such as power plants or chemical processing plants where the extremely heavy investment in machinery and equipment has justified a substantial expenditure for annunciator equipment. Furthermore, annunciator equipment has been relatively large and bulky particularly in the complex relay circuits and equipment which have been employed. Some attempts have been made to reduce the size and bulk of the equipment, but commercial systems by and large remain bulky, complex, expensive and difficult to install and maintain.

The present invention relates to an annunciator system which has been developed to use transistors and other semi-conductor devices and other small components and which adapts itself to use of printed circuit boards of small size, i.e., a board with its components having a thickness usually less than an inch and other dimensions on the order of several inches. Moreover, the present invention lends itself to a modular construction whereby one such printed circuit board supplies all the switching and control electronics required for one, two, three or four points of an annunciator system. Similar printed circuit modules may be provided for circuitry for other system functions such as the flasher, the power supply (B+), and audible control circuits. Simple plug in connections connect the modules and in some cases instead of being placed on their individual cards, several modules may be combined on one card. It should be understood that many annunciator point modules can employ the same flasher, the same power supply, the same audible, and other circuits. Each point will, of course, require its own indicator light or lights and sensing means, but all points in a group may share common acknowledgement, reset, and test switches which are preferably manually actuated push buttons.

The annunciator point modules of the present invention have the great advantage of versatility in type of performance to be attained as well as conditions under which a specific type of performance is to be obtained. The circuitry employed is stable over wide ranges of temperature despite the known temperature sensitivity of transistors. The voltages employed with a given module may vary through wide ranges of D.C. and over a fairly substantial range of 60 cycle A.C. Not only are the printed circuit modules small and convenient to handle cards but they are inexpensive to manufacture so that they may be discarded if they become defective in use and a new card easily substituted particularly where employed with plug-in type circuitry. Use with plug-in circuitry is facilitated by arrangement of their terminals in standard locations along the edge of a card. Standard locations may even be used with various types of points so that the user has a choice of sequence of operation in a given location. Moreover, a standard annunciator point module according to the present invention provides the option of normally open or normally closed contacts by a simple circuit change involving use of a jumper connection.

The various point modules for achieving different sequences are derived from a basic point module which employs a gate responsive to sensing contacts to permit a lamp to change its condition. This gate is controlled by a flasher which causes the lamp to flash upon receiving a signal from the sensing means. Acknowledgment means, including a flip-flop and a manually controlled switch, is so arranged that actuation of the switch changes the state of the flip-flop which is connected to the gate in such a way as to overcome the effect of the flasher and cause a steady acknowledged alert condition of the lamp following acknowledgment.

Upon this simple basic circuit are built many variations of annunciator combinations including those involving one lamp or more than one lamp. For example, some points retain an alert signal after normal condition of the monitoring device has allowed the sensing means to return to normal while others do not. Means for resetting the device is necessitated by retention of an alert signal even after the sensing switch returns to normal. Two or more lamps in combination in a single point employing a group of interdependent annunciator points enable, for example, a system in which the first point to become abnormal lights one kind of lamp whereas the next lights another kind.

For a better understanding of the present invention, reference is made to the accompanying drawings, in which:

FIG. 1 is a block diagram showing alternative sensing means connections in the basic circuit of the annunciator point of the present invention;

FIG. 2 is a chart of the sequence of operation of the circuit of FIG. 1;

FIG. 3 is a circuit diagram of a preferred form of the circuit of FIG. 1;

FIG. 4 is a block diagram of a modified type annunciator circuit;

FIG. 5 is a sequence chart applying to the circuit of FIG. 4;

FIG. 6 is a circuit diagram showing a preferred form of the circuit of FIG. 4;

FIG. 7 is a block diagram of still another annunciator point modification;

FIG. 8 is a sequence chart for the annunciator point of FIG. 7;

FIG. 9 is a block diagram of still another annunciator point modification;

FIG. 10 is a sequence chart for the annunciator point of FIG. 9;

FIG. 11 is a block diagram of a still further modified annunciator point circuit;

FIG. 12 is a sequence chart for the annunciator point of FIG. 11;

FIG. 13 is a circuit diagram of a preferred embodiment of the circuit of FIG. 11; and

FIG. 14 is a representative block diagram showing various possible connections for an annunciator system group employing multiple annunciator point modules.

Referring first to FIG. 1, there is shown the annunciator point module of the basic tube in accordance with the present invention. The annunciator point module itself is that part of the circuitry within the dashed line **10** and this circuitry including the various circuit elements are included as an integral module on the printed circuit board. The annunciator module includes an input gate **11A** or **11B**, which in some cases is omitted or combined with a flip-flop or other circuitry. The sensing means **12A** or **12B** are external of the circuit board and connected to the gates **11A** and **11B**, respectively. As indicated by the dashed lines in connection with sensing means **12B**, only one of the sensing means is employed and the other is omitted. Sensing means **12A** is a switch in the region to be monitored consisting of normally open contacts which are closed on occurence of the alert condition to be monitored. Alternatively, normally closed contacts **12B**, which are opened by occurrence of the alert condition, may be employed. In preferred embodiments instead of employing separate gates **11A** or **11B**, a minor circuit modification permits the use of the same active element as the gate in either case. The signal from gate **11A** or gate **11B**, whichever is used in a particular case, is fed to the signal terminal of gate **13**, whose output is connected to lamp indicator **14**, here shown as two lights of the same type in parallel. Additionally an extension light **14***a* at some location remote from the annunciator panel board may be employed. It is frequently desirable to employ an amplifier **15** between the lamp or lamps **14** and gate **13**. Connected to the control terminal of gate **13** is flasher unit **16** which provides a signal which causes the gate **13** to alternately open and close, thereby causing the lamps **14** to flash on and off alternately. The input signal from gate **11A** or gate **11B** also causes flip-flop **17** to assume one of its stable states and causes the audible circuitry **18** to be energized to produce an audible sound from a horn, buzzer or other audible device. When an observer on the premises sees a flashing light of lamp **14** or hears the audible sound, by pushing the acknowledgment button to close the acknowledgment switch **19** he produces a pulse which causes flip-flop **17** to change its state and provide a continuous signal to the control terminal of gate **13**. The steady signal overcomes the flasher and causes the gate to assume a state which is ordinarily conductive. This also causes the lamps **14** to assume their acknowledged alert condition which ordinarily is lit to give a steady bright light.

The sequence of operation just described is tabulated in the chart of FIG. 2. It will be observed that this sequence requires no reset because in the event that the sensing means returns to normal either before or following acknowledgment the lamp will return to its normal condition, which in the ordinary system is off.

A test switch **20** is provided to test the operability of the circuit and to make sure lights are not burned out. When the test switch is closed, the same conditions obtain as when sensing means switch contacts **12A** or **12B** are energized so that the lamp **14** is flashed.

A preferred circuit for the module shown in FIG. 1 and having the sequence of FIG. 2 is shown in FIG. 3. Referring to FIG. 3, the same gate **11** serves whether for normally open or closed contacts so that separate gates **11A** and **11B** as shown as possibilities in FIG. 1 are not necessary. If normally open contacts **12A** are employed, when they are closed, they complete a circuit from B+ to ground through resistors R1', R2' and R3' which pulls the base of PNP transistor Q1 negative from the B+, which it assumed through its connection to resistor R3', thereby rendering it conductive. On the other hand, if normally closed contacts **12B** are employed, B+ is connected through these contacts to the junction of resistors R1 and R2 so that the base of transistor Q1 is maintained positive. In this situation the contact for the terminal for the normally open contact is jumpered to ground (as shown in dashed lines) so that the full voltage drop of B+ to ground appears across resistor R1. Then when normally closed contacts **12B** open, the same potential distribution appears as in the situation of the opening of the normally open contact, the base of transistor Q1 is pulled negative and causes the transistor to conduct. It will be appreciated that use of contacts **12A** and **12B** at the same time is inconsistent so that the choice of one is made, the other is eliminated and the circuit adjusted accordingly before use. When transistor Q1 is rendered conductive by actuation of the sensing means it effectively applies a signal to the emitter terminal of transistor Q2' which serves as gate **13** leaving it to act as the switch or relay for energizing the lamps **14**. The base of transistor Q2 which serves as the control electrode for the gate **13** is connected through coupling resistor R4 and diode D1 to the flasher **16**. The flasher supplies alternating positive and negative pulses to the base of transistor Q2, thereby periodically rendering that NPN transistor conductive when pulsed positive. The conduction path from B+ to ground includes resistors R5 and R6, transistors Q2 and Q1 and resistors R7 and R8. This conduction lowers the potential on base of PNP transistor Q3 which acts as an amplifier of any signal through transistor Q2 and therefore causes lamps **14** to flash alternately on and off. Since the lamps are in a circuit, the current can then flow from B+ through diode D2, transistor Q3, resistor R10 and the lamps to ground. Zener diode DZ3 and diode D2 are preferably outside the printed circuit board and may serve in common for all points in the same group with this one. These diodes function as voltage-dropping devices to provide voltage somewhat lower than B+ in two stages.

It will also be observed that the emitter of transistor Q1 is connected through capacitor C1, diode D4 and resistor R12 to the audible module **18** so that, upon rendering gate **11** conductive by actuation of switch **12A** or **12B**, as the case may be, a negative pulse is produced which passes through the circuit elements described to trigger a flip-flop or like device in the audible module circuit.

When the acknowledgement push button is closed, separate contacts not shown but associated with switch **19** as another pole interrupt the audible. In addition, a negative pulse occurs through resistor R13 and diode D5 to the base of transistor Q4 which has previously been biased positively through resistor R14 to B+. This negative pulse causes transistor Q4 to conduct in a path including diode D2, transistor Q4, resistors R15, R16 and resistor R8 to ground. This flow drives the base of transistor Q5 positive rendering the NPN transistor conductive from B+ through resistors R14 and R17 to transistor Q5 and thence through transistor Q1 and resistors R7 and R8 to ground. This flow maintains the necessary negative bias on PNP transistor Q4 to keep it conducting so that in this way flip-flop **17** achieves a stable state. In this stable state, a positive potential applied through diode D6 back biases diode D1 and places a continuous positive potential on transistor Q2 sufficient to make it continuously conductive. As a consequence, the lamp **14** is lit steadily through the same circuit through which is previously flashed.

When the monitored point returns to normal, the sensing means **12A** or **12B** also returns to its normal condition, thereby causing a positive potential to be reimposed on the base of transistor Q1 cutting it off and

cutting off conduction to the gate **13** so that the lamps **14** are extinguished. At the same time, the conduction path from transistor Q5 is interrupted so that the interruption of current flow through transistor Q5 causes transistor Q4 to cut off thus placing the flip-flop back in its nonconducting state.

In order to test the circuit, test push button **20** is closed through resistor R1A similar to the resistor R1 and providing a similar circuit through diode D7 to that provided by the flow condition of the sensing means **12A** or **12B** so that a flashing condition is produced. Holding the test push button closed and pressing the acknowledge push button will close switch **19** permitting test of the flip-flop **17** and acknowledge circuitry.

It will be clear to those skilled in the art that some simplification in the circuit module is possible if the sensing means is always to be a normally open contact or always to be a normally closed contact. With a normally open contact, for example, the gate **11** can be eliminated and its function combined with gate **13** such that the contacts of the sensing means are in series with the collector and emitter of transistor Q3, for example, and these contacts provide the only current flow path to ground through the transistor. The circuit illustrated in FIG. 3 is preferred for general use, however, because of a versatility enabling change from normally open to normally closed contacts, or vice versa, as required in the field.

Referring next to FIG. 4, the block diagram shown has essentially the same elements as those of FIG. 1, and corresponding elements are designated by the same number designators. There is added, however, the flip-flop **22** which has an effect on flip-flop **17**, and in turn, is affected by flip-flop **17**. Flip-flop **22** is so located before gate **13** that as an alert condition is sensed by contacts **12A** or **12B** (whichever is employed) the signal will be first applied to the flip-flop **22** causing it to change state to a stable state which will be maintained even if the alert condition passes and the contacts return to normal. In such event, the flip-flop **22** causes the signal to be maintained on gate **13** and the light continues to burn until actuation of acknowledgement switch **19** which causes flip-flop **17** to change state as in the circuit of FIG. 1. This change, in turn, has the effect of placing flip-flop **22** into a condition whereby it maintains gate **13** only so long as a signal is imposed by the alert condition of the remote contacts. After acknowledgement, the contacts of the sensing means return to normal, the light of the lamps **14** will go out. This sequence is indicated on the sequence chart of FIG. 5. Details of a preferred embodiment of the circuit are shown in FIG. 6.

Referring to the circuit diagram of FIG. 6, the input gate **11'** has been combined with the first flip-flop **22**, transistor Q1', serving with transistor Q6 in this flip-flop circuit. Transistor Q6 is connected in circuit from the B+ power supply through resistors R3', R20, R19, transistor Q6 and resistors R7 and R8 to ground. Whereas minor circuit changes necessitate the change in resistor values, and in some cases changes in the type of transistor employed, in other respects the circuit except for the flip-flop **22** and its related circuitry are essentially the same. Here and elsewhere the same designator primed indicates the same kind of element in the same general function but of some different type or value. Thus, when an alert signal is imposed on the base of transistor Q1' causing it to conduct from B+ through diode D2, through transistor Q1', resistors R21, R22, and R8 to ground, a flip-flop action similar to that of flip-flop **17** is initiated for flip-flop **22**. The conduction raises the potential on the base of the NPN transistor Q6 causing it to conduct through resistors R3', R20 and R19, transistor Q6, and resistors R7 and R8 to ground. This current flow, in turn, lowers the potential on the base of PNP transistor Q1' maintaining its conduction.

When transistor Q6 is rendered conductive gate **13** and its transistor Q2' is able to transmit current through resistor R5', R6', transistor Q2, transistor Q6 and thence through resistors R7 and R8 to ground. Transistor Q3' again serves as an amplifier of signals applied to its base and when transistor Q2' is conductive it permits current flow which causes the lamp **14** to light. Since the flasher **16** applies an alternating positive and negative signal to the base transistor Q2' to turn it on and off, it produces flashing of the lamp **14** through control of transistor Q3'.

The negative pulse that trips flip-flop **22** actuates the audible module **18** in the same way that the audible is actuated in FIG. 3.

When the acknowledge push button is pushed closing switch **19**, flip-flop **17** is rendered conductive exactly in the manner described in connection with the similar flip-flop in FIG. 3, the diode **D1** is back biased by a constant positive signal through diode **D6** which causes transistor Q2' to conduct and thereby causes the lamp **14** to burn steadily exactly as it did in connection with the arrangement of FIG. 3.

The flip-flop **17** applies a positive potential to flip-flop **22** through diode D7 through transistor Q4 to the base of PNP transistor Q1'. When **12A** returns to normal flip-flop **22** will go out.

In testing, the test push button closes switch **20** causing Q1' to act exactly as it does in response to sensing means contacts **12A** or **12B**, whichever is used.

As will be readily appreciated by those skilled in the art, the basic circuit shown in FIG. 1 itself can be varied considerably in its effect and sequence of operation by relatively few changes. One example of such a modification is described in FIG. 4. Practical circuitry for each annunciator point circuit as shown in block diagrams can also vary greatly. FIGS. 3 and 6 have shown and described as preferred embodiments of practical circuitry of their respective cases and it will be apparent to those skilled in the art that many other variations are possible. Two other modifications to give different effects and sequences are shown in FIGS. **7** and **9** and a sequence chart showing the sequence of the operation of each of them is provided in FIGS. 8 and 10, respectively.

Referring to FIG. 7, it will be seen that the system of FIG. 4 has been modified so that flip-flop **17** in response to the actuation of acknowledgment button no longer returns flip-flop **22** to its initial state. Thus, in this embodiment of the present invention, not only does the flip-flop **22** hold the signal on the signal terminals of gate **13** when the sensing means returns to normal before acknowledgment but also when the sensing means returns to normal after acknowledgment, as can be seen in the sequence table of FIG. 8. In this annunciator point the returning to normal of the contacts **12A** or **12B** (whichever one is employed) even after acknowledgment, does not turn off the lamp **14**. The acknowledgment through flip-flop **17** back biases the flasher **16** and thus causes the lamps to burn steadily and it also preferably turns off the audible **18** through a separate pole on switch **19**. However, after the system returns to normal, it is necessary to reset the annunciator to normal condition by pressing the reset switch push button which returns flip-flops **17** and **22** to normal condition and allows the rest of the system to return to normal condition. The circuitry is not shown, but to accomplish this purpose, the circuitry of FIG. 6 is modified by omission of diode **D7**. The reset switch may be used to extinguish the flip-flops by applying the proper potential to cut off one of the pair of transistors in each case, as for example connecting the bases of transistors Q5 and Q6 to ground through a normally open reset switch.

Referring to FIG. 9, a still further modification is illustrated. The reset feature of FIG. 7 is present and the system operates generally as FIG. 7 does. This system, however, is so arranged that, upon return to normal, flip-

flop 17 will be reset in its original state thus removing the back bias from flasher 16 and permitting the flashing signal to be imposed on gate 13 through amplifier 15 to the lamps 14 causing them to flash. This is made possible by a conduction path feeding to flip-flop 17 through amplifier 25 of any signal which indicates a change in state. Thus, the opening of normally closed sensing means contacts 12B, if they are employed, or alternatively the closing of the normally open sensing means contacts 12A, whichever system is used, will produce a pulse through amplifier 25 to set the flip-flop 17 in its initial state. Rectifier means can limit the pulsing to the particular direction of the pulse involved when the return to normal from alert occurs and thereby prevent its action when the initial alert occurs. This makes it possible to use a separate audible module 24 in addition to audible 18 which in other respects, however, may be identical to audible module 18 but preferably makes a different sound. This audible module 24 is preferably triggered by a pulse and may be D.C. decoupled by amplifier 25 which, as previously noted, passes pulses. Just as audible 18 is provided with a separate set of contacts associated with the acknowledgment switch 19 to turn off that audible, so audible 24 may be provided with a pair of contacts interrupting its signal when actuating the reset means 23. The reset contacts at the same time set the annunciator point back to normal just as they do in the case of the annunciator point of FIG. 7. It will also be noted from the sequence of FIG. 10 that the audible 24 will sound at any time the sensing means returns to normal. Thus, even though the return to normal occurs during the flashing period of the lamps, the fact that it does return to normal may be ascertained by the energization of the second audible which as above noted is preferably of a different tone from the first audible.

It is possible to devise much more complex systems using the same basic circuitry. For example, it is possible to use lock-out techniques to obtain the alternative energization of lights of different colors, such as red and white lights, one to indicate the first in a series of alerts and the other to indicate subsequent alert signals. In the description which follows, the first alert will be represented by a red light whereas the second alert will be represented by a white light. Of course, any different colored lights or merely differences in locations or other differences than in color may be employed to distinguish the first from later alerts.

As can be seen in FIG. 11, the red light and the white light 14R and 14W, respectively, each have their own gate 13R and 13W and amplifier 15R and 15W, respectively. As in the other cases, either normally open or normally closed contacts can be employed as a sensing means using contacts 12A or contacts 12B. The gate feature, as in the FIGS. 4–6 embodiment and those following, is combined with flip-flop 22 which functions to hold the red light on in the event the sensing means returns to normal. Gate 22 also functions to actuate audible circuit 18. The test circuit employing test switch 20 is essentially the same as the circuits for sensing means except that gate 25 is employed in this line to flip-flop 22. The acknowledgment circuit is essentially the same as that used in other embodiments and employs a flip-flop actuated by pressing button closing acknowledgment contacts 19. The acknowledgment push button as indicated in connection with previous systems may be provided with a second set of contacts which interrupt the audible circuit 18. The reset switch 23 functions slightly differently as will be explained. The flasher 16 operates essentially as described in previous embodiment but is used for both lights. Gate 13' is the back biased diode arrangement described in the other embodiment. In addition, it is necessary to employ the necessary lock-out and sequencing circuitry which constitutes most of the balance of the system. Again, the whole circuit can be printed on a single card, represented by the circuitry within the dashed lines 10.

The circuit of FIG. 11 operates as follows. Upon the occurrence of an alarm at the output of contacts 12A or 12B, the flip-flop 22 has its state changed thereby energizing the audible circuit 18. This also places a signal in the complex "and" or "but not" gate 13W which will be described later and a signal on the lock-out gate 26. If the signal is the first within its lock-out group, gate 26 will permit the signal to pass to flip-flop 27, thereby changing its state and impressing a signal on gate 13R. The output of flip-flop 27 through gate 26 feeds back a positive signal locking out gate 13W so that no signal can be applied to amplifier 15W. Before acknowledgment, the flasher 16 imposes a signal through gate 13' on gate 13R to cause the red lamp 14R to flash. However, following acknowledgment by closing contacts 19, the flip-flop 17 through gate 40 is set to provide back biasing on gate 13' which effectively cuts off the flasher and imposes a steady signal on gate 13R, thereby allowing the red light 14R to burn steadily. Pressing the reset button 23 will reset the flip-flop 27 through gate 42 and extinguish the red light. This, in turn, removes the positive lock-out on gate 13W, thus allowing it to conduct and igniting lamp 14W. Pressing the acknowledgment buttons closes switch 19 and also closes an additional set of contacts to extinguish the audible in the way previously described.

In the event that the signal applied at this point is subsequent to a signal applied at another point, the lock-out bus will impose a signal on gate 26, causing that gate to reject the signal impressed upon it. In that event, flip-flop 27 will remain in its initial state and will not impose a signal on gate 13W. Gate 13W having a signal from flip-flop 22 provides an output through gate 13W to white lamp 14W. By virtue of the flasher 16 being connected through gate 13' to gate 13W, the white light will flash alternately on and off. The closing of the acknowledgment contacts, however, will change the state of flip-flop 17 causing it to back bias gate 13' to prevent the flasher signal from reaching the gate 13W and, therefore, the lamp will burn steadily. When gate 13W and flip-flop 22 are cut off, the signal passing back through gate 28 will reset the flip-flop 17 so that on the next cycle flashing can occur.

The sequence thus described is illustrated in the sequence chart of FIG. 12. It will be observed in this chart that while the red signal continues to burn after the sensing means contacts return to normal, the white lamp signal is extinguished.

Referring now to the circuit diagram of a preferred embodiment of the FIG. 11 annunciator point shown in FIG. 13, the similarities to the previously illustrated and described circuitry of FIGS. 3 and 6 will be apparent. Corresponding parts have been given similar designators and those parts in which many of the values of the components have been changed have been given the same designator but with the addition of a prime thereto.

Thus, it will be observed that the arrangement of normally open and normally closed terminals or contacts are the same so that if the normally closed contacts are to be employed and connected to the B+, the normally open contacts are omitted and the terminal jumpered directly to ground, in which case, the full B+ voltage appears across resistor R1. In this case, the test push buttons are connected across a resistor R25 and through a diode D8, but in other respects acts exactly as the normally open contacts in lowering the potential on the base of transistor Q1 which, because it is a PNP transistor will cause it to conduct. Transistor Q1 conducts from B+ through diode D2, resistors R26 and R27 and resistor R8' to ground. Conduction of transistor Q1 raises the potential on the base of transistor Q6 thereby causing it to conduct since it is an NPN type transistor. When transistor Q6 is rendered conductive, transistor Q8 which is biased to be normally conductive permits a flow of cur-

rent from the B+ through resistors R3' and R20' to transistor Q6, through transistor Q8, transistor Q7, which has just been rendered conductive, transistor Q9 and resistors R7' and R8' to ground. It also similarly causes NPN transistor Q7 to be conductive for purposes which will be explained later.

The same pulse which renders transistor Q1 conductive acts through resistor R20', capacitor C1 and diode D4 to energize the audible module 18.

When the transistor Q1 is rendered conductive it applies a positive pulse to the base of transistor Q10 of flip-flop 27 through diode D9 and capacitor C3. This positive pulse renders transistor Q10 conductive from B+ through resistors R28 and R29, transistor Q10 and resistors R7 and R8 to ground. This conduction, in turn, lowers the potential on the base of transistor Q11 rendering it conductive from B+, through diode D2, the transistor Q11, resistors R30 and R31 and resistor R8' to ground. The flow through transistor Q11 maintains the positive potential on the base of Q10 to keep it conductive. Rendering flip-flop 27 conductive provides a conductive path from B+ power supply through resistors R5R, R6R, transistor Q2'R, transistor Q10 and resistors R7 and R8' to ground. At this point, the flasher 16 is effective to alternately turn transistor Q2'R on and off by applying alternating positive and negative pulses to its base. This provides lamp 14R with a flashing signal in the manner described above with respect to other circuits where transistor Q3R which provides amplifier 15R which actually controls current to the red lamp 14R.

Also under these circumstances, unless a signal occurs within few milliseconds after the first signal recorded at this point, the lock-out circuit will be effective. This circuit is effective due to the conduction of transistor Q11 which imposes a positive potential at the lock-out gate 29. This path is from B+ through diode D2, transistor Q11, and diode D10 to the lock-out bus or lock-out gate 29. This signal on the lock-out bus which is common to all points in the group back biases diode D9 and prevents the positive pulse across capacitor C3 from triggering flip-flop 27 at other points and thus prevents other red lights from coming on. Another conductive path through diode D11 permits the positive potential present when transistor Q11 becomes conductive to be applied to the base of PNP transistor Q9 in order to cut off that transistor and current flow through it. Cutting off transistor Q9 cuts off transistor Q8 and hence transistor Q6 but by this time flip-flop 27 has been set and the red light is on and will stay on flashing or steady (acknowledged) until the reset button closes switch 23 to turn it off.

Acknowledgment of a flashing red light in the audible signal is accomplished through closing the acknowledgment switch 19. This preferably also provides a separate switch pole to interrupt the audible. Closing switch 19 momentarily pulls down the potential of the base of the PNP transistor Q4 thereby causing it to conduct. Its conduction from the B+ is through diode D2, transistor Q4 and resistors R15, R30, R32 and R8' to ground. This conduction raises the potential on the base of transistor Q5 and thereby renders it conductive from the B+ through resistors R14, R17', transistor Q5, diode D12, transistor Q10 and resistors R7 and R8' to ground. This conduction, in turn, sustains the conduction of transistor Q4 and in this way a steady positive potential is applied through diode D6 to back bias the flasher diode D1 and apply a steady potential at the base of transistor Q2'R to cause the red lamp 14R to burn steadily.

When it is desired to reset the annunciator point, the push button operating reset switch 23 is actuated to close that switch and this connects ground to the base of transistor Q10 through resistor R33, then diode D13 thereby cutting off the transistor Q10 which, in turn, cuts off transistor Q11 thus extinguishing the flip-flop 27. The turning off of transistor Q10 cuts off the signal current through gate transistor Q2'R and, therefore, deprives amplifier transistor Q3R and lamp 14R of the necessary current to light said lamp and the lamp is extinguished. With Q11 cut off, the positive potential is removed from the base of Q9 through D11 allowing gate 13W to conduct. With flip-flop 17 conducting, a positive potential is applied to the base of Q2W through diode D6 and R4. Thus, the white light 14W will burn steadily. It will be discussed later how the white light 14W will automatically reset on return to normal condition. With Q11 in a non-conducting state, the positive potential is removed from the lock-out gate thus permitting the next alert that occurs to flash the red light 14R to indicate a new first alert in a series. Note this can occur even though a white light is lighted in another module.

Let us assume now that the signal at this point is subsequent to the first signal so that a positive potential has been applied to the lock-out bus. When the potential is applied to the base of transistor Q1 causing it to conduct from the B+ through diode D2, transistor Q1, and resistors R26, R27 and R8' to ground, transistor Q6 will be rendered conductive as before, transistor Q7 will be rendered conductive as before, through transistor Q8, transistors Q7, Q9 and resistors R7 and R8' to ground. The audible 18 will be sounded by the pulse across capacitor C1 as before. However, the pulse attempting to pass through diode D9 will encounter a positive back biasing from the lock-out gate and the point first alerted which prevents it from reaching capacitor C3. Hence, flip-flop 27 will not turn on. Since no cut-off positive potential is applied through transistor Q11 to the base of transistor Q9 via diode D11, conduction is maintained through transistor Q9. Since transistor Q9 remains conductive current can flow from B+ through resistors R5W, R6W, through the "and" or "but not" gate 13W consisting of transistors Q2W, Q7 and Q9 and through resistors R7 and R8' to ground. A flow of current through transistor Q2W causes amplifier Q3W to turn on white light 14W. However, the base of transistor Q2W is connected to the flasher 16, in the same manner Q2R is, and until acknowledgment occurs will flash.

In the case of a flashing white light, acknowledgment occurs in the same way that it does for the red light, turning on flip-flop 17 which then permits transistor Q4 to conduct and back bias the flasher diode so that a steady positive potential is applied to the base of transistor Q2W and the light 14W burns steadily.

It will be observed that when the signal returns to normal with the red light, the nature of arrangement of flip-flop 27 causes it to be held on. However, with the white light no such flip-flop is interposed. As long as the white light is flashing, even return to normal of the sensing contacts will not extinguish it because flip-flop 22 will remain on. However, the positive potential produced by transistor Q4 following acknowledgment acting through diode D15 causes PNP transistor Q8 to cut off which turns off transistor Q6 by depriving it of a conduction path. Transistor Q1 will remain on as its path is through contact 12A or 12B. With 12A or 12B returning to normal, Q1 will be cut off as its conducting path will be broken. This in turn deprives the base of transistor Q7 of its required positive potential and hence interrupts the path through transistor Q2W so that sensing contacts 12A or 12B return to normal. With gate 13W non-conducting, the emitter of Q5 has its path broken through diode D25, Q7, Q9, R7, R8. Flip-flop 17 will stop conducting.

From what has been said above, it will be appreciated that many variations can be achieved in the circuit of FIG. 13 to accomplish other sequences and, in view of the teaching of the present invention, such modifications will occur to those skilled in the art. In the circuitry shown by way of illustration flip-flop circuits using one PNP and one NPN transistor have been used since this makes it possible to turn the flip-flop completely off or completely on. It will be apparent to those skilled in the art that

flip-flop circuits shown have been designed to be turned off normally in order to save power, another flip-flop may be substituted as desired in other installations. It will be apparent, however, that the circuits used are designed particularly for transistors with which they may be inexpensively constructed. Other elements substituted for transistors in such circuits would be quite expensive and/or would defeat the purpose of compactness.

In FIGS. 3, 6 and 13 component sizes or types have been indicated directly on the drawing. These sizes and types in each case are intended to be by way of example and not limitation as it will be clear to those skilled in the art many modifications might be made. The circuits illustrated accommodate a B+ range of at least 15–150 volts D.C. and 100–130 volts A.C., for example.

FIG. 14 is supplied merely to show the relationship of one point with respect to other points in a given group. Within a given group, there may be many points up to a certain reasonable limit of say 200 points. All points in a group share such things as the B+ power supply and preferably a common ground. They may share the same audible **18** and the same flasher **16** and may even share such push button contacts as those for test **20**, acknowledgement **19** and reset **23**. In the case of the reset push button, only such points as require reset would be connected. In the case of a first in, first out sequence employing a lock-out circuit, such as those of FIGS. 11–13 the lock-out circuit to function as such must be common to the whole group. The only external circuitry necessarily exclusive to each point are the sensing means or contacts which may be normally open and normally closed as previously described and one or more sets of lights associated with and identifying that point. Where white lights are used, for example, in the first in, first out sequence of FIGS. 11–13, observation of the lights of all the points in a group will tell immediately which points are under alert conditions and which was the first to assume that condition.

Since the individual points may be made on small cards, as printed circuits using transistor and other components of miniature size, a very small structure can be constructed and the total circuitry of the annunciator system may be kept extremely compact. It is also possible to make the power supply B+ and external circuitry, such as the audible circuit or circuits and the flasher in printed circuit card form. Not only is this highly convenient but it allows ready replacement of a faulty point by simply substituting one card for another in a plug-in type of arrangement to which these cards in the circuitry described are readily adaptable. It will be seen, therefore, that specific circuits designed expressly for use with small, compact, rugged, solid state devices enable not only major savings in cost, but also major savings in space, yet at the same time they may be relatively temperature insensitive in any normal environment where they might be used.

Modifications of the annunciator point circuit of the present invention both broadly and specifically has been shown and described and other modifications suggested. Still other variations and modifications within the scope of the claims will occur to those skilled in the art. All such variations and modifications are intended to be within the scope and spirit of the present invention.

I claim:

1. An annunciator point for monitoring the condition of a device which has normal and alert conditions comprising a lamp which has a normal condition indicating the device is in normal condition, sensing means for sensing alert and normal conditions producing a signal only in alert condition, a first gate means having input, output and control terminals with its output terminal coupled to the lamp and its input terminal coupled to the sensing means to derive a continuous input signal from the sensing means in the alert condition, and a flasher connected to the control terminal and providing a control signal at the first gate means in order to flash the lamp alternately on and off and acknowledgment means connected to said control terminal and including a flip flop distinct and separate from the first gate means, said flip flop having an input terminal connected to a manually controlled acknowledgement switch, an output terminal coupled to the control terminal of the first gate means through which terminal said acknowledgement means is able to overcome the effect of the flasher when the flip flop is in the state selected by the acknowledgement switch, a further terminal coupled to the first gate means other than to the control terminal so that upon discontinuance of the signal current flow through the gate means the flip flop will be restored to the state in which it cannot overcome the effect of the flasher, and second gate means connecting the input terminal of the first gate means and the sensing means, thereby to provide isolation of the flip flop from the sensing means.

2. An annunciator point for monitoring the condition of a device which has normal and alert conditions comprising a lamp which is out when the device is in normal condition, sensing means for sensing alert and normal conditions and lighting the lamp only in alert conditions, a first gate means having input, output and control terminals with its output terminal coupled to said lamp and its input terminal coupled to the sensing means to derive a continuous input signal from the sensing means in the alert condition, a flasher connected to the control terminal and providing a control signal at the first gate means in order to flash the lamp alternately on and off and acknowledgment means connected to said control terminal and including a flip flop distinct and separate from the first gate means, said flip flop having an input terminal connected to a manually controlled acknowledgment switch, an output terminal coupled to the control terminal of the first gate means through which terminal said acknowledgment means is able to overcome the effect of the flasher when the flip flop is in the state selected by the acknowledgement switch, a further terminal coupled to the first gate means other than to the control terminal so that upon discontinuance of the signal current flow through the gate means the flip flop will be restored to the state in which it cannot overcome the effect of the flasher, and second gate means connecting the input terminal of the first gate means and the sensing means, thereby to provide isolation of the flip flop from the sensing means.

3. The annunciator point of claim **2** in which the flasher is connected to the control terminal of the first gate means through a diode and the flip-flop produces a signal to back bias that diode and maintain a steady signal on the gate so that flashing is terminated.

4. An annunciator point for monitoring the condition of a device which has normal and alert conditions and for use with a group of similar annunciator points to determine whether it was first to signal an alert condition or subsequent to some other point comprising first and second lamps each of which has a normal condition indicating the device is in normal condition and producing a signal only in alert condition, sensing means for sensing alert and normal conditions, first and second gate means having at least input, output and control terminals, the output of the first gate being coupled to the first lamp and the output of the second gate being coupled to the second lamp and the input of each gate being direct current coupled to the sensing means to derive a continuous signal from the sensing means in the alert condition, lock out gate means in said coupling to said first gate input for blocking the signal from the sensing means to the input of the second gate and impressing the signal on the first gate and generating blocking signal to prevent the first light of other similar points in the group from assuming its alert condition if no blocking signal from another point is applied to said lock out gate, and

which blocks the signal to the first gate and permits the signal to reach the second gate if a blocking signal from another point is applied to said lock out gate, and flasher means connected to the control terminal of each of the first and second gates and providing an intermittent signal at said gates to flash their respective lamps alternately on and off.

5. The annunciator point of claim 4 in which acknowledgment means including a flip-flop and a manually controlled switch to set said flip-flop into a predetermined state, is employed and coupled with the flasher to the control terminal of each of the first and second gates in order to overcome the effect of the flasher and cause the lamp whose control gate has a signal to assume a steady condition indicative of continuing alert.

6. A circuit module for an annunciator point for monitoring the condition of a device which has normal and alert conditions comprising a series resistance voltage divider providing a mid-terminal and first and second end terminals at its respective ends, the first end terminal being connectable to one electrical potential, a further series resistance connected at one end to the second terminal of the voltage divider and providing a third terminal at its other end, a first gate means having input, output and control terminals with the output terminal being connectable to a lamp, the input terminal being direct current coupled to the mid-terminal of the voltage divider to derive a continuous input signal in the alert condition, and the control terminal being connectable to a flasher in order to flash the lamp on and off, acknowledgement means connected to said control terminal and including a flip-flop distinct and separate from the first gate means, said flip-flop having an input terminal connected to a manually controlled acknowledgement switch, an output terminal coupled to the control terminal of the first gate means through which terminal said acknowledgment means is able to overcome the effect of the flasher when the flip-flop is in the state selected by the acknowledgement switch, and a further terminal direct coupled to the first gate means other than to the control terminal so that upon discontinuance of the signal current flow through the gate means the flip-flop will be restored to the state in which it cannot overcome the effect of the flasher, and second gate means connecting the input terminal of the first gate means and the sensing means thereby to provide isolation of the flip-flop from the sensing means, the continuous input signal from the sensing means being derivable either from the closing of normally open contacts connectable between the third terminal and a second potential or from the opening of normally closed contacts connectable between the second terminal and the same potential applied to the first terminal provided that the third terminal is connected to a second potential.

7. The circuit module of claim 6 in which a terminal for a test switch is connected to some point along the series circuit including the voltage divider and the further series resistance whereby the test switch may be used to apply a continuous input signal to the input terminal of the gate means.

8. The annunciator point of claim 1 in which a series resistance voltage divider having end terminals and at least one middle terminal is connected at its middle terminal to the input terminal of the gate means and connected at one end terminal to one potential, the sensing means being a normally open contact connected between the other end terminal and a second potential, whereby upon closing the normally open contact a constant signal is applied to the input terminal of the gate means.

9. The annunciator point of claim 1 in which a series resistance voltage divider having first and second end terminals and at least one middle terminal is connected at its middle terminal to the input terminal of the gate means and connected at its first terminal to one potential, a further resistance connected at one end to the second terminal of the voltage divider and provided at its other end with a third terminal which is connected to a second potential, the sensing means being a normally closed contact connected between said second contact and the same potential to which the first terminal is connected, whereby upon opening the normally closed contact a constant signal is applied to the input terminal of the gate means.

10. An annunciator point for monitoring the condition of a device which has a normal condition indicating the device is in normal condition, sensing means for sensing alert and normal conditions and producing a signal upon alert condition, a first flip-flop direct current coupled to the sensing means to derive a continuous input signal from the sensing means in the alert condition but set in a stable state by momentary alert indication from the sensing means to retain the signal imposed on said input terminal even after the sensing means returns to normal, a gate means having output and control terminals with the output terminal coupled to the lamp and its input provided by the first flip-flop, a flasher connected to the control terminal and providing a control signal at the gate in order to flash the lamp alternately on and off and acknowledgment means connected to said control terminal and including a second flip-flop and a manually controlled switch, said acknowledgement means overcoming the effect of the flasher when the flip-flop is in the state selected by said switch.

11. The annunciator of claim 10 in which the first flip-flop conducts until the second flip-flop is reset at which time said flip-flop causes said first flip-flop to return to its other state provided, however, that conduction may continue through a portion of the first flip-flop to maintain an alert signal on the gate as long as the sensing means indicates an alert condition.

12. The annunciator of claim 10 in which a reset switch is provided to reset said second flip-flop by application of required reset potential and in which the first flip-flop conducts until the second flip-flop is reset by said reset switch from its acknowledged state to its other state removing the signal from the control terminal of the gate if no signal remains from the sensing means but retaining the signal if a signal continues from the sensing means.

13. The annunciator point of claim 10 in which the second flip-flop is arranged to be reset to its original state by the acknowledgement means.

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