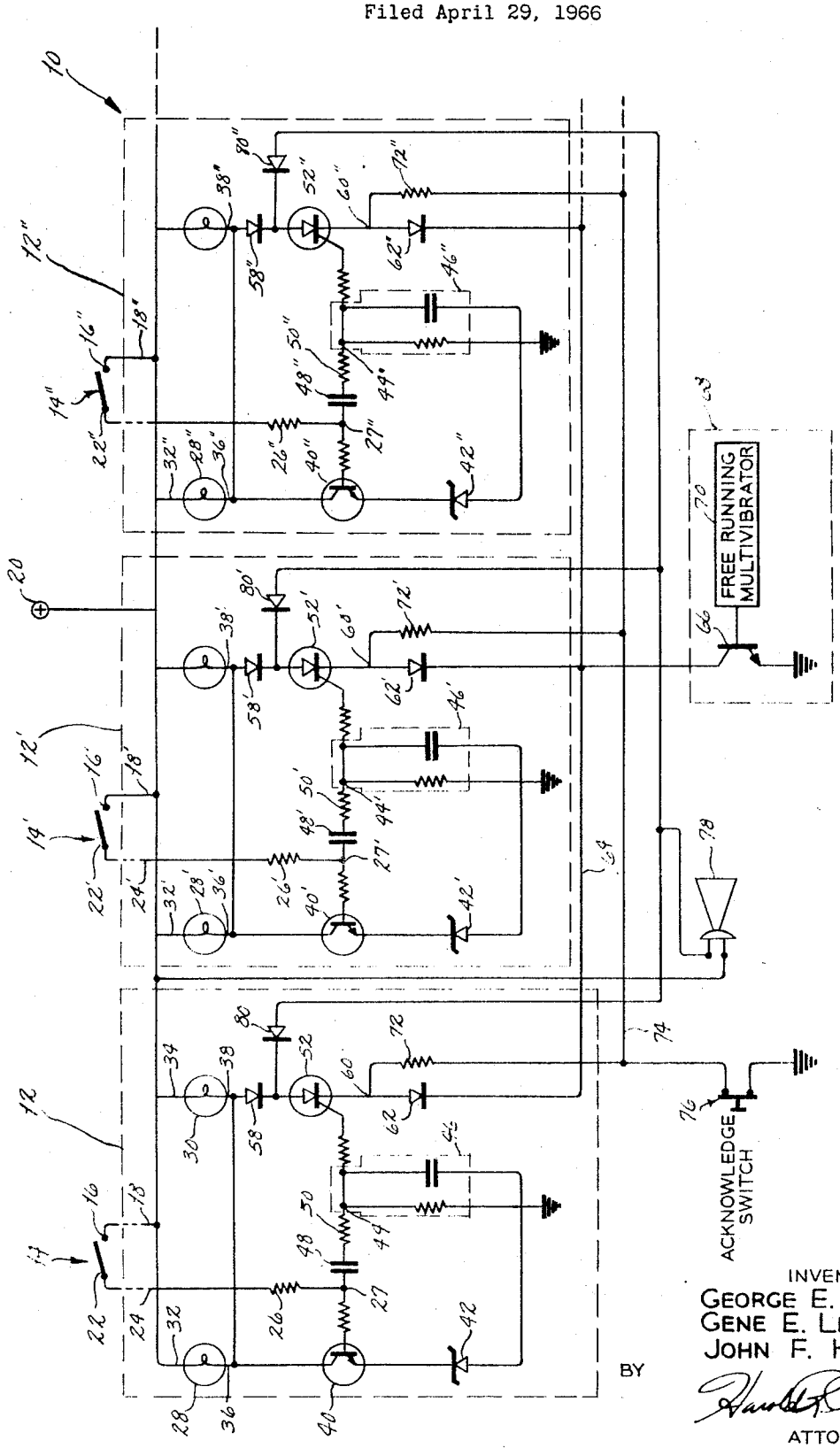
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ALARM ANNUNCIATOR CIRCUITRY

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ALARM ANNUNCIATOR CIRCUITRY

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The present invention relates generally to electronic alarm annunciator circuitry responsive to the occurrence of abnormal conditions, and more particularly to solid-state circuitry which, until operator acknowledgment is made, provides an intermittent or continuously varying visible and/or audible indication. Additionally, the invention pertains to circuitry which, after operator acknowledgment will provide an indication different from that prior to acknowledgment and maintain such indication until the detected abnormal condition has been corrected.

Alarm annunciators have found wide application in process control and other supervised systems, wherein a multiplicity of remote plant conditions are monitored and an alarm indication provided at a central station or control room should any of the conditions become abnormal. In such applications, it is desirable that the alarm annunciator be characterized by an attention-attracting mode of operation; for example a flashing or intermittently-occurring indication which will attract the attention of the control room operator. After the operator has noted the occurrence of the abnormal condition, he may acknowledge it by terminating the intermittent operation of the annunciator, and initiating a steady-state or other indication condition noticeably different from the attention-attracting operation. This steady state operation then prevails until the abnormal condition has been corrected.

Heretofore, separate flasher, or like circuits, have been employed for each of the indicator circuits housed in an alarm annunciator. In addition, these flasher circuits as well as the indicator circuits have included many mechanical relays and elaborate electrical circuitry requiring many components. Although such annunciators have served the purpose, they have not proved entirely satisfactory under all conditions of service for the reason that mechanical relays are not highly reliable and the requirement of a separate flasher for each indicator circuit renders them costly to manufacture in quantity.

The general purpose of this invention is to provide a solid-state alarm annunciator circuit which possesses the advantages of similarly employed annunciators, but does not possess the aforedescribed disadvantages. To attain this, the present invention utilizes unique circuitry which enables a three-terminal current control device, such as a silicon-controlled rectifier, to be used in a plurality of indicator circuits; a single intermittently-operated circuit serving all of the indicator circuits.

Therefore, among the several objects of the present invention is the provision of an inexpensive solid-state alarm annunciator capable of providing sustained intermittent visible or audible indications.

Another object of the invention is the provision of an alarm annunciator which may be first triggered by an abnormal condition to an intermittent-operation state, switched to a steady acknowledgment state by an operator, and maintained in the steady-state mode until the abnormal condition has been corrected.

Still another object of the present invention is to employ solid-state control devices in a plurality of indicator circuits, such control devices being switchable to a conducting state and maintained in such state, even though the triggering or gating signal has been removed and the device controlled thereby simultaneously operated in an intermittent fashion.

These objects (as well as others apparent herein) are achieved generally by providing alarm annunciator circuitry comprising a plurality of indicating circuits electrically connected across the terminals of a D.C. power supply. Each of the indicating circuits includes an incandescent lamp or other indicating means which is connected in series circuit with the normally-conducting current path of a solid-state, unidirectional current control device, such as a silicon-controlled rectifier (SCR). The silicon-controlled rectifier has a gating terminal to which a signal indicative of an abnormal condition may be applied to render the current path of the SCR conductive, and thus actuate the indicating means.

Two parallel circuits branch from the control device. One of these circuits includes a predetermined fixed resistance and the other includes an intermittently-operated switch or other current conduction means, so that its resistance may be switched from some infinite value to some value substantially less than the fixed resistance of the other parallel circuit. Both of the parallel circuits are connected to corresponding circuits in the other indicating circuits by common bus leads.

Utilization of the invention will become apparent to those skilled in the art from the following description of a preferred embodiment, as illustrated in the accompanying drawing, in which:

The accompanying drawing is a schematic circuit diagram of the electronic alarm annunciator of the present invention.

Referring now to the drawing, wherein like reference characters designate like or corresponding parts, there is shown in FIG. 1 an alarm annunciator circuit, generally designated **10**, comprising three "points," indicated by the dashed lines **12**, **12'**, and **12''**. The term "point" is used to denote a modular circuit section or portion of the entire annunciator. To a control room operator it designates some specified remote, monitored station. Upon the occurrence of an abnormal condition, at the station it provides an alarm indication which may take any one or a combination of various forms, for example, the flashing of lights, the sounding of horns, etc. Since the points **12**, **12'** and **12''** are substantially identical circuits, only point **12** will be described in detail, it being understood that as many points as desired may be incorporated in a single annunciator panel.

A normally-open contact closure **14** is shown with its fixed contact **16** connected by lead **18** to the positive terminal **20** of a D.C. power supply, whose other terminal is preferably at ground potential. The movable contact **22** of the contact closure **14** is connected by lead **24** to a current-limiting resistor **26** which in turn connects to a junction point **27** of the indicating circuit. Typically the contact closure **14** is provided at some plant location remote from a control room where the alarm annunciator circuit **10** is located. The leads **18** and **24** are preferably a twisted or shielded wire pair suitable for transmitting low-level D.C. information signals over the required distance to the alarm point **12**.

At the alarm point **12** the indicating circuit shown includes a pair of incandescent lamps **28**, **30** connected in parallel with filament leads **32**, **34** directly connected to the positive terminal **20** of the D.C. power supply. Although a single lamp may be sufficient, the redundancy of two lamps adds to the reliability of the alarm circuitry **10**. The other filament leads **36**, **38** of the lamps **28**, **30** are directly connected to the collector electrode of an NPN normally-nonconducting, switching transistor **40**, whose emitter electrode is coupled to ground by means of a Zener diode **42**. The Zener diode **42** is chosen to provide a breakdown voltage of a predetermined magnitude, so that the current in the collector-emitter path of the

transistor 40, and thus through the lamps 28, 30, may be maintained at some minimum value when the transistor 40 is triggered to its conducting state. This operation will be more fully described in the operational description hereinafter.

The base electrode of the transistor 40 is coupled to the junction point 27, which in turn is coupled to one terminal 44 of a shunting R-C filter section 46 by means of a coupling capacitor 48 and a current-limiting resistor 50.

A silicon-controlled rectifier 52, which also serves to control the current through the lamps 28, 30 of the indicating circuit, has its gating electrode 54 coupled to the terminal 44 of the filter section 46 by means of a current-limiting resistor 56. The anode electrode of the SCR 52 is coupled to the filament leads 36, 38 of the lamps 28, 30 by means of a diode 58, and the cathode electrode is connected to a junction point 60.

At the junction point 60 the indicating circuit branches into two parallel paths which converge again at the common ground terminal. One of the branching parallel circuits includes an isolating diode 62 whose anode is connected to the junction point 60 and whose cathode is connected to a common bus lead 64, which connects to the cathodes of the isolating diodes 62', 62'' of the corresponding branched, parallel circuits of the points 12' and 12'' respectively.

The bus lead 64 is connected to the collector electrode of a NPN, transistor 66 operated in the grounded-emitter mode and comprising a portion of an intermittently-operated current conduction circuit, generally designated 68. The base electrode of the transistor 66 is connected to and driven by a free-running multivibrator 70 in the conventional fashion.

The other parallel circuit branching from junction point 60 consists of a potential-dropping, fixed resistor 72 connected to a common bus lead 74 and a push-button type acknowledgment switch which is normally-closed so as to connect the bus lead 74 to ground potential. It should be noted that, in the same manner that bus lead 64 interconnects the several isolating diodes 62, 62' and 62'' to the circuit 68, the bus lead 74 connects the resistors 72, 72' and 72'' to the common ground terminal of the alarm circuitry 10.

To augment the visible indicating circuitry, an audible indicator is also provided. This audible indicator may take the form of a D.C. operated horn 78 having one terminal coupled to the anode electrodes of the SCR's 52, 52' and 52'' by means of isolating diodes 80, 80' and 80''. The other terminal of the horn 78 is connected to the positive terminal 20 of the D.C. power supply.

In the quiescent state, SCR 52 and transistor 40 are in their non-conducting states and the transistor 66 is driven intermittently between its conducting and nonconduction states by the multivibrator.

Assume that an abnormal condition occurs at the stations being monitored by point 12. Contact closure 14 will detect the condition and close the contacts 22 and 16. In so doing the positive potential of the power supply is applied to junction joint 27 by leads 18, 24 and resistor 26.

This potential rise at point 27 provides a positive-going pulse which is coupled to the gating electrode 54 of SCR 52 by means of the capacitor 48, resistors 50, 56 and the filter section 46. SCR 52 is thus triggered to its conducting state by the positive-going pulse and resulting current flows from positive terminal of the D.C. power supply 20, through the lamps 28, 34, diode 58, the anode-cathode path of SCR 52 to the junction point 60.

The current at junction point 60 divides into the two parallel paths in a manner determined by the state of the power transistor 66 of the flasher circuit 68. That is, assume that the multivibrator 70 in its high bistable state so that the potential applied to the base is substantially positive with respect to the emitter or ground potential. When this condition exists, the transistor 66 is in its conductive state and current flow from the junction point 60 is substantially through that parallel circuit which includes the isolating diode 62, the bus lead 64, the collector-emitter path of the transistor 66 to ground. After some specified time period, say one-half second, the multivibrator will switch to its low bistable state, thus switching the transistor 66 to its nonconducting state. The substantial current flow through the transistor 61 is then directed from junction point 60 to that parallel circuit which includes the fixed resistance 72, the bus lead 74, the acknowledgment switch 76 and to ground. The current flow through the SCR 52 and thus the lamps 28, 30 is much greater during the conducting state of transistor 66, because the resistance of the diode 62 and the transistor 66 are extremely small compared to that of the fixed resistor 72.

In the preferred embodiment of the invention the circuit components are selected so that when the current flows in the diode-transistor circuit, (62–66) the lamps 28, 36 illuminate at substantially full brightness, and when the current flows in the resistor-acknowledgment switch circuit (72–76), the lamps 28, 30 are illuminated at approximately half of their full brightness. In this manner, the lamps 28, 30 provide an attention-attracting flashing indication.

It should be apparent that the value of resistor 72 could be chosen to provide degrees of brightness other than half brightness during half of the flashing cycle. In fact, the resistor 72 may be chosen so that for all practical purposes, the lamps appear to flash between their full brightness and their "off" states, yet current conduction through the SCR 52 will be maintained above the minimum threshold level at which it will return to its nonconducting state. Thus, the parallel circuit including the resistor 72 serves the important function of permitting flashing or intermittent operation of the indicating devices, but yet allows the control devices (the SCR's) to operate as latching devices. That is, even though the actuation signal from the contact closures 14 is eventually lost, the control devices continue to provide a flashing indication until operator acknowledgment is made. The diodes 62 serve an equally important function of isolating the control SCR 52 of one point from that of another point. In this manner the single flasher circuit 68 may be employed to serve all of the indicating points.

After the flashing indication has been observed by an operator at the central location, acknowledgment may be made by opening the contacts of the acknowledgment switch 76. During that half cycle of the operation when current normally flows through resistor 72, the current through the control SCR 52 is reduced to zero because of the open-circuit produced by the acknowledgment switch 76. The absence of the sustaining current at SCR 52 causes it to be switched back to its nonconducting state and the intermittent flashing operation ceases.

However, a steady indication is still observable because of the operation of the switching transistor 40, now to be described. The actuating signal in the form of the rising potential applied to junction point 27 not only triggers the SCR 52 to its conducting state, but is also applied to the base electrode of the NPN switching transistor 40. The transistor 40 is switched from its nonconducting state to its conducting state and current flows from the positive terminal 20 of the D.C. power supply, through the lamps 28, 30, the collector-emitter path of transistor 40, and the Zener diode 42 to ground. The substantially constant breakdown voltage across the Zener diode 42 insures that the current through the lamp 28, 30 is held at some predetermined value. Therefore even after the intermittent current flow brought about by the cyclic operation of the flashing circuit 60 ceases, the control circuitry including the transistor 40 and diode 42 take over and hold the lamps 28, 30 on at a steady preselected brightness. The lamps 28, 30 will remain in this condition

until the abnormal condition at the remote station has been corrected and the contact closure **14** returned to its original state.

The operation of the optional audible alarm or horn **78** should be apparent: it is connected in parallel with the lamps **28, 30** between the positive terminal **20** of the D.C. power supply and the anode of the control SCR of each indicating circuit. Its operation is analogous to that of the lamps **28, 30** during the intermittent-indication cycles of the circuit. However, during the steady state portion of the operation, the diodes **58** prevent the horn from being controlled by the transistor **40**, and in essence it is disconnected from the power supply during this period.

Obviously, many modifications and variations of the present invention are possible in view of the above teachings.

We claim:

1. In a solid-state electronic alarm annunciator of the type wherein the detection of an abnormal condition yields an intermittently-occurring indication, the circuitry comprising

a two-terminal source of electrical energy,

a plurality of indicating circuits electrically connected to said two-terminal source,

each indicating circuit including indicating means and a unidirectional-current control device having a gating terminal and a normally-nonconducting current conduction path connected in series circuit with said indicating means, said current conduction path being switchable to its conducting state upon the application of a predetermined signal to said gating terminal,

said indicating circuits further including first and second parallel circuits branching from said control device and converging at one of said terminals of said two-terminal source,

each of said first parallel circuits of said plurality of indicating circuits being connected by a common bus lead and including means to isolate its associated control device from the other of said control devices, and

intermittently-operated current conduction means connected between said bus lead connecting said first parallel circuits, and said terminal,

whereby, upon actuation of one of said indicating circuits, said first and second parallel circuits provide for the sustained conduction of the actuated control device together with the simultaneous intermittent operation of said intermittently-operated current conducting means.

2. The circuitry as defined in claim **1** wherein said second parallel circuit, comprises

resistance means of a value substantially greater than that of said first parallel circuit when in its current conducting state, and

normally-closed switching means for acknowledging the actuation of said indicating circuits by interrupting the current in said second parallel circuit.

3. The circuitry as defined in claim **2**, further comprising

signal source means for providing a signal indicative of an abnormal condition at a monitored station,

a normally-nonconducting electronic switching circuit means connected to each said indicating means and said signal source means and switchable to a conducting state upon the occurrence of a signal therefrom and maintained in such state until such signal is removed, said electronic switching circuit means including current-limiting means of such value as to establish for said indicating means a minimum level of actuation, said minimum level being less than full actuation.

4. The circuitry as defined in claim **3** wherein said electronic switching circuit, comprises

a transistor whose base electrode is connected to said signal source means and whose collector electrode is connected to said indicating means, and

a Zener diode connected in the emitter electrode circuit of said transistor.

5. The circuitry as defined in claim **4**, wherein

said unidirectional-current control devices are silicon-controlled rectifiers.

6. The circuitry as defined in claim **5** wherein said intermittently-operated current conducting means, comprises

a single transistor whose emitter-collector path is connected between the common bus lead of said first parallel circuit and one terminal of said two-terminal source, and

a free-running multivibrator connected to drive base electrode of said single transistor.

References Cited

UNITED STATES PATENTS

3,392,379 7/1968 Thomason et al. ____ 340—213.1

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