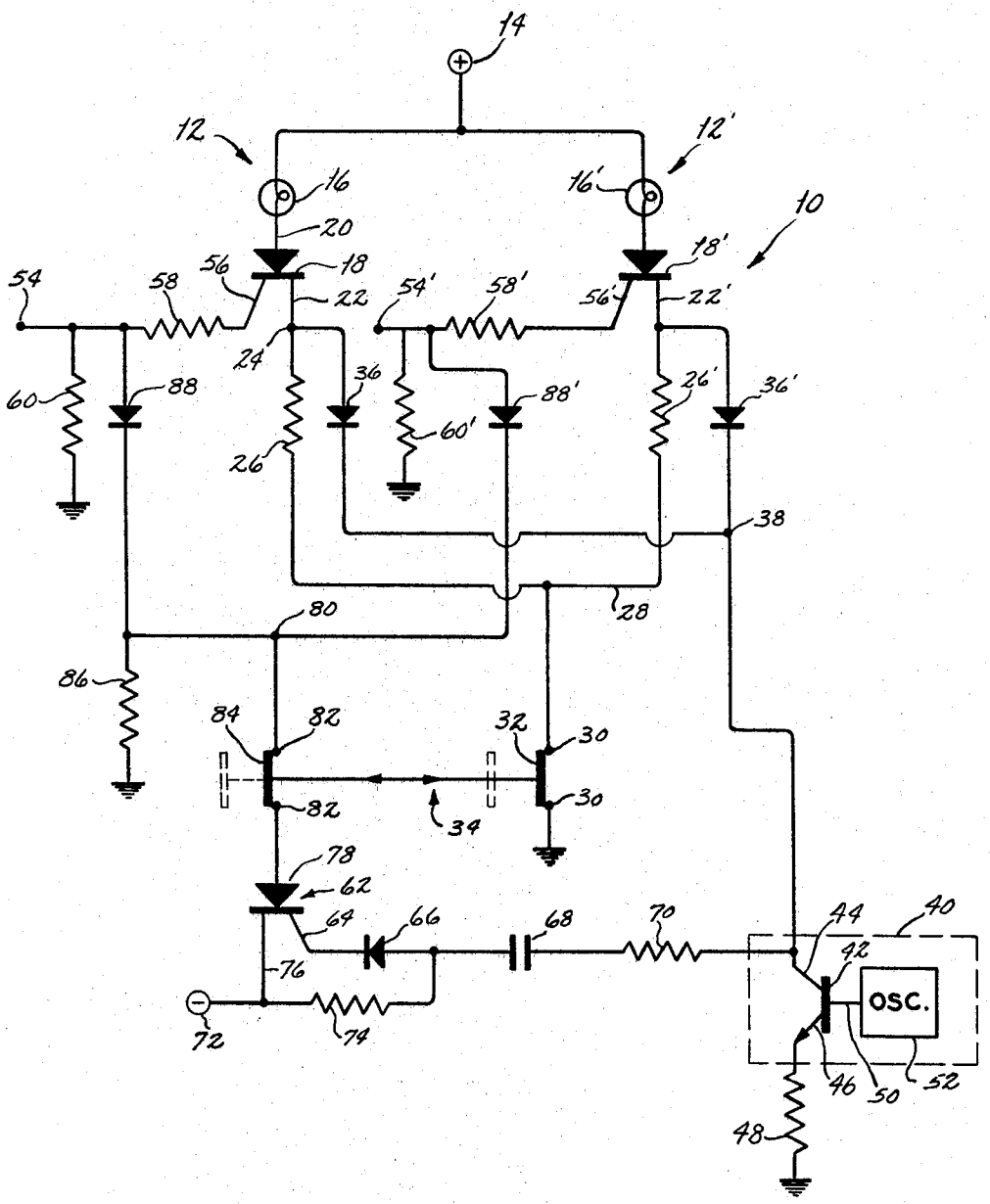
Oct. 21, 1969 G. E. LIGHTNER ET AL 3,474,443

ALARM FIRST-OUT CIRCUITRY

Filed March 30, 1966



INVENTORS
GENE E. LIGHTNER AND
JOHN F. HIGHFILL
BY Harold R. Patton
ATTORNEY

United States Patent Office 3,474,443 Patented Oct. 21, 1969

3,474,443

ALARM FIRST-OUT CIRCUITRY

Gene E. Lightner, St. Louis, and John F. Highfill, St. Charles, Mo., assignors to Monsanto Company, St. Louis, Mo., a corporation of Delaware

Filed Mar. 30, 1966, Ser. No. 538,630
Int. Cl. G08b 19/00; H04q 3/00
U.S. Cl. 340—415 6 Claims

ABSTRACT OF THE DISCLOSURE

An alarm annunciator circuit for indicating abnormal conditions in monitored variables includes a "first-out" circuit for preventing actuation of any alarm indicators following actuation of the initial alarm indicator. Thereby, an indication of the first variable to become abnormal is preserved. For each variable to be monitored there is an individual indicator circuit which includes a visual indicator in series with the cathode-anode path of a silicon controlled rectifier responsive to the variable becoming abnormal to start conducting and provide energizing current to the visual indicator. Each of the indicator circuits is connected in common to a flasher circuit which causes the visual indicator associated with the conducting silicon controller rectifier to flash. A second common connection between all indicating circuits and a reference potential is provided to maintain a minimum current through the conducting silicon controlled rectifier when the flasher circuit periodically turns off the associated visual indicator. An auxiliary silicon controlled rectifier, connected to the same common terminal to which the flasher is connected, responds to the current caused by any one of the indicating circuits being energized, and operates to connect the gate terminals of all silicon controlled rectifiers in the indicating circuits to a source or potential which prevents the silicon controlled rectifiers from being turned on.

The present invention relates generally to electronic circuitry for an alarm annunciator, and more specifically to circuitry for indicating which one of a plurality of monitored devices attains an abnormal state before any other of such devices. Such alarm circuitry is commonly referred to in the art as "first-out" alarm annunciator circuitry.

In many control or monitoring systems, one abnormal condition will often result in a "chain-reaction" occurrence of a multiplicity of abnormal conditions. As a simple example, abnormally low oil level in a compressor bearing will result in a compressor shut-down, which in turn causes an abnormally low pressure to exist at the compressor. In most instances several sensing devices for detecting the occurrence of abnormal conditions are monitored in a single control room, where the abnormal conditions are indicated by indexed alarm annunciating equipment. For maintenance and supervisory reasons, it is often highly desirable to know which of the abnormal conditions occurred first. The present invention provides such "first-out" information reliably, at the speed of modern solid state electronic components, and yet at low cost.

Heretofore alarm annunciators of the general type have employed complicated logic circuits which include many expensive elements; for example AND gates, OR gates, and the like. Other types of alarm circuits have utilized mechanical relays in an attempt to provide the "first-out" feature. Although such circuits have served the purpose, they have not proved entirely satisfactory under all conditions of service for the reason that they have

been susceptible to spurious signal triggering, relatively slow switching speeds and other related problems.

The general purpose of this invention is to provide alarm annunciator circuitry which embraces the "first-out" advantages of similarly employed annunciators, but yet does not possess the aforedescribed disadvantages. To attain this, the present invention utilizes a unique "first-out" circuit including a solid state control device, which, after the first indicating circuit has been actuated, positively prevents all other indicating circuits from being triggered to their actuated state.

An object of the present invention is the provision of a novel alarm annunciator circuit which assures that only the first-actuated indicating circuit of a plurality of such circuits remains in its actuated state upon the happening of some obnormal condition.

Another object is to provide an alarm annunciator consisting of a number of indicating circuits corresponding to the number of devices to be monitored, and wherein, until acknowledgment by an operator, the circuit provides an intermittent or flashing indication to draw attention to the first-actuated circuit.

A further object of the invention is the provision of alarm annunciator circuitry consisting of a plurality of independent indicating circuits controlled by a single "first-out" solid-state control circuit in common therewith.

A still further object of the invention is the provision of a "first-out" type alarm annunciator, wherein an operator may acknowledge an alarm indication and reset the first-out control circuit by means of a single acknowledgment switch.

In the present invention these purposes (as well as others apparent herein) are achieved generally by providing a plurality of indicating circuits which are electrically connected in parallel between the terminals of a power supply source. Each indicating circuit includes a unidirectional current control device, preferably a solid state silicon-control rectifier, having a gating terminal. The gating terminal is connectable to a source capable of providing a signal indicative of the occurrence of an abnormal condition at some monitored remote station. A second terminal of the control device is electrically coupled to one terminal of the two-terminal supply source and its remaining terminal is connected to two parallel circuits which are returned to the other terminal of the supply source. Each of the parallel circuits includes a junction terminal which is common to corresponding parallel circuits in the other indicating circuits.

An auxiliary solid-state unidirectional current device is provided to serve as the "first-out" control device. It has a gating terminal electrically coupled to one of the common terminals of a parallel circuit of the indicating circuits. Another of its terminals is connected to an auxilliary potential source, while its remaining terminal is coupled to the gating terminals of the control devices of the indicating circuits. When any one of the indicating circuits is actuated, the auxiliary control device is triggered to its conducting state. This allows the auxilliary potential source to be coupled to the gating terminals of the indicating circuit control devices, thereby to prevent triggering of these control devices after any one of them has been actuated.

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

The only figure of the drawing is a schematic diagram of the alarm annunciator circuit of the present invention, the ganged acknowledge switch being shown in its closed position and the dashed lines indicating its open position.

Referring now to the drawing, wherein like reference characters designate like or corresponding parts, there is shown in the drawing the alarm annunciator circuitry **10** of the present invention. The alarm annunciator circuitry **10** consists of a plurality of indicating circuits, generally designated **12**, connected in parallel between the terminals of a D.C. power supply **14**. In the present invention the two-terminal power supply **14** has a positive terminal and a grounded terminal and is preferably rated at approximately 24 volts. It should be understood that although only two indicating circuits **12** and **12'** are shown in the drawing additional indicating circuits **12''**, **12'''** etc., substantially identical to those shown, may be provided as desired. It is not uncommon, for example, to include as many as ten indicating circuits in a single alarm annunciator package.

Each of the indicating circuits **12** is comprised of an indication device **16** connected in series circuit with a control device **18**. As shown in the drawing, the indication device **16** takes the form of an incandescent lamp, while the control device **18** is a solid state unidirectional current element, commonly referred to as a silicon-controlled rectifier (SCR). It should be apparent that a D.C. operated horn or other indication device could be used instead of the lamp **16**. One terminal of the incandescent lamp **16** is connected directly to the positive terminal of the two-terminal power supply **14** and its other terminal is connected to the anode electrode **20** of the control SCR **18**. The SCR **18** is preferably biased so that it is normally-nonconducting but switchable to its conducting state upon the application of a gating pulse, as more fully described hereinafter. The cathode electrode **22** of the control SCR **18** is connected at circuit point **24** to two parallel circuits which branch from the point **24** and converge at the grounded terminal of the power supply **14**.

One of these parallel circuits includes a current-limiting resistor **26** whose one terminal is connected to the circuit point **24** and whose other terminal is connected to a junction terminal **28**. The terminal **28** is common to all of the indicating circuits **12** and is connected to the grounded terminal of the power supply **14** by the acknowledgement contacts **30** and contact arm **32** of a ganged double-pole, single-throw switch, generally designated **34**.

The other parallel circuit branching from circuit point **24** includes an isolation diode **36** whose anode electrode is connected directly to the circuit point **24** and whose cathode electrode is connected directly to a junction terminal **38**. The terminal **38** is common to all of the indicating circuits **12**, but it is isolated from the cathode terminal **22** of each circuit by means of the isolation diodes **36**. The common terminal **38** is coupled to the grounded terminal of the power supply **14** by means of an intermittently-operated flasher circuit, generally designated **40**.

In essence the intermittent-flasher circuit **40** is an electronic switch circuit which includes an NPN transistor **42** whose collector electrode **44** is connected to the common junction terminal **38**. The emitter electrode **46** of the transistor **42** is coupled to the ground terminal of the power supply **14** by means of a current-limiting resistor **48**. The base electrode **50** of the transistor **42** is connected to a conventional oscillator circuit **52** which periodically and cyclically causes the transistor **42** to switch between its conducting and nonconducting modes of operation.

The alarm annunciator circuitry **10** is provided with input terminals **54** which are connectable by suitable leads (not shown) to the devices which provide the signals indicative of the occurrence of abnormal conditions at the remote stations. Each indicating circuit **12** has a separate input terminal **54** coupled to the gating terminal **56** of its control SCR **18** through a current-limiting resistor **58**; the input terminals **54** further being connected to ground through a shunting resistor **60**.

A solid state auxiliary control device, generally designated **62**, is provided to ensure that only the first-actuated indicating circuit **12** will be actuated upon the occurrence of an abnormal signal at one of the monitored stations. Preferably the control device **62** is a unidirectional current device such as an SCR. In the present invention this "first-out" control SCR **62** has its gating terminal **64** connected to the collector electrode **44** of the transistor **42** by means of a series circuit including a diode **66**, a coupling capacitor **68**, and a current-limiting resistor **70**. The diode **66** is poled such that its cathode is directly connected to the gating terminal **64** and its anode is connected to an auxiliary source of potential **72** by means of a resistor **74** and coupled to the collector **44** of the transistor **42** by the capacitor **68** and the resistor **70**.

The particular value of the potential of the auxiliary source **72** is chosen such that, when applied to the gating terminals **56** of the control SCR's **18**, it prohibits any input pulse or simultaneously applied signal from triggering the control devices **18** to their conducting states. The auxiliary potential source **72** is directly connected to the cathode electrode **76** of the auxiliary control SCR **62**. The anode terminal **78** of this "first-out" control SCR **62** is connected to a common junction terminal **80** by means of the "first-out" reset contacts **82** and contact arm **84** of the switch **34**. In turn, the terminal **80** is connected to the junction of a shunting resistor **86** and the cathode electrode of isolation diodes **88**. The anode electrodes of the isolation diodes **88** are connected to the input terminals **54** of the respective indicating circuits **12**. Thus, the auxiliary potential source **72** is coupled to the gating terminals **56** of the control SCR's **18** by the circuit including the resistors **58**, the diodes **88**, the reset switch contacts **82**, and the anode-cathode path of the "first-out" control SCR **62**.

To understand the operation of the alarm annunciator circuitry **10**, assume that an abnormal condition has occured at some remote monitored station, thereby to provide an input signal in the form of a positive pulse to the input terminal **54** of the indicating circuit **12**. The resistors **58** and **60** are chosen in accordance with the known magnitude of the input signal so that a pulse of approximately 0.5–0.7 volt is applied to the gating electrode **56** of the control SCR **18**. Such a pulse is sufficient to trigger the control SCR **18** and it switches from its normally-nonconducting state to its conducting state. Thus, current is allowed to flow from the positive terminal of the power supply **14** through the indicating lamp **16**, the anode-cathode path of the control SCR **18**, to the circuit point **24**. At circuit point **24** the current can flow either through the resistor **26** and the acknowledgment contacts **30** of the switch **34** to the grounded terminal of the power supply **14** or through the diode **36**, the collector-emitter path of the transistor **42** to ground. This latter condition occurs only when the transistor **42** has been switched to its conducting state. When the oscillator **52** provides a sufficiently positive signal to the base electrode **50** of the NPN transistor **42**, it is rendered conductive and substantially all current flow in the indicating circuit **12** is through the transistor **42** and the current-limiting resistor **48** to ground. However, when the signal from the oscillator is such that the transistor **42** is turned off, as it will be during intermittent intervals, the current flow through the indicating circuit **12** will be through the resistor **26** and the acknowledgment conductors **30** of the switch **34** to ground. It should be noted that the parallel circuits including the resistor **26** is necessary to the proper operation of intermittently-operated flasher circuit **40**; i.e. so that a flashing indication is observable at the indicating lamps **16**. Without such parallel circuit arrangement, the current in the indicating circuit **12** would be reduced to a level (substantially zero) insufficient to sustain conduction of the control SCR **18** when transistor **42** is in its "off" cycle. This would defeat the purpose of utilizing SCR's as latching elements in the alarm annunciator circuitry **10**.

When current flows through the indicating circuit **12** and the flasher-circuit transistor **42**, a pulse is generated and coupled to the gating terminal **64** of the first-out con-

trol SCR **62** by means of the resistor **70**, the coupling capacitor **68**, and the diode **66**. This triggering pulse actuates the control SCR **62** to switch it from its normally-nonconducting state to its conducting state. In so doing the auxiliary potential source **72** is coupled to the gating terminals **56** of all of the control SCR's **18**, **18'** etc. by means of the circuits which includes the cathode-anode path of the "first-out" control SCR **62**, the reset contacts **82** and arm **84** of the switch **34**, the common terminal **80**, the isolating diodes **88**, and the current limiting resistors **58**. Since the auxiliary potential source is chosen to be of a predetermined magnitude (in the present invention, approximately —3 volts), all of the control SCR's **18** are prevented from switching to their conducting state even though input signals are applied to their associated inputs **54**.

The application of the auxiliary potential **72** to the gating terminal **56** of the first-actuated control device **18** does not adversely affect its operation. Once the control SCR has been switched to its conducting state it will continue to conduct until the current through its anode-cathode path is reduced below its sustaining threshold level, as is well known in the art.

When an operator has noted the abnormal condition indication and taken steps to correct it, the alarm annunciator circuitry **10** may be reset by simply opening the "first-out" reset contacts and the acknowledgment contacts of the switch **34**. This open circuit reset operation interrupts the current flow through the first-out SCR **62**, and the first-actuated control SCR **18** is returned to its nonconducting state. The contacts **30** and **82** of the switch **34** are then again closed and the alarm annunciator circuitry **10** is ready to detect and indicate the next occurrence of an abnormal condition at the stations being monitored.

Obviously, many modifications and variations of the present invention are possible in view of the above teachings. For example instead of the SCR's disclosed hereinabove, circuits equivalent to an SCR such as the well known two-transistor "Hook circuit" or a vacuum tube thyration may be substituted without departing from the teachings of the present invention.

Also instead of the transistor **42** operating between its non-conducting state and a heavily conducting state, it may be biased between two discrete current conducting states. In this manner, the indicator lamp **16** of the indication circuit which is actuated will glow dimly in one state and more brightly in the other state. Therefore, it is to be understood that the invention may be practiced otherwise than as specifically described.

We claim:

1. Alarm circuitry for indicating which one of a plurality of monitored devices attains an abnormal state before other of such devices, comprising

a two-terminal source of electrical energy,

a plurality of indicating circuits electrically connected to said two-terminal source to receive electrical power therefrom, each indicating circuit including a unidirectional current control device having a first terminal serving as a gating terminal and a second terminal electrically coupled to one terminal of said two-terminal source, a third terminal being connected to first and second parallel circuits branching therefrom and being connected at opposite ends to first and second common terminals respectively, said common terminals being common to corresponding parallel circuits in the other of said indicating circuits, said control devices being normally in a non-conducting state but being switchable to a conducting state in response to a switching signal being applied to said gating terminal,

intermittently-operated switching circuit means connected between said first common terminal and said other terminal of said two terminal source of electrical energy for intermittently increasing and reducing the current flow from said first common terminal to ground when one of said current control devices is in the conducting state,

a circuit path between said second common terminal and ground for maintaining more than a predetermined minimum turn off current through one of said current control devices which is in a conducting state, when said intermittently-operated switching means reduces the current flow from said first common terminal to ground,

an auxiliary potential source of a predetermined magnitude,

an auxiliary solid state unidirectional current control device having a gating terminal electrically coupled to said first common terminal, a second terminal of said auxiliary control device being connected to said auxiliary potential source, and a third terminal thereof being coupled to said gating terminals of said control devices of said indicating circuits,

whereby actuation of one of said indicating circuts triggers said auxiliary control device, thereby to apply said auxiliary source potential to said gating terminals of said indicating circuit control devices.

2. The alarm circuitry as defined in claim **1**, wherein

said unidirectional current control devices are silicon-controlled rectifiers.

3. The alarm circuitry as defined in claim **1**, wherein said circuit path comprises

normally closed acknowledgement switching means connected to said second common terminal, whereby upon opening said switching means, any actuated indicating circuit is reset to its initial state of operation.

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

first-out reset switching means connecting said auxiliary control device to said gating terminals of said control devices of said indicating circuits.

5. The alarm circuitry of claim **4**, wherein

said first parallel circuit of each indicating circuit includes a diode sufficient to electrically isolate its associated control device from said common terminal thereof, and

said other parallel circuit of each indicating circuit includes resistance means.

6. The alarm circuitry as defined in claim **5**, wherein

said first-out reset switching means and said acknowledgment switching means comprise a ganged double-pole, single-throw mechanical switch.

References Cited

UNITED STATES PATENTS

3,029,421	4/1962	Beguin	340—415
3,147,464	9/1964	Spielman	340—415
3,381,286	4/1968	Walsh	340—415

THOMAS B. HABECKER, Primary Examiner

U.S. Cl. X.R.

307—252