June 12, 1962 E. A. KELLER 3,039,085

MAGNETIC CORE ANNUNCIATOR SYSTEM

Filed Aug. 17, 1959 3 Sheets-Sheet 1

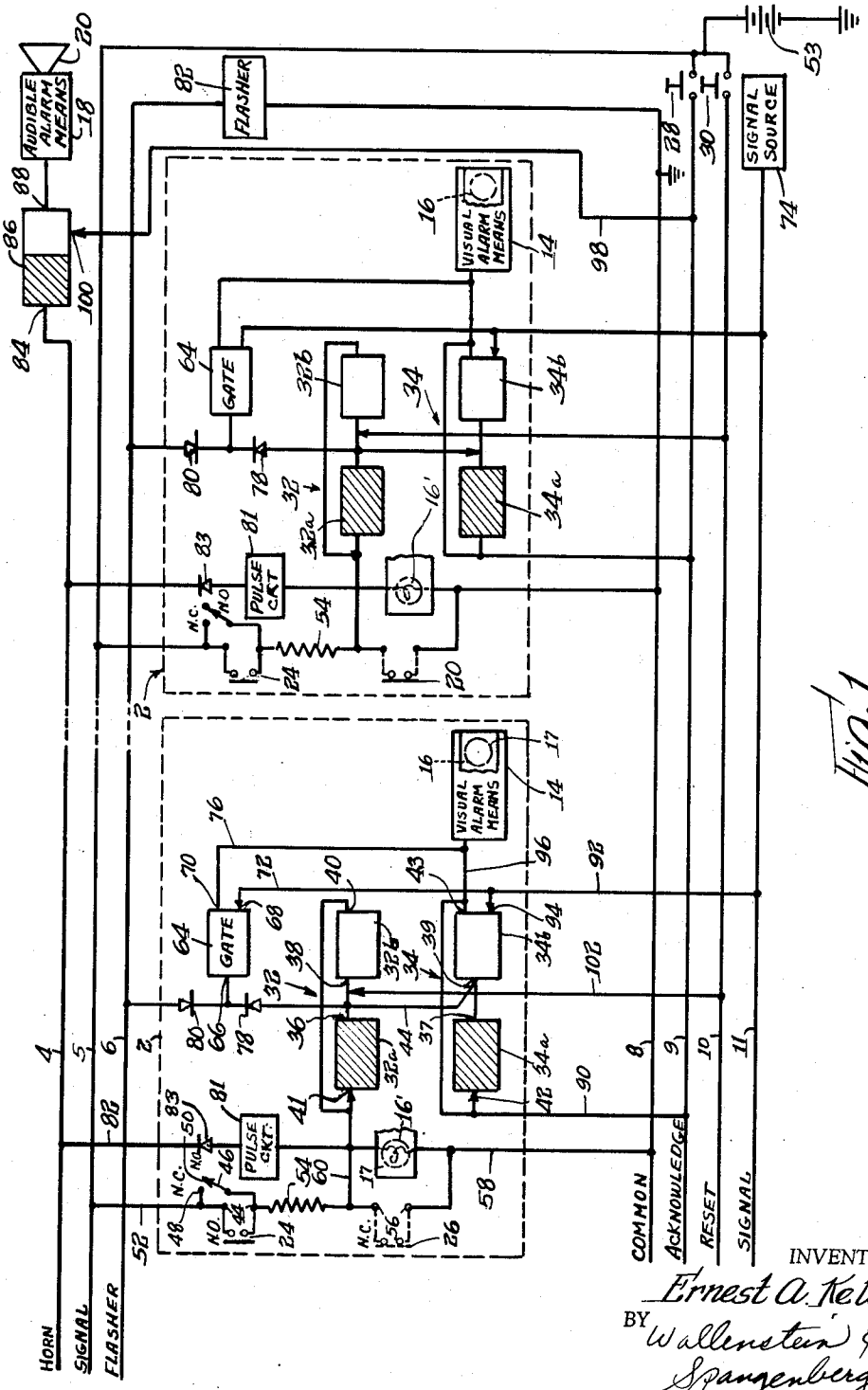


Fig. 1.

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MAGNETIC CORE ANNUNCIATOR SYSTEM

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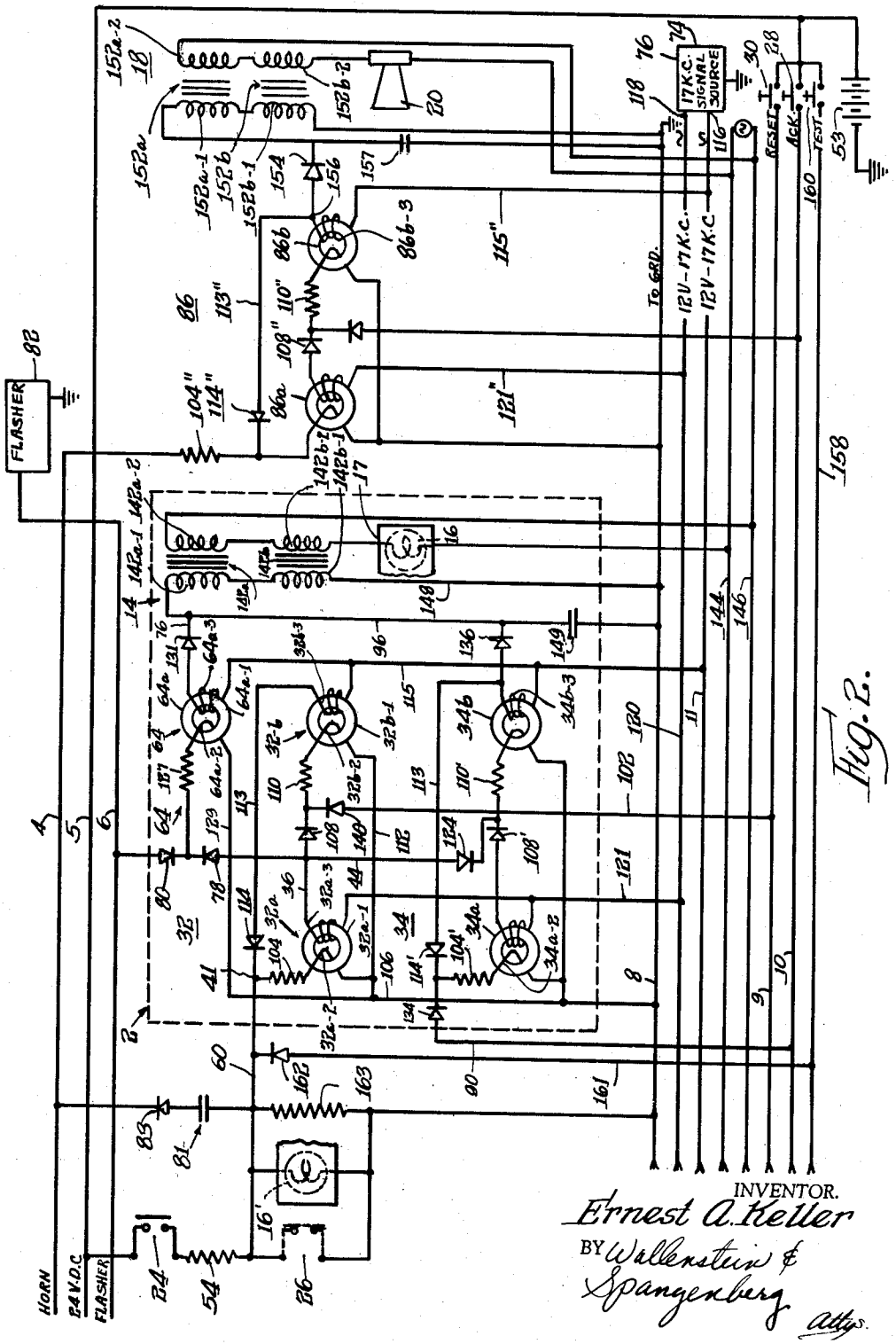


Fig. 2.

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MAGNETIC CORE ANNUNCIATOR SYSTEM

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Fig. 3.

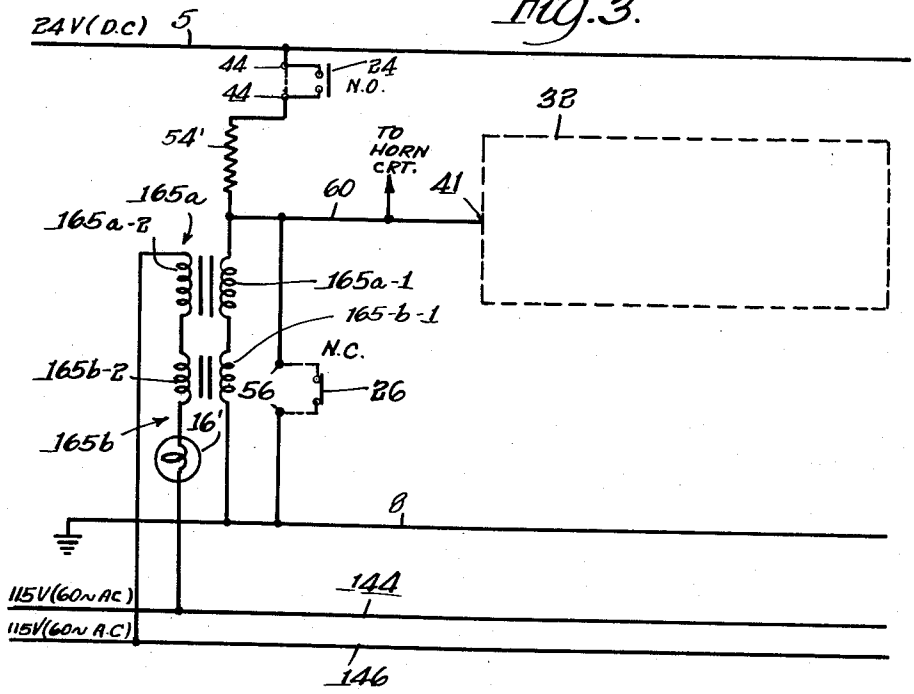
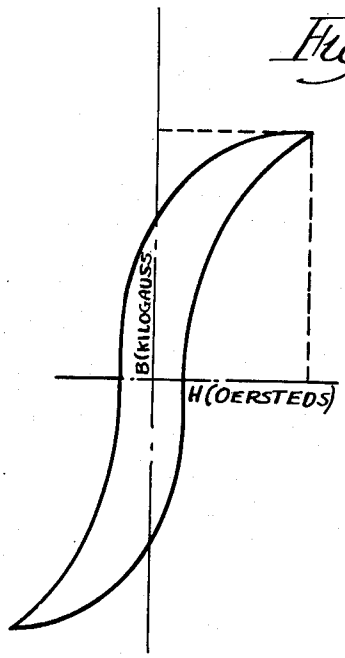


Fig. 4.



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3,039,085

MAGNETIC CORE ANNUNCIATOR SYSTEM

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18 Claims. (Cl. 340—213)

This invention relates to annunciator systems of the type wherein a visual alarm unit, such as a light unit, is provided for each variable to be monitored, and, when the variable becomes abnormal, a pair of field contacts are actuated to operate the visual alarm unit which indicates that the variable involved has just become abnormal. A manually operable acknowledgement switch is usually provided, which, when operated, changes the indication of the visual alarm unit to indicate that the alarm has been acknowledged by the operator. Usually, an audible alarm is also included to attract the operator's attention to a central control panel containing the visual alarm units associated with practically all of the variables to be monitored in the plant involved, so that the operator can determine at a glance the condition of all of the variables.

For the most part, annunciator systems of the kind just described have heretofore been hydraulically or relay controlled systems, and these systems left much to be desired from the standpoint of reliability because of mechanical wear and, in the case of the relays, additionally because the relay coils sometimes burned out. Obviously, it is quite important for annunciator systems to be reliable, since otherwise, they could not fulfill their intended purpose. More recently, static control elements, such as magnetic cores, have been used in annunciator systems to replace relays to provide a system of improved reliability. Annunciator systems have also been recently developed operating with transistor control elements. Although these systems have proven satisfactory for some purposes, they are not as reliable as magnetic core annunciator systems and also do not have sufficient flexibility to be useful for certain applications, such as applications requiring a single light for each variable which light flashes during initial alarm indication and is steady-on when acknowledged. Particularly with magnetic core systems, the annunciators have not been provided with a true manual reset feature. For true manual reset, an acknowledged alarm indication is removed by momentary depression of a manual reset switch provided the variable has returned to normal. Heretofore, in annunciator systems using magnetic core elements, the depression of the manual reset switch when the variable was still abnormal changes a steady acknowledged visual alarm indication to a flashing alarm indication, requiring depression of a manual acknowledgement switch to restore the steady acknowledgement indication.

It is, accordingly, an object of the present invention to provide an annunciator system made of static elements, preferably magnetic core elements, which have a higher degree of flexibility and, for certain applications, are more simple and reliable than static annunciator systems heretofore developed.

Another object of the present invention is to provide an annunciator system which includes one or more bistable control units, commonly referred to as flip-flop circuits, which are arranged and related to one another and to various control switches commonly found in annunciator systems in a unique manner so as to provide, in a relatively simple, economical and reliable manner, a flashing light sequence with provision for manual reset.

Still another object of the present invention is to

provide an annunciator system using static control elements, most preferably magnetic core elements, wherein, in a very simple and reliable manner, the aforesaid flashing sequence may be obtained using only a single alarm lamp. An ancillary object of the present invention is to provide an annunciator system as just described wherein provision is made for true manual reset operation.

Another object of the invention is to provide an annunciator system satisfying any one or more of the above objects wherein operation with either normally-open or normally-closed signal contacts may be simply obtained by the same equipment.

Still another object of the invention is to provide an annunciator system providing a dim light condition indicating a normal condition of the variable in a unique manner using a magnetic amplifier.

In accordance with one aspect of the invention, there is associated with each variable to be monitored by the annunciator system two bistable or flip-flop circuits formed of static elements, preferably magnetic core elements, which control the condition of operation of an associated alarm light. Each bistable control circuit has two conditions of operation, one which will be referred to as a normal or initial condition of operation and the other which will be referred to as an abnormal condition of operation. The normal and abnormal conditions of each variable are sensed by a primary detecting element, commonly a device including a set of normally-open or normally-closed signal contacts which are respectively opened or closed when the variable is normal. The signal contacts are connected between a signal source, which may be a source of direct current potential, and an input to a first one of said bistable control circuits. Operation of the signal contacts into a position indicating an abnormal variable couples said signal source to the first bistable control circuit to trigger it from an initial or normal condition to an abnormal condition. The second bistable control circuit is unaffected by the triggering of the first bistable control circuit to an abnormal condition of operation. For reasons to be explained, the bistable circuits are interconnected so that the second bistable circuit will automatically be triggered into its normal condition when the first bistable control circuit is triggered into its normal condition. Means are provided for flashing an alarm light when the first bistable control circuit is triggered into its abnormal condition. Most preferably, the first bistable control circuit controls the operation of a gate through which a source of energizing potential is coupled to the alarm light or to an intermediate control device such as a magnetic amplifier. A flashing indication is provided preferably by opening and closing the gate at a visible flashing rate as long as the first bistable control circuit is in its abnormal condition and the second bistable circuit remains in its normal condition.

A manually operable acknowledgement switch is provided which, upon momentary operation thereof, feeds a control signal to an input of the second bistable control circuit to trigger it from its normal to its abnormal condition. Means are provided which couple a continuous energizing potential to the alarm light or to an intermediate control device associated therewith to operate the alarm light in a steady-on condition when the second bistable control circuit is in its abnormal condition. Most advantageously, the pulsating or flashing signal at the output of the aforementioned gate is mixed with a continuous energizing signal controlled by the second bistable control circuit producing an overall result which is a steady light indication. This mixing of signals is particularly desirable where an intermediate control device controls the operation of the alarm light, the con-

trol device acting as an on or an off switch, such as in the case of a magnetic amplifier having saturated and unsaturated conditions of operation.

A manually operable reset switch is most advantageously provided, momentary operation of the manual reset switch normally connecting a signal to an input of the first bistable control circuit which returns the same to its normal condition provided the associated variable responsive signal contacts are then in their normal condition indicating state. Otherwise, the first-mentioned signal source coupled through the signal contacts will maintain the first bistable control circuit in its abnormal condition despite the feeding of a reset signal thereto. As previously indicated, when the first bistable control circuit is triggered into its normal condition, the second bistable control circuit also returns to its normal condition. When both bistable control circuits are in their normal condition, the alarm light is de-energized due to the resultant de-coupling of the aforesaid energizing signals from the alarm light or the intermediate control device controlling the same.

In accordance with another aspect of the invention, the aforesaid intermediate control device to which the aforementioned energizing signals are fed comprises a special type of magnetic amplifier. Instead of using a high-quality, magnetic core material having a low leakage current in the output winding thereof, the magnetic amplifier uses a relatively low quality iron in the core thereof which may be a commercial grade silicon iron material, to provide a relatively high leakage current in the output winding, so that an alarm light connected in series with the output winding and a source of 60 cycle A.C. voltage will be operated in a dim but visible condition when the core is in an unsaturated state.

The aforementioned energizing signals are fed in parallel to the primary winding of the magnetic amplifier, which signals saturate the core material. The alarm light connected in series with the output winding of the magnetic amplifier receives a relatively high energizing current when the core of the magnetic amplifier is saturated.

In accordance with still another aspect of the invention, in addition to the alarm light circuit above described, a second alarm light may be associated with each variable which alarm light provides a steady-on light indication only when the associated signal contacts are in their abnormal indicating state. The second alarm light may be mounted behind a translucent panel adjacent the first mentioned alarm light so that an apparent single light indication is provided which is the resultant of the two alarm lights. This application has the advantage of increased reliability since failure of the first mentioned alarm light will still leave a visual light indication. A steady-on light of the second alarm light superimposed on the flashing light of the first-mentioned alarm light will result in an overall flashing light indication, so that the second alarm light will not adversely affect the flashing light sequence desired.

Another aspect of the invention relates to the lighting of the second-mentioned alarm light through a magnetic amplifier whose input circuit includes provision for connection to either normally-open or normally-closed signal contacts. The use of normally-closed signal contacts to shunt current around the alarm light generally requires a current-limiting resistor in series with the variable responsive signal contacts to prevent a short circuit condition. Where a high wattage light is desired, this arrangement is disadvantageous because the resistor must take the large current passing through the light, resulting in wastage of power, and, in many cases, problems in preventing overheating of the adjacent equipment.

In accordance with the present invention, the normally-closed signal contacts are connected in parallel with the input windings of a magnetic amplifier which greatly reduces the current requirements of the input circuit. In such case, the normally-closed signal contacts shunt the primary windings of the magnetic amplifier. Opening of these contacts causes a saturating current to flow in the primary windings which results in the passage of a large energizing current in the output winding of the magnetic amplifier. This magnetic amplifier circuit is also readily adaptable for use in normally-open signal contacts which are connected in series with the input windings of the magnetic amplifier.

Other aspects of the invention relate to the details of the bistable control circuits and the specific interconnections of various components associated therewith. These together with the various aforesaid aspects of the invention will be described in detail in the specification to follow, the claims and the drawings wherein:

FIG. 1 is a simplified box diagram of a preferred form of the present invention;

FIG. 2 is a schematic diagram of the preferred embodiment of the form of the invention illustrated in FIG. 1;

FIG. 3 shows a modified form of the invention wherein a magnetic amplifier is associated with the signal contacts which may be either normally-open or normally-closed; and

FIG. 4 shows the B-H curve of the magnetic core material used in the magnetic amplifiers illustrated in FIGS. 1 through 3.

Referring now to FIG. 1, an annunciator system is there shown including a number of annunciator units or stations **2** connected in parallel between various buses **4** through **11** which will be identified in the paragraphs to follow. Each of the annunciator stations contains all of the components exclusively associated with each variable to be monitored and includes visual alarm means **14** which may include an incandescent lamp **16** mounted behind a lense unit (not shown) or a translucent panel **17**. For reasons to be explained, a second incandescent lamp **16'** is also preferably mounted behind the panel **17** but it could be omitted without affecting the light sequence provided by the annunciator system.

Audible alarm means **18** including a horn or bell **20** is used in common with all of the annunciator stations and, in conjunction with the alarm lamp **16** and/or **16'**, provides various signals to indicate the normal, initial abnormal and acknowledged abnormal conditions of the associated variables.

The operation of the horn **20** and the various lights **16** and **16'** are controlled by variable responsive means associated with each annunciator unit, the variable responsive means shown in the drawings being either normally-open signal contacts **24** or normally-closed signal contacts **26**. A common manually operable acknowledgement push-button switch **28** and a common manually operable push-button reset switch **30** are provided for manually controlling the annunciator system. Various means to be described interconnect the buses **4** through **11**, the individual signal contacts **24** or **26**, the lamps **16** and **16'**, the common horn **20** and the switches **28** and **30**, to form an operative annunciator system. As will appear, these means are adapted to sound the horn **20** and cause a flashing indication to appear on the alarm light **16** associated with any variable which becomes abnormal upon closure of the associated normally-open signal contacts **24** or the opening of the associated normally-closed signal contacts **26**. Upon momentary depression of the manually operable acknowledgement switch **28**, the flashing indication on alarm lamp **16** is changed to a steady-on condition, and the horn **20** is silenced. The steady-on condition of the alarm lamp **16** will continue until the variable involved has returned to normal and the reset switch **30** subsequently is momentarily depressed. When these conditions are met, the alarm lamp **16** will become de-energized.

The alarm lamp **16'** is provided with each annunciator station in the interest of increasing the reliability of the annunciator system. Each lamp **16'** responds directly to the associated signal contacts **24** or **26** so as to provide

a steady-on light condition when the associated variable is abnormal or a de-energized condition when the variable is normal.

The alarm lamp **16'** is preferably mounted behind the same translucent panel **17** as the alarm lamp **16**, so that an over-all single light indication is provided which is a flashing indication during an initial alarm condition and a steady-on condition after acknowledgement. The purpose of the alarm light **16'** is to provide an alarm indication should the alarm light **16** burn out or otherwise become inoperable.

For controlling the operation of the alarm lamps **16**, each annunciator station is provided with a pair of bistable control circuits generally indicated by reference numerals **32** and **34**. Bistable control circuit **32** includes a pair of static current control devices **32***a* and **32***b* and bistable control circuit **34** includes a pair of static control devices **34***a* and **34***b*. In accordance with the broadest aspect of the invention, the current control devices may be any kind of static element such as transistor or magnetic core elements, magnetic cores being the preferred type of static element, however, for reasons including their reliability, and the simplicity of the circuitry resulting from their use. Each pair of current control devices are connected to form a bistable or flip-flop circuit preferably of the type where the devices have opposite stable conductive or signal output conditions which are reversed when the conductive or output conditions of one device is changed.

The static devices **32***a* and **34***a* of bistable control circuits **32** and **34** respectively have outputs **36** and **37** connected to inputs **38** and **39** respectively of the associated static devices **32***b* and **34***b*. Likewise, the static devices **32***b* and **34***b* have outputs **40** and **41** respectively connected to inputs **41** and **42** of static devices **32***a* and **34***a*. For reasons to be explained, output **36** of static device **32***a* of bistable control circuit **32** is connected by a conductor **44** to the input **39** of the static device **34***b* of the other bistable control circuit **34**.

The two possible operating states of the bistable control circuits considered as a whole will be respectively referred to as the normal and abnormal states thereof. The connection between the output **36** of the static device **32***a* and the input **39** of the static device **34***b* is such that the change in the output condition of the static device **32***a* when the bistable circuit **32** is changed from its abnormal to its normal operating state will trigger the bistable control circuit **34** from an abnormal to a normal operating state. However, the output condition existing at output **36** of static device **32***a* when the bistable control circuit **32** changes from its normal to its abnormal operating state will not have any effect upon the bistable control circuit **34**. This arrangement of bistable control circuits provides a relatively simple and reliable means for controlling the operation of the associated alarm light **16** in response to the various operations of the associated signal contacts **24** and **26** and the acknowledgement and reset switches **28** and **30**.

A pair of screw terminals **44**—**44** are provided in each annunciator unit **2** across which the normally-open signal contacts **24** may be removably connected. Provision is also made for shorting the terminals **44**—**44** when the normally-closed signal contacts **26** are utilized. To this end, a jumper may be used, or, as illustrated, a single pole double-throw switch **46** is provided with the movable pole thereof connected to the lower terminal **44** and movable selectively against an "N.C." switch contact **48** connected to the upper terminal **44** or an unconnected "N.O." switch contact **50**. The upper terminal **44** is connected by a conductor **52** to the bus **5**, sometimes referred to as a signal bus. The signal bus **5** is shown connected to the terminal of a source **53** of direct current voltage, but, in accordance with the broader aspects of the invention, could be a source of pulses. The lower terminal **44** is connected through a current-limiting resistor **54** to the upper of a pair of screw terminals **56**—**56** across which the set of normally-closed signal contacts **26** may be connected when operation with this type of field contacts is desired. The alarm lamp **16'** is connected across the terminals **56**—**56**. The lower terminal **56** is connected by a conductor **58**, to the bus **8**, referred to as a common bus, which is grounded. A conductor **60** extends between the juncture of current-limiting resistor **54** and the upper terminal **56** and the input **41** of the static device **32***a* of the bistable control circuit **32**.

The bistable control circuit **32** is arranged so that it will be triggered from its normal operating state to its abnormal operating state whenever the signal on the signal bus **5** is connected to the input **41**. For operation with the normally-open signal contacts **24**, this results upon closure of the signal contacts which connects the signal bus **5** through these contacts, current-limiting resistor **54** and conductor **60** to the input **41** of the bistable control circuit. The same result occurs with operation with the normally-closed signal contacts **26**. In such case, the input **41** is continuously connected to the signal bus **5** through the resistor **54**, the switch **46** and conductor **52**. When the associated variable is normal, the signal from the bus **5** is short circuited to ground by the normally-closed signal contacts **26**. Opening of these contacts will, however, result in the coupling of the signal on the bus **5** to the bistable control circuit input **41** which triggers the bistable control circuit **32** into its abnormal operating state. This state is maintained until externally triggered into its normal operating state. However, the bistable control circuit **32** cannot be triggered into the latter state until the input **41** is uncoupled from the signal bus **5**, as by the opening of the normally-open signal contacts **24** or the closing of normally-closed signal contacts **26**.

When the bistable control circuit **32** is in its abnormal operating state and the other bistable control unit **34** is in its normal operating state, the visual alarm lamp **16** provides an initial alarm indication which, in the embodiment of the invention illustrated, is a flashing indication. Also, the horn **20** will be sounded.

The circuit for providing a flashing indication on the alarm lamp **16** in the embodiment illustrated in FIG. 1 includes a gate unit **64** having a control signal input terminal **66**, a signal input terminal **68** and a gated signal output terminal **70**. The signal input terminal **68** is connected by a conductor **72** to a signal bus **11** extending to a signal source **74**. The gated signal output terminal **70** is connected by a conductor **76** to the input of visual alarm means **14**. When the gate unit **64** is open, energizing signals from the signal source **74** pass through the gate unit to the input of the visual alarm means **14**. When the gate unit **64** is closed, the energizing signals do not pass through the gate control unit **64**.

The input **66** of the gate unit **64** extends through an isolating diode **78** to the output **36** of the static device **32***a* of the bistable control circuit **32** and also through an isolating diode **80** to flasher bus **6** which is connected to a source of signals **82** which provides a signal at the input terminal **66** of the gate control unit **64** which, in the absence of other gate-closing signals thereat will open and close the gate unit **64** at a visible flashing rate. When the bistable control circuit **32** is in its normal operating state, a gate-closing signal is fed from the output thereof to the input terminal of the gate unit **64** which continuously closes the gate unit. When the bistable control circuit **32** is in its abnormal operating state, the only operative signal fed to the gate input terminal **66** is from the flasher bus **6** which, as above indicated, alternately opens and closes the gate unit at a visible flashing rate so as to feed a modulated energizing signal to visual alarm means **14** which produces a flashing indication on the alarm lamp **16**.

A circuit for sounding the horn **20** is established by an annunciator station when the associated variable initially becomes abnormal. This circuit extends from the

conductor 60 extending from the bottom terminal of the current-limiting resistor 54, and includes in the case where the signal bus 5 is connected to a source of direct current potential a pulsing circuit 81 and an isolating diode 83 connected by a conductor 82 to horn bus 4. The horn bus 4 extends to the input 84 of a horn bistable control circuit 86 which may be similar to either the bistable control circuit 32 or 34. When the direct current potential on the signal bus 5 is connected to the pulse circuit 81, a pulse is produced of a polarity which triggers the bistable control circuit 86 into an operating state which provides an output condition at its output terminal 88 capable of energizing audible alarm means 18 to which it is connected to sound the horn 20.

In addition to the flashing of alarm lamp 16 and the sounding of the horn 20 upon an initial abnormal condition of a variable, the alarm lamp 16' connected between common bus 8 and the lower end of the current-limiting resistor 54 will be energized by the voltage connected thereto from signal bus 5 upon closure of the normally-open signal contacts 24 or the opening of the normally-closed signal contacts 26 which previously short circuited the lamp 16'. Where the alarm lamps 16 and 16' are mounted behind the aforesaid common translucent panel 17, the overall indication will still be a flashing light. As previously explained, the purpose of the lamp 16' is merely to provide some kind of light indication should alarm lamp 16 burn out or be inoperative because of a defect in the control circuit therefor.

As previously indicated, momentary closure of the acknowledgement pushbutton switch 28 will change the light indication on the translucent panel 17 from a flashing indication to a steady-on indication and sound the horn 20. To this end, the acknowledgement switch 28 is connected between the upper terminal of direct current voltage source 53 or other suitable signal source and acknowledgement bus 9 and the bus 9 is connected by a conductor 90 to the input 42 of the bistable control circuit 34 of each annunciator station. The momentary closure of the switch 28 will couple a signal voltage capable of triggering the bistable control circuit 34 from its normal operating state to its abnormal indicating state, provided the associated bistable control circuit 32 is also in its abnormal operating state. If it were in its normal operating state, the condition at the output 36 of the static device 32*a* thereof is such that the signal coupled to the input 39 of the static device 34*b* will keep the bistable control circuit 34 in its normal operating state. When the bistable control circuit 34 is triggered into its abnormal operating state by operation of acknowledgement switch 28, a signal is fed to the input of the visual alarm means 14 which will result in a continuous indication on the alarm lamp 16.

In the embodiment of the invention illustrated in FIG. 1, the static device 34*b* of each bistable control circuit 34 acts as a gate for gating the signal from signal bus 11. A conductor 92 extends from the signal bus 11 to a signal input terminal 94 of each device 34*b*. The signal appearing therein is coupled through the static device 34*b* to the output terminal 43 thereof when the bistable control circuit 34 is in its abnormal operating state. This signal, which is a continuous signal, is fed through a conductor 96 to the input of visual alarm means 14.

In the circuit just described, it will be apparent that two signals are fed in parallel to the input of the visual alarm means 14, one a modulated signal fed by a conductor 76 from the gate unit 64 and the other a continuous signal fed from device 34*b* acting as a gate. The visual alarm means 14 is designed so that the combination of a continuous signal and a signal modulated at a visible flashing rate will produce a continuous indication on the alarm lamp 16. It will be described in connection with the specific and preferred annunciator circuit illustrated in FIG. 2.

For silencing the horn 20 after acknowledgement, a conductor 98 extends from acknowledgement bus 9 to an input 100 of the horn bistable control circuit 86 which triggers the circuit into its normal operating state. This results in an output condition at the output 88 thereof which will result in the de-energization of the horn 20.

After acknowledgement, the steady-on light indication on any alarm lamp 16 is locked-in until momentary operation of the reset pushbutton switch 30. Operation of this switch will de-energize the alarm lamp 16 provided the signal contacts have been returned to their normal indication position. The reset switch 30 is connected between the upper terminal of the direct current voltage source 53 and reset bus 10. A conductor 102 extends between the reset bus 10 and the input 38 of the static device 32*b* of the bistable control circuit 32 of each annunciator station. Momentary closure of the reset switch 30 will couple a voltage of proper polarity to the input 38 of any static device 32*b* in an abnormal state or condition of operation which will trigger the bistable control circuit involved into its normal operating state, provided the associated signal contacts have been returned to their normal indicating state. Otherwise, operation of the reset switch 30 will have no result. When the bistable control circuit 32 is returned to its normal operating state, as previously indicated, the signal condition at the output 36 of the associated static device 32*a* will be effective to trigger the associated bistable control circuit 34 to its normal operating state. This will close the associated gate unit 64 and the gate formed by the static device 34*b*, resulting in the de-energization of the alarm lamp 16. The alarm lamp 16' has then already been de-energized when the associated signal contacts returned to their normal indicating position.

Refer now more particularly to FIG. 2 which shows a substantially complete circuit diagram for the annunciator circuit illustrated in box form in FIG. 1 constructed with magnetic core static elements. Only one of the annunciator stations 2 appears in this figure, it being understood that all of the other annunciator stations are identical to the one illustrated. Corresponding reference numerals have been used to identify corresponding portions of the circuit in FIGS. 1 and 2. All of the bistable control circuits in the embodiment of FIG. 2 may be conventional bistable magnetic core circuits. Bistable control circuit 32 comprises a pair of magnetic core units 32*a* and 32*b* each of which may comprise a core 32*a*–1 or 32*b*–1 made of a magnetic material having a rectangular hysteresis curve. An input winding 32*a*–2 or 32*b*–2 and an output winding 32*a*–3 or 32*b*–3 having a greater number of windings than the associated input winding is wound around each core. A resistor 104 is connected between the upper terminal of the input winding 32*a*–2 and the input 41 to the bistable control circuit 32 involved. The bottom terminal of the input winding 32*a*–2 is connected to a ground conductor 106 extending to ground bus 8. The upper terminal of the output winding 32*a*–3 may constitute the output 36 referred to in FIG. 1 and is connected through a diode 108 polarized to pass only positive pulses to a resistor 110 connected to the upper terminal of the input winding 32*b*–2 of the magnetic core unit 32*b*. The bottom terminal of the input winding 32*b*–2 is connected by a conductor 112 to grounded conductor 106. The upper terminal of the output winding 32*b*–3 of the magnetic core unit 32*b* is connected to a conductor 113 leading to a diode 114 polarized to pass only positive pulses to the input 41 of the magnetic core unit 32*a*. The bottom terminal of the output winding 32*b*–3 is connected by a conductor 115 to signal bus 11 to which is coupled a source of alternating current which may be a signal from an output 116 of a 17 kc. signal source 74. The signal source 74 has a second output 118 coupled to a signal bus 120 which does not appear in the embodiment of FIG. 1, the signal appearing at the output 118 also being a 17 kc. signal but one 180° out of phase with the signal at output 116. The bus 120 is connected via a

conductor 121 at each annunciator station to the bottom terminal of the output winding 32*a*–3 of the associated magnetic core unit 32*a*.

The aforesaid coupling conductor 44 extends from the upper terminal of the output winding 32*a*–3 through a diode 124 polarized to pass only positive pulses to the right hand end of a diode 108' in the magnetic core bistable control circuit 34 which diode 108' corresponds to the diode 108 in the bistable control circuit 32. The details of the magnetic core bistable control circuit 34 and the horn bistable control circuit 86 may be identical to bistable control circuit 32 just described, so that a detailed description of these control circuits will not be given. Except for the magnetic core elements which are identified by reference numbers 34*a*—34*b*, 86*a*—86*b*, corresponding elements of these bistable control circuits are similarly numbered except that a single prime (') will be used in association with the reference numbers of the bistable control circuit 34 and a double prime (") will be used in association with the reference numbers in the bistable control circuit 86. Suffice it to say this point that the 17 kc. signal on bus 11 is fed by conductors 115 and 115" to the bottom terminals of the output windings of the right hand magnetic core units 34*b* and 86*b*, respectively, and the 180° out of phase 17 kc. signal on bus 120 is fed by conductors 121 and 121" to the bottom terminals of the left hand magnetic core units 34*a* and 86*a*.

Each of the magnetic core units 32*a*, 32*b*, 34*a*, 34*b*, 86*a* and 86*b* of the various bistable control circuits 32, 34 and 86 is connected as a "not" gate circuit which provides at the upper terminal of the associated output winding, to be referred to as a signal output terminal, relatively large positive pulses indicating the opening of the gate circuit involved provided the upper terminal of the associated input winding did not receive a similar positive pulse one-half cycle before. The associated signal input terminal, such as terminal 41 of core unit 32*a*, is referred to as a "not" control signal input terminal. The appearance of such large positive pulses is referred to as a signal output condition. Conversely, relatively small insignificant positive pulses will appear at the upper terminal of the associated output winding when a similar positive pulse was fed to the associated input winding one-half cycle before. Such insignificant pulses is referred to as a no-signal output condition. This action is due to the factors now to be described.

As previously indicated, due to the aforesaid diodes associated with the bistable control circuits, only positive voltage pulses appearing on the buses 11 and 120 are effective to provide operating current through the windings of the core units and these positive pulses are applied 180° out of phase respectively to the bottom terminals of the output windings of the associated cores of each bistable control circuit. Considering a particular magnetic core, if the current flowing in the output winding as a result of such a positive pulse is in a direction which will maintain the existing state of saturation of the core, then the output winding acts as a relatively low impedance so that a relatively large current pulsation results. If, on the other hand, the core is in a state of saturation such that the current resulting from the positive voltage pulse would drive the core to an opposite state of operation, then the core acts as a relatively high impedance and only a relatively small current pulsation results. In the former situation, the gate said to be open since large current pulsations are fed through the core and in the latter case the gate is said to be closed since relatively small or current pulsations pass through the core.

With the interconnection of the magnetic cores described, where the output of each core unit is coupled to the input of the associated core unit, a signal output condition of a particular core will maintain a relatively no-signal output condition in the other core and vice versa to form a true bistable circuit. Thus, if a continuous or momentary positive voltage is fed to the "not" control signal input terminal of a core unit having a signal output condition, this voltage will result in a no-signal output condition of the core unit which will then effect a signal output condition in the associated core unit which results in the triggering of the bistable control circuit involved into an opposite operating state.

When a particular annunciator station has been reset and the associated signal contacts are in their normal indicating position, the magnetic core bistable units 32 and 34 will be in a condition whereby the right-hand magnetic cores will be in a no-signal output condition and the left-hand core will be in a signal output condition. Relatively large positive current pulsations will then be passing through the output winding 32*a*–3 of the magnetic core unit 32*a* of the annunciator station involved. Part of this current will flow through the diode 108, resistor 110 and the input winding 32*b*–2 of magnetic core unit 32*b* and part of this current will pass through diode 78 (polarized to pass only positive current pulsations) to the aforesaid gate unit 64. The gate unit 64 in FIG. 2 is a "not" magnetic core gate circuit similar to the "not" magnetic core gate circuits making up bistable control circuits 32, 34 and 86. Thus it has an input winding 64*a*–2, an output winding 64*a*–3 having many more windings than the input winding and a core 64*a*–1 around which these windings extend. The upper end of the input winding 64*a*–2 is connected to a resistor 127 which, in turn, is connected to the juncture between diode 78 and the aforesaid diode 80 connected to the flasher bus 6. The bottom terminal of the input winding 64*a*–2 is coupled by a conductor 129 to ground conductor 106 leading to the ground bus 8. The upper terminal of the output winding 62*a*–3 is connected through an isolating diode 131 polarized to pass positive current pulsations to the conductor 76 leading to the visual alarm means generally indicated by reference numeral 14, and which will be described in detail in the paragraphs to follow. The bottom terminal of the output winding 64*a*–3 is connected to the aforesaid conductor 115 leading to the 17 kc. signal bus 11. The positive current pulses fed to the input winding 64*a*–2 of the magnetic core unit 64 from magnetic core unit 32*a* are 180° out of phase with the positive current pulses fed to the output winding 64*a*–3 from bus 11.

The output winding 64*a*–3 presents a relatively large impedance to flow of positive current pulses therethrough to provide a closed condition of the gate if the positive current pulses fed to the output winding are operative to switch the state of saturation of the associated core 64*a*–1. This occurs when the input winding 64*a*–2 has received a relatively large positive current pulse one-half cycle before which sets the core 64*a*–1 into a reference state of saturation. As previously indicated, such current pulses are present in the input winding 64*a*–2 when the bistable control circuit 32 is in its normal operating state, where the output of the left-hand core unit 32*a* has a signal output condition. Following the triggering of bistable control circuit 32 into its abnormal operating state upon the operation of the associated signal contacts 24 or 26 to their abnormal variable indicating position, the output of the magnetic core unit 32*a* has a no-signal output condition so that the core 64*a*–1 is not reset to its reference state of saturation. Consequently, the current pulses passing through the output winding 64*a*–3 of the gate unit 64 will be operative to maintain the saturation of the core as long as this condition prevails. In this situation, the output winding 64*a*–3 has a relatively low impedance to the passage of positive current pulses. However, as previously explained, positive current pulses are fed to the input winding 64*a*–2 from the flasher bus 6 periodically at a visible flashing rate, so that a gate unit 64 is alternately opened and closed at a visible flashing rate when the bistable control circuit 32 is in its abnormal indicating state. This condition of the gate unit 64 continues until the annunciator circuit is reset.

As previously indicated, the flashing signal received

from the gate unit **64** is superimposed within the visual alarm means **14** upon a signal fed from the right-hand magnetic core unit **34***b* of the bistable control circuit **34**. The right-hand magnetic core unit **34***b* acts as an open gate circuit after it has been acknowledged. Normally, the right-hand magnetic core unit **34***b* is in a no-signal output condition, which means that the output of the left-hand magnetic core unit **34***a* which feeds the input winding of magnetic core unit **34***b* is in a signal output condition. When the acknowledgement pushbutton switch **28** is momentarily closed, this feeds a positive pulse via conductor **90** and a diode **134** polarized to pass positive pulses to the input winding 34a–2 of the magnetic core unit **34***a*. Momentary closure of the acknowledgement switch **28** will feed a relatively large positive pulse to the "not" signal input terminal of the left-hand magnetic core unit **34***a* to trigger the same into a no-signal output condition which, in turn, triggers the right-hand core unit **34***b* into a signal output condition. The resultant large positive current pulses passing through the output winding **34***b*–3 of the magnetic core unit **34***b* passes, in part, through diode **136** polarized to pass only positive pulses to the input of visual alarm means **14**. A continuous series of such positive current pulses passes through the input of visual alarm means **14** to effect a steady-on condition of the associated alarm lamp **16** until the bistable control circuit **34** is returned to its normal operating state. As previously indicated, this occurs when the signal contacts **24** or **26** involved are returned to their normal variable indicating position and reset bushbutton switch **30** is subsequently momentarily depressed. Then, a positive pulse is fed from reset bus **9** through conductor **102** and a diode **140** at each annunciator station, the diode being polarized to pass only positive pulses to the input winding **32***b*–2 of the right-hand magnetic core unit **32***b* of the bistable control circuit **32**. This changes the signal output condition of the magnetic core unit **32***b* to a no-signal output condition which, in turn, effects the change of the output condition of the left-hand magnetic core unit **32***a* from a no-signal output condition to a signal output condition which effects the closing of the gate unit **64**. Also, the resultant positive pulses in the output circuit of the magnetic core unit **32***a* are coupled through the conductor **44** and the diode **124** to trigger the bistable control circuit **34** into its normal operating state by changing the signal output condition of the magnetic core unit **34***b* to a no-signal output condition.

As previously indicated, the visual alarm means **14** is designed to provide a flashing indication on the alarm lamp **16** provided only a signal modulated at a visible flashing rate is fed to the input thereof, and to provide a steady-on light indication thereon when a substantially continuous constant amplitude signal is fed thereto. To this end, a pair of magnetic amplifiers **142***a* and **142***b* are provided. Magnetic amplifier **142***a* has an input winding **142***a*–1 and an output winding **142***a*–2 and magnetic amplifier **142***b* has an input winding **142***b*–1 and an output winding **142***b*–2. For reasons to be explained, the input windings **142***a*–1 and **142***b*–1 are connected in series bucking relation so that any A.C. potential induced therein from the output windings **142***a*–2 and **142***b*–2 will cancel out. The output windings **142***a*–2 and **142***b*–2 are connected in series with the alarm lamp **16** and with a source of alternating current of ordinary commercial 60 cycle frequency through the medium of buses **144**—**146**. The aforesaid conductors **76** and **96** extending from the signal output terminals of gate units **64** and **34***b* extend to the upper end of the input winding **142***a*–1. The bottom end of the input winding **142***b*–1 is connected by a conductor **148** to the ground bus **8**. The magnetic core amplifiers **142***a* and **142***b* act as saturable devices where the output windings **142***a*–2 and **142***b*–2 act as relatively low impedances to flow of 60 cycle alternating current when the associated cores are saturated, and act as relatively high impedances when the associated cores are unsaturated. In the latter case, little or no current flows through the alarm lamp **16** and in the former case a relatively high current flows through the alarm lamp **16** to light the same brightly.

The flow of relatively large positive current pulses from either the gate unit **64***a* or the gate unit **34***b* through the input windings **142***a*–1 and **142***b*–1 will saturate the associated cores to energize the alarm lamp **16**. When current pulses flowing in the input windings originate only from the gate **64***a*, which is alternately opened and closed at a visible flashing rate, the alarm lamp **16** will accordingly flash at a visible flashing rate. When the gate **34***b* is open to pass continuous positive pulses to the input winding **142***a*–1 and **142***b*–1, then the cores are substantially continuously saturated so that a steady-on light appears on the alarm lamp **16**.

A filter capacitor **149** may be connected in parallel with the input windings **142***a*–1 and **142***b*–1 to filter the 17 kc. pulse components from the current fed thereto so that a substantially direct current potential is applied to the input windings. However, the capacitor **149** is of sufficiently small value that it does not filter out the lower frequency modulations of the 17 kc. current pulses which effect flashing of the alarm lamp **16**.

The audible alarm means **18** includes, in addition to the horn **20**, a pair of magnetic amplifiers **152***a* and **152***b* which may be identical to and operated in the same manner as the magnetic amplifiers **142***a* and **142***b* just described. Thus, these magnetic amplifiers have input windings **152***a*–1 and **152***b*–1 connected in series bucking relation and output windings **152***a*–2 and **152***b*–2 connected in series with the horn **20** and with the 60 cycle alternating current buses **144** and **146**. The upper end of the input winding of magnetic amplifier **152***a* is connected through a diode **154** polarized to pass only positive pulses to the signal output terminal **156** of magnetic core bistable control circuit **86**, the terminal **156** being connected to the upper end of the output winding **86***b*–3 of the right-hand magnetic core unit **86***b* thereof. A filter capacitor **157** is connected in parallel with input windings **152***a*–1 and **152***b*–1 of magnetic amplifiers **152***a* and **152***b* to filter out the 17 k.c. pulses. It is apparent that the horn **20** will be sounded whenever the right-hand magnetic core unit **86***b* is in a signal output condition and will be silenced whenever the right-hand magnetic core **86***b* is in a relatively no-signal output condition.

The pulse circuit **81** at each annunciator station for pulsing the horn bus **4** may comprise a capacitor connected between diode **83** and the input line **60** so that a positive pulse is produced as capacitor **60** charges up to the direct current voltage coupled thereto by the operation of the signal contacts **24** or **26** to their abnormal variable indicating condition.

Means are provided in the annunciator circuit shown for manually triggering all of the annunciator stations simultaneously to test the operation of the system. To this end, a test bus **158** is provided which is connected through a normally-open pushbutton switch **160** to the positive terminal of the direct current voltage source **53**. A conductor **161** is associated with each annunciator station which extends from the test bus **158** through a diode **162** polarized to pass a positive voltage to the input **41** of the associated bistable control circuit **32**. Momentary closure of the test pushbutton switch **160** will trigger the bistable control circuits **32** into their abnormal operating state which provides flashing indications on the alarm lamps **16**. Subsequent operation of acknowledgement pushbutton switch **128** will change the flashing indications on alarm lamps **16** to a steady-on indication, and subsequent depression of the reset pushbutton switch **30** will reset all the annunciator stations.

The customer may desire to have a dimly lit indication on the alarm lamps **16** so that the operating condition of the alarm lamps **16** can be immediately determined by noting the dim light indications thereof. To this end,

in accordance with another aspect of the invention, unique means are provided to obtain a dim indication on the alarm lamps **16**. This is obtained in each of the visual alarm means **14** by using a high loss, commercial grade iron in the cores of magnetic amplifiers **142***a* and **142***b*, such as a silicon-iron material, so that a relatively large leakage current will flow through the secondary windings **142***a*–**2** and **142***b*–**2** during the unsaturated condition of the cores to light the associated alarm lamps **16** dimly. FIG. 4 illustrates the hysteresis curve of a high loss commercial grade iron. Magnetic cores in current use in control devices use high grade ferrous materials having rectangular shaped hysteresis curves.

As previously described, the alarm lamp **16'** of each annunciator station is placed in series with the current-limiting resistor **54** where the annunciator system is adapted for use with normally-closed field contacts **26** placed in shunt with the alarm lamp **16'**. In order to insure operation of annunciator stations with normally-open signal contacts **24** should the alarm lamp **16'** burn out, or to otherwise provide proper input impedance conditions, a resistor **163** may be placed in parallel with each alarm lamp **16'**. In this circuit, appreciable current flows through the current-limiting resistor, namely the current which is necessary to energize the alarm lamp **16'**. The resistor **54** must accordingly be sufficiently small to allow this required current to flow under the voltage conditions involved. A relatively small resistor **54** will, of course, result in appreciable current drain and consequent heating and power loss under normal variable conditions when normally-closed signal contacts are used. Since it is desirable to minimize the amount of current passing through current-limiting resistor **54** to minimize power loss and heating problems, the alarm lamp **16'** is desirably a low wattage lamp. For example, the alarm lamp **16'** may be a one watt lamp whereas the alarm lamps **16** my preferbly be six watt lamps. To further reduce the current drain required in the input circuit to the various annunciator stations, the input circuit shown in FIG. 3 is preferred.

This input circuit includes a pair of magnetic amplifiers **165***a* and **165***b* arranged in a manner similar to that previously described in connection with the magnetic amplifiers associated with the alarm lamps **16** and the horn **20**. Thus, magnetic amplifier **165***a* has an input winding **165***a*–**1** and an output winding **165***a*–**2** and the magnetic amplifier **165***b* has an input winding **165***b*–**1** and an output winding **165***b*–**2**. The input windings **165***a*–**1** and **165***b*–**1** are connected in series bucking relationship. The upper end of the input winding **165***a*–**1** is connected in series with a much larger current-limiting resistor **54'** than the resistor **54** previously described and the bottom end of the input winding **165***b*–**1** is connected to a lower terminal **44** of a pair of terminals **44**—**44** across which the normally-open signal contacts **24** are connected. The upper terminal **44**, as in the previously described circuit, is connected to the signal bus **5**.

Terminals **56**—**56** across which the normally-closed signal contacts **26** are to be placed are respectively connected between the juncture of resistor **54'** and the upper end of the input winding **162***a*–**1**, and the ground bus **8**. The latter juncture point is connected by the aforesaid conductor **60** to the input **41** of the bistable control circuit **32**.

The output windings **165***a*–**2** and **165***b*–**2** are connected in series with one another and with the alarm lamp **16'**, which may now be a six watt lamp, and with the 60 cycle current buses **144** and **146**. Where dim operation of the alarm lamp **16'** is desired, the cores of magnetic amplifiers **165***a* and **165***b* are made of a high loss material exemplified by the hysteresis curve in FIG. 4.

The input circuit shown in FIG. 3 is designed so that upon closing of normally-open signal contacts **24** or opening of normally-closed signal contacts **26** (in the latter situation the terminals **44**—**44** are shorted), the current flowing through the resistor **54'** is sufficient to saturate the cores of the magnetic amplifiers **165***a* and **165***b*. As is common knowledge in the art, the amount of current required to saturate such magnetic cores may be much less than the current required to light a one watt lamp. The resistor **54'**, therefore, may be many times larger than the resistor **54** required in the prtviously described circuit so that current flow under both normal and abnormal variable conditions is substantially less than before. When the cores of the magnetic amplifiers are saturated, the impedance of the output windings **165***a*–**2** and **165***b*–**2** is relatively low, so that relatively large current flows through the alarm lamp **16'** to light the same brightly. When the cores are unsaturated, the impedance of these windings is low, and due to the relatively large leakage current caused by the high loss iron used in the cores of the magnetic amplifiers, the alarm lamp **16'** is dimly lit to a point where it is just visible to the naked eye.

The present invention has provided an improved static element annunciator circuit which is highly desirable from the standpoint of simplicity, reliability and flexibility, particularly where a flashing sequence with a single alarm lamp is desired.

It should be understood that numerous modifications may be made of the preferred forms of the invention illustrated and described without deviating from the broader aspects of the invention.

What I claim as new and desire to protect by Letters Patent of the United States is:

1. An annunciator including: visual alarm means, condition responsive means having a normal variable indicating state and an abnormal variable indicating state, manually operable acknowledgement means, and control circuit means responsive to said condition responsive means and said manually operable acknowledgement means to provide different alarm indications on said visual alarm means comprising: a first and a second bistable circuit each comprised of a pair of static control elements and having two operating states, means for setting said first bistable circuit into one of its operating states when said condition responsive means is in its abnormal variable indicating state, means for operating said visual alarm means to provide an initial alarm indication when said first bistable circuit is in said one operating state, and for providing a normal indication thereon when said first bistable circuit is in its other operating state, means for setting said second bistable circuit into one of its operating states when said manually operable acknowledgement means is operated, means for changing said initial alarm to an acknowledged alarm indication on said visual alarm means when said second bistable circuit is in said one operating state, and means for setting said first and second bistable circuits into their other operating states after said condition responsive means is in its normal variable indicating state.

2. An annunciator including: visual alarm means, condition responsive means having a normal variable indicating state and an abnormal variable indicating state, manually operable acknowledgement means, manually operable reset means, and control circuit means responsive to said condition responsive means and said manually operable acknowledgement and reset means to provide different alarm indications on said visual alarm means comprising. a first and a second bistable circuit each comprised of a pair of static control elements and having two operating states, means for setting said first bistable circuit into one of its operating states when said condition responsive means is in its abnormal variable indicating state, means for operating said visual alarm means to provide an initial alarm indication when said first bistable circuit is in said one operating state, and for providing a normal indication thereon when said first bistable circuit is in its other operating state, means for setting said second bistable circuit into one of its operating states when manually operable acknowledgement means is operated, means for changing

said initial alarm to an acknowledged alarm indication on said visual alarm means when said second bistable circuit is in said one operating state, and means for setting said first and second bistable circuits into their other operating states when said manually operable reset means is operated and said condition responsive means is in its normal variabel indicating state.

3. An annunciator including: visual alarm means, condition responsive means having a normal variable indicating state and an abnormal variable indicating state, manually operable acknowledgement means, manually operable reset means, and control circuit means responsive to said condition responsive means and said manually operable acknowledgement and reset means to provide different alarm indications on said visual alarm means comprising: a first and a second bistable circuit each comprised of a pair of static control elements and each having two operating states, means for setting said first bistable circuit into one of its operating states when said condition responsive means is in its abnormal variable indicating state, means for operating said visual alarm means to provide an initial alarm indication when said first bistable circuit is in said one operating state, and for providing a normal indication thereon when said first bistable circuit is in its other operating state, means for setting said second bistable circuit into one of its operating states when said manually operable acknowledgement means is operated, means for changing said initial alarm to an acknowledged alarm indication on said visual alarm means when said second bistable circuit is in said one operating state, means for changing said initial alarm on said visual alarm means to an acknowledged alarm indication when said scond bistable circuit is in said one operating state, means for setting said first bistable circuit into its other operating state when said manually operable reset means is operated and said condition responsive means is in its normal variable indicating state, and means for setting said second bistable circuit to its other operating state to cancel said acknowledged alarm indication when said first bistable circuit is triggered into said other operating state.

4. An annunciator including: visual alarm means, condition responsive means having a normal variable indicating state and an abnormal variable indicating state, manually operable acknowledgement means, and control circuit means responsive to said condition responsive means and said manually operable acknowledgement means to provide different alarm indications on said visual alarm means comprising: a first static element bistable control circuit controlled by said condition responsive means and triggered into one operating state when said condition responsive means is operated to its abnormal variable indicating state and triggered into its other operating state after said condition responsive means returns to its normal variable indicating state, a second static element bistable control circuit controlled by said manually operable acknowledgement means and triggered into one operating state when said manually operable acknowledgement means is operated, means feeding a first energizing signal pulsating at a visible flashing rate to said visual alarm means to flash the same only when said first bistable circuit is in said one operating state, and means superimposing a second energizing signal upon said first energizing signal to provide a substantially constant indication on said visual alarm means only when said second bistable circuit is in said one operating state.

5. An annunciator including: visual alarm means, condition responsive means having a normal variable indicating state and an abnormal variable indicating state, manually operable acknowledgement means, manually operable reset means, and control circuit means responsive to said condition responsive means and said manually operable acknowledgement and reset means to provide different alarm indications on said visual alarm means comprising: a first static element bistable control circuit controlled by said condition responsive means and said manually operable reset means and triggered into one operating state when said condition responsive means is operated to its abnormal variable indicating state and triggered into its other operating state when said manually operable reset means is operated and said condition responsive means returns to its normal variable indicating state, a second static element bistable control circuit controlled by said manually operable acgnowledgement means and said first bistable control circuit and triggered into one operating state when said manually operable acknowledgement means is operated and into its other operating state when said first bistable circuit is triggered to said other operating state, means feeding a first energizing signal to said visual alarm means to provide an initial alarm indication only when said first bistable circuit is in said one operating state, means feeding a second energizing signal to said visual alarm means to provide an acknowledged alarm indication only when said second bistable circuit is in said one operating state, and means for setting said first and second bistable circuits into their other operating states when said manually operable reset means is operated and said condition responsive means is in its normal variable indicating state.

6. An annunciator including: visual alarm means, condition responsive means having a normal variable indicating state and an abnormal variable indicating state, manually operable acknowledgement means, and control circuit means responsive to said condition responsive means and said manually operable acknowledgement means to provide different alarm indications on said visual alarm means comprising: a first static element bistable control circuit controlled by said condition responsive means and triggered into one operating state when said condition responsive means is operated to its abnormal variable indicating state and triggered into its other operating state after said condition responsive means returns to its normal variable indicating state, a second static element bistable control circuit controlled by said manually operable acknowledgement means and said first bistable control circuit and triggered into one operating state when said manually operable acknowledgement means is operated and triggered into its other operating state when said first bistable circuit is triggered to said other operating state, means feeding a first energizing signal to said visual alarm means to provide an initial alarm indication only when said first bistable circuit is in said one operating state, and means feeding a second energizing signal to said visual alarm means which effects an acknowledged alarm indication thereon only when said second bistable circuit is in said one operating state.

7. An annunciator including: visual alarm means, condition responsive means having a normal variable indicating state and an abnormal variable indicating state, manually operable acknowledgement means, manually operable reset mens, and control circuit means responsive to said condition responsive means and said manually operable acknowledgement and reset means to provide different alarm indications on said visual alarm means comprising: a first static element bistable control circuit controlled by said condition responsive means and said manually operable reset means and triggered into one operating state when said condition responsive means is operated to its abnormal variable indicating state and triggered into its other operating state when said manually operable reset means is operated and said condition responsive means returns to its normal variable indicating state, a second static element bistable control circuit controlled by said manually operable acknowledgement means and triggered into one operating state when said manually operable acknowledgement means is operated, means feeding a first energizing signal pulsating at a visible flashing rate to said visual alarm means to flash the same only when said first bistable circuit is in said one operating state, means superimposing a second energizing signal upon said first energizing signal to provide a resultant substantially constant

indication signal on said visual alarm means only when said second bistable circuit is in said one operating state, and means for setting said first bistable circuit into its other operating state when said manually operable reset means is operated and said condition responsive means is in its normal variable indicating state.

8. An annunciator including: visual alarm means, condition responsive means having a normal variable indicating state and an abnormal variable indicating state, manually operable acknowledgement means, manually operable reset means, and control circuit means responsive to said condition responsive means and said manually operable acknowledgement and reset means to provide different alarm indications on said visual alarm means comprising: a first static element bistable control circuit controlled by said condition responsive means and said manually operable reset means and triggered into one operating state when said condition responsive means is operated to its abnormal variable indicating state and triggered into its other operating state when said manually operable reset means is operated and said condition responsive means returns to its normal variable indicating state, a second static element bistable control circuit controlled by said manually operable acknowledgement means and said first bistable control circuit and triggered into one operating state when said manually operable acknowledgement means is operated, means feeding a first energizing signal pulsating at a visible flashing rate to said visual alarm means to flash the same only when said first bistable circuit is in said one operating state, means superimposing a second energizing signal upon said first energizing signal to provide a resultant substantially constant indication signal on said visual alarm means only when said second bistable circuit is in said one operating state, means for setting said first bistable circuit into its other operating state when said manually operable reset means is operated and said condition responsive means is in its normal variable indicating state, an audible alarm, a third static element bistable control circuit controlled by said condition responsive means and said manually operable acknowledgement means and operating independently of said first and second bistable control circuits, said third bistable control circuit being triggered into one operating state when said condition responsive means is in its abnormal variable indicating state and being triggered into its other operating state when said manually operable acknowledgement means is operated, and means for feeding an energizing signal to said audible alarm only when said third bistable circuit in said one operating state.

9. In an annunciator circuit including an alarm light, variable responsive switch means having a normal variable indicating condition and an abnormal variable indicating condition, and a source of alternating current for energizing said alarm light in response to operation of said switch means from its normal to its abnormal variable indicating condition, the improvement in a circuit connected between said switch means and said alarm light comprising: a saturable magnetic device having a magnetic core with input and output windings on the core, the output winding being connected between said alarm light and said source of alternating current, a source of current for saturating said core substantially continuously when fed to the input winding thereof, the impedance of the output winding when the core is saturated being sufficiently low that a relatively large current flows through the alarm light to light the same brightly and the impedance thereof when the core is unsaturated being relatively high to provide a substantially de-energized condition of the alarm light, said core being made of a high-loss magnetic material wherein the leakage current under unsaturated core conditions is sufficient to light the light, and means coupling said switch means to said source of saturating current and to said input winding to saturate said core when said switch means is in its abnormal variable indicating condition and to unsaturate the core when said switch means is in its normal variable indicating condition.

10. In an annunciator circuit including an alarm light, a first set of terminals for selective connection to a set of normally-closed variable responsive signal contacts, a second set of terminals for selective connection to a set of normally-open variable responsive signal contacts, and a source of alternating current for energizing said alarm light in response to opening of said normally-closed signal contacts or upon closure of said normally-open signal contacts, the improvement in a circuit connected between said first and second set of terminals and said alarm light comprising: a saturable magnetic device having a magnetic core with input and output windings on the core, the output winding being connected between said alarm light and said source of alternating current, a source of current for saturating continuously said core when fed to the input winding thereof, the impedance of the output winding when the core is saturated being sufficiently low that a relatively large current flows through the alarm light to light the same brightly and the impedance thereof when the core is unsaturated being relatively high to provide a substantially de-energized condition of the alarm light, said core being made of a high-loss magnetic material wherein the leakage current under unsaturated core conditions is sufficient to light the alarm light dimly to a point where it is visible to the naked eye, a current-limiting resistor, means connecting said current-limiting resistor and said second set of terminals between said input winding and said source of saturating current, means connecting said first set of terminals in series with said current-limiting resistor and in shunt with said input winding whereby saturating current is shunted around the input winding as long as the signal contacts are closed, said source of saturating current being de-coupled from said input winding when said normally-open contacts are open.

11. In an annunciator circuit including an alarm light, a first set of terminals for selective connection to a set of normally-closed variable responsive signal contacts, a second set of terminals for selective connection to a set of normally-open variable responsive signal contacts, and a source of alternating current for energizing said alarm light in response to opening of said normally-closed signal contacts or upon closure of said normally-open signal contacts, the improvement in a circuit connected between said first and second set of terminals and said alarm light comprising: a saturable magnetic device having a magnetic core with input and output windings on the core, the input winding being connected between said alarm light and said source of alternating current, a source of current for saturating continuously said core when fed to the input winding thereof, the impedance of the output winding when the core is saturated being sufficiently low that a relatively large current flows through the alarm light to light the same brightly and the impedance thereof when the core is unsaturated being relatively high to provide a substantially de-energized condition of the alarm light, a current-limiting resistor, means connecting said current-limiting resistor and said second set of terminals between said input winding and said source of saturating current, and means connecting said first set of terminals in series with said current-limiting resistor and in shunt with said input winding whereby saturating current is shunted around the input winding as long as the signal contacts are closed, said source of saturating current being de-coupled from said input winding when said normally-open contacts are open.

12. In an annuniciator circuit including an alarm light, variable responsive means having a normal variable indicating condition and an abnormal variable indicating condition, and a manually operable acknowledgement switch, the improvement in a circuit for providing a flashing indication on said alarm light when the variable responsive means is in its abnormal indicating condition and a steady indication thereon upon subsequent operation of said

acknowledgement switch, said circuit comprising: a first signal source for providing a current of an amplitude varying at a visible flashing rate, a second signal source for providing a current of relatively constant amplitude, a saturable magnetic control device having a magnetic core with input and output windings on the core, said output winding being connected in series with said alarm light and a source of energizing current pulses, the impedance of said output winding when the associated core is saturated being relatively low to provide energizing current which lights the alarm light brightly, first gating means connected between said first signal source and the input winding of said magnetic control device, second gating means connected between said second signal source and said input winding to feed current from said second signal source to said input winding, means responsive to the abnormal variable indicating condition of said variable responsive means by opening said first gating means to pass the current therefrom to said input winding to successively saturate and unsaturate the core at a visible flashing rate to flash said alarm light, and means responsive to operation of said acknowledgement switch by opening said second gating means to pass current therefrom to said input winding to saturate the core substantially continuously to light the alarm light continuously brightly.

13. In an annunciator circuit including an alarm light, variable responsive means having a normal variable indicating condition and an abnormal variable indicating condition, and a manually operable acknowledgement switch, the improvement in a circuit for providing a flashing indication on said alarm light when the variable responsive means is in its abnormal indicating condition and a steady indication thereupon subsequent operation of said acknowledgement switch, said circuit comprising: a first signal source for providing a current of an amplitude varying at a visible flashing rate, a second signal source for providing a current of relatively constant amplitude, a saturable magnetic control device having a magnetic core with input and output windings on the core, said output winding being connected in series with said alarm light and a source of energizing current pulses, the impedance of said output winding when the associated core is saturated being relatively low to provide energizing current which lights the alarm light brightly, said core being made of a high-loss magnetic material wherein the current flowing in the output winding under unsaturated core conditions where the impedance of the output winding is relatively high and is yet sufficient to light the alarm light dimly to a point that it is visible to the naked eye, first gating means connected between said first signal source and the input winding of said magnetic control device, second gating means connected between said second signal source and said input winding to feed current from said second signal source to said input winding, means responsive to the abnormal variable indicating condition of said variable responsive means by opening said first gating means to pass the current therefrom to said input winding to successively saturate and unsaturate the core at a visible flashing rate to flash said alarm light, and means responsive to operation of said acknowledgement switch by opening said second gating means to pass current therefrom to said input winding to saturate the core substantially continuously to light the alarm lights continuously brightly.

14. An annunciator comprising an alarm light, manually operable acknowledgement means, and control circuit means responsive to said condition responsive means and said acknowledgement means for controlling said alarm light means comprising: a first and a second static element bistable circuit each having two operating states, means for operating said first bistable circuit to one of its operating states when said condition responsive means is changed from its normal to its abnormal variable indicating state, means for setting said second bistable circuit into one of its operating states when said manually operable acknowledgement means is operated, a saturable control device having an input which operates the control device in a first state of operation when the signal fed thereto has an amplitude exceeding a given value and operates the control device in a second state of operation when the amplitude of a signal given thereto is below said amplitude, means responsive to operation of said first bistable control circuit in said one operating state by coupling to said input signals whose amplitude exceed said given value at a visible flashing rate so that the saturable control device is saturated at a visible flashing rate, means responsive to the operation of said second bistable control circuit to said one operating state for feeding to said input a continuous signal which continuously saturates the control device, and circuit means connecting said alarm light to said saturable control device to energize the alarm light when the control device is in one of said states of operation and to de-energize the alarm light when the control device is in its other state of operation.

15. In an annunciator circuit including a first and a second bistable circuit, each bistable circuit comprising: a first and a second magnetic core "not" gate stage, each "not" gate stage including a magnetic core unit with windings thereon, a main signal input terminal, a "not" control signal input terminal and a signal output terminal, signal voltage means connected to said main signal input terminals of said first and second "not" gate stages, said first and second magnetic "not" gate stages each further including means connecting said various associated terminals to the associated core windings so that appreciable signals from said voltage means appear at the associated signal output terminal if a no-signal condition exists at the associated control signal input terminal, and a relatively no-signal output condition exists at the associated signal output terminal if a signal condition exists at the associated "not" signal input terminal, means connecting said signal output terminal of each "not" gate stage to the control signal input terminal of the other "not" gate stage, whereby the output condition of each "not" gate stage controls the output condition of the other "not" gate stage; variable responsive switch means having abnormal and normal variable indicating conditions, first circuit means connecting the variable responsive switch means to the control signal input terminal of the first "not" gate stage of the first bistable control circuit for feeding a signal thereto to provide a no-signal output condition thereof when the variable responsive switch means is in its abnormal variable indicating condition, the latter gate stage being in a signal output condition when the variable responsive switch means is in its normal variable indicating condition, manually operable acknowledgement switch means, second circuit means connecting said acknowledgement switch means to the control signal input terminal of the "not" gate stage of the second bistable control circuit which is normally not a signal output condition following the initial triggering of said first gate stage of the first bistable control circuit into a no-signal output condition, said second circuit means effecting the feeding of a signal to the control signal input terminal of the first "not" gate stage of the second bistable control circuit to trigger the same into a no-signal output condition, and visual alarm means, and means connecting said visual alarm means to both of said bistable control circuits to provide an initial alarm indication when the first bistable control circuit has been initially triggered by operation of said variable responsive switch means, and to provide an acknowledged alarm indication when said second bistable circuit has been triggered by said acknowledgement switch means.

16. In an annunciator circuit including a first and a second bistable circuit, each bistable circuit comprising: a first and a second magnetic core "not" gate stage, each "not" gate stage including a magnetic core unit with windings thereon, a main signal input terminal, a "not" control signal input terminal and a signal output terminal,

signal voltage means connected to said main signal input terminals of said first and second "not" gate stages, said first and second magnetic "not" gate stages each further including means connecting said various associated terminals to the associated core windings so that appreciable signals from said signal voltage means appear at the associated signal output terminal if a no-signal condition exists at the associated control signal input terminal, and a relatively no-signal output condition exists at the associated signal output terminal if a signal condition exists at the associated "not" signal input terminal, means connecting said signal output terminal of each "not" gate stage to the control signal input terminal of the other "not" gate stage, whereby the output condition of each "not" gate stage controls the output condition of the other "not" gate stage; variable responsive switch means having abnormal and normal variable indicating conditions, first circuit means connecting the variable responsive switch means to the control signal input terminal of the first "not" gate stage of the first bistable control circuit for feeding a continuous signal thereto to provide and maintain a no-signal output condition thereof when the variable responsive switch means is in its abnormal variable indicating condition, the latter gate stage being in a signal output condition when the variable responsive switch means is in its normal variable indicating condition, manually operable acknowledgement switch means, second circuit means connecting said acknowledgement switch means to the control signal input terminal of the "not" gate stage of the second bistable control circuit which is normally not a signal output condition following the initial triggering of said first gate stage of the first bistable control circuit into a no-signal output condition, said second circuit means effecting the feeding of a momentary signal to the control signal input terminal of the first "not" gate stage of the signal bistable control circuit to trigger the same into a no-signal output condition, manually operable reset switch means, third circuit means connecting the reset switch means to the control signal input terminal of the second "not" gate stage of the first bistable control circuit for connecting a momentary signal thereto upon momentary operation of the reset switch means to provide a no-signal output condition thereof provided said variable responsive switch means has returned to its normal variable indicating condition, and visual alarm means, and means connecting said visual alarm means to both of said bistable control circuits to provide an initial alarm indication when the first bistable control circuit has been initially triggered by operation of said variable responsive switch means to provide an acknowledged alarm indication when said second bistable circuit has been triggered by said acknowledgement switch means and to provide a normal visual indication when operation of said manual reset switch means is effective to trigger said first bistable control circuit.

17. An annunciator circuit comprising: variable responsive means directly to the variable and having a normal condition when the variable is abnormal, manually operable acknowledgement switch means, manually operable reset switch means, visual alarm means, and a control circuit responsive to said variable responsive means and said acknowledgement and reset switch means for providing an initial visual alarm indication on said visual alarm means when the variable responsive means is operated to its abnormal condition by the associated variable and a different acknowledged visual alarm indication thereon when said acknowledgement switch is operated, said control circuit comprising a first and a second pair of current control devices each forming a "not" gate control circuit having "not" signal input terminals and a gated signal output terminal and related means interconnecting the same to form first and second bistable circuits each having a first and a second state of operation, means coupling said variable responsive means to the "not" signal input terminal of one of the current control devices of said first bistable control circuit for effecting the triggering of the circuit formed thereby from its first to its second state of operation when said variable responsive means is operated to said abnormal condition and to then maintain this state of operation at least until said variable responsive means is returned to its normal condition, means coupling said acknowledgement switch means to the "not" signal input terminal of one of the current control devices of the second bistable circuit for effecting the triggering thereof from a first to a second state of operation upon momentary operation of said latter switch means, means interconnecting the first and second bistable circuits for effecting the triggering of the second bistable circuit into its first state of operation when the first bistable circuit is triggered into one of its states of operation, means coupling said visual alarm means to said control circuit to provide an initial visual alarm indication when the first bistable circuit is in its second state of operation and the second bistable circuit in its first state of operation, and to provide said acknowledged visual alarm indication when the first bistable circuit is in its second state of operation and the second bistable circuit is in its second state of operation, and means coupling said reset switch means to the "not" signal input terminal of one of the current control devices of said first bistable circuit for effecting the triggering thereof from its second back to its first state of operation upon momentary operation of said reset switch means provided said variable responsive means has returned to its normal condition.

18. In an annunciator circuit including an alarm light, a first set of terminals for selective connection to a set of normally-closed variable responsive signal contacts, and a source of alternating current for energizing said alarm light in response to opening of said normally-closed signal contacts, the improvement in a circuit connected between said first set of terminals and said alarm light comprising: a saturable magnetic device having a magnetic core with input and output windings on the core, the output winding being connected between said alarm light and said source of alternating current, a source of current for saturating continuously said core when fed to the input winding thereof, the impedance of the output winding when the core is saturated being sufficiently low that a relatively large current flows through the alarm light to light the same brightly and the impedance thereof when the core is unsaturated being relatively high to provide a substantially de-energized condition of the alarm light, a current-limiting resistor, means connecting said current-limiting resistor between said input winding and said source of saturating current, and means connecting said first set of terminals in series with said current-limiting resistor and in shunt with said input winding whereby saturating current is shunted around the input winding as long as the signal contacts are closed.

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